**Lok. Nr. 565-00072: Det tidligere Grindstedværket, 7200 Grindsted**

# Indsats overfor jordforurening

## Laboratorieforsøg til test af AOP metoder overfor forureningsfanen fra det tidligere Grindstedværkets fabriksgrund

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REGION SYDDANMARK

# Grindstedværkets fabriksgrund, valg af renseteknik til behandling af forurenet grundvandsfane

EVALUERINGSRAPPORT

| PROJEKTNR. | DOKUMENTNR. |
|---|---|
| A121940 | Endelig udgave |

| VERSION | UDGIVELSESDATO | BESKRIVELSE | UDARBEJDET | KONTROLLERET | GODKENDT |
|---|---|---|---|---|---|
| 2.0 | 27. oktober | Evaluering af laboratorieforsøg | JAD, Geosyntec, FLDX og TJR | KIRU | LNS |

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# 1 Indledning

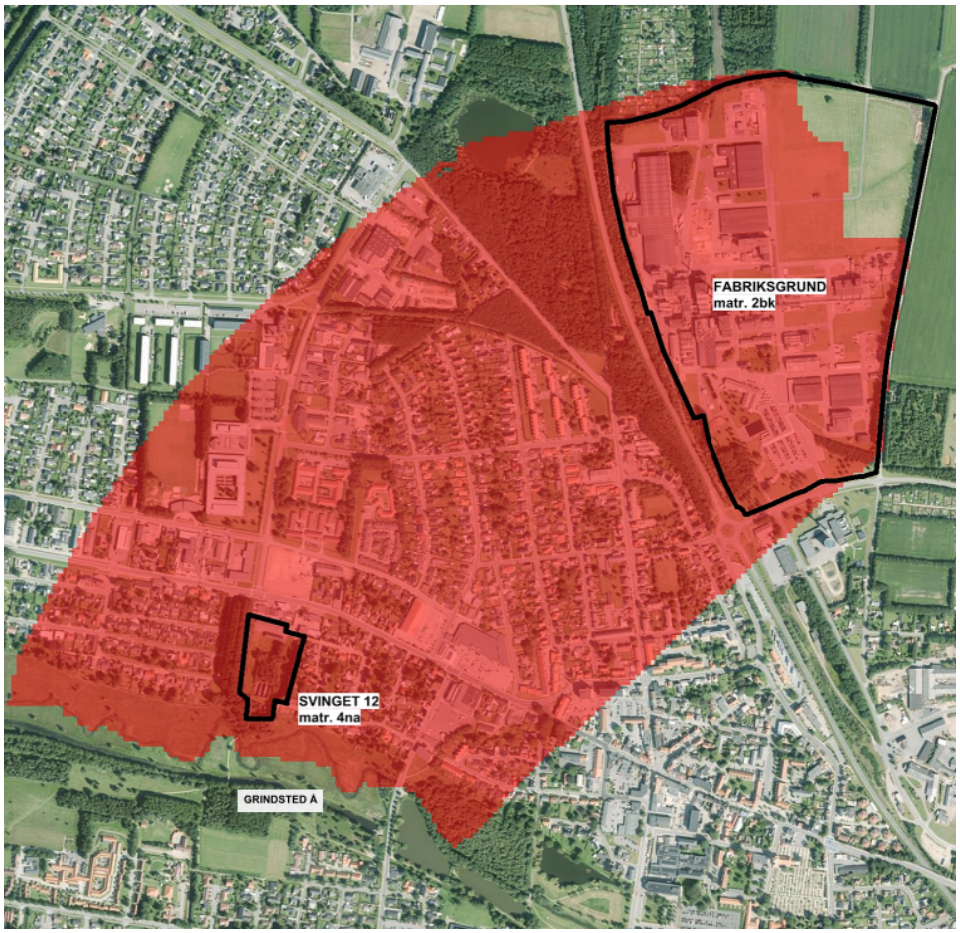
Baggrund

I/S Grindstedværket blev grundlagt i 1924, og der har gennem tiden været anvendt og opbevaret enorme mængder kemikalier på fabriksgrunden. Spild har medført en forurening af fabriksgrunden og grundvandet herunder.

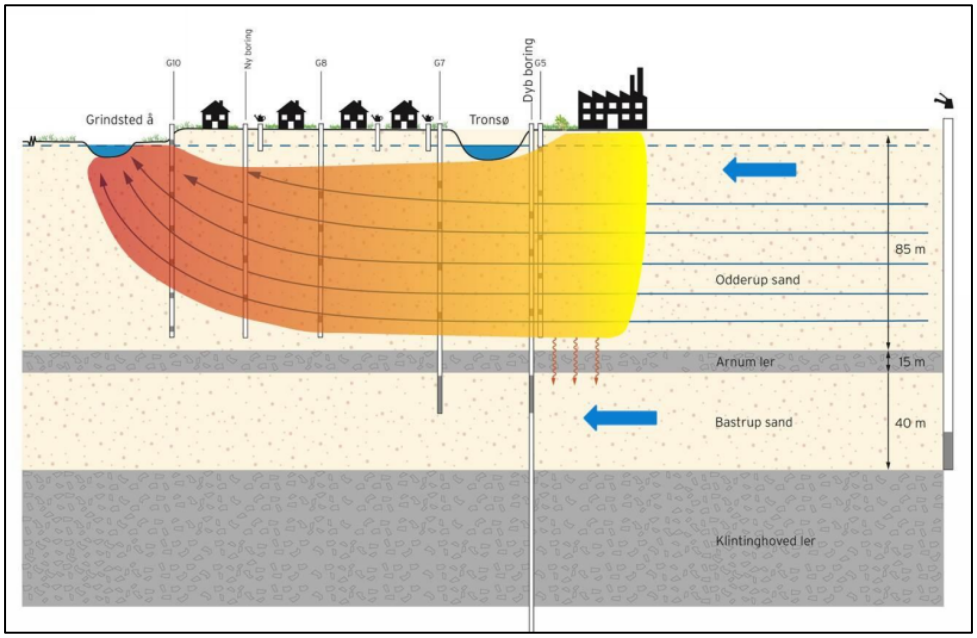
Det forurenede grundvand strømmer fra kildegrunden mod sydvest mod Grindsted Å. Undervejs når forureningen til en dybde af ca. 70 m under terræn, inden den stiger op mod terræn og strømmer ud i Grindsted Å.

En stor del af forureningen strømmer ud i åen nedstrøms tidl. Renseanlæg Vest, Svinget 12, 7200 Grindsted /3/.

Beliggenheden af fabriksgrunden og tidl. Renseanlæg Vest kan ses på Figur 1-1, mens en konceptuel model for forureningens spredning i grundvandet kan ses på Figur 1-2.




*Figur 1-1 Modelleret udbredelse af forureningsfanen i det øverste grundvand fra fabriksgrunden mod Grindsted Å.*




*Figur 1-2 Konceptuel model af forureningens spredning i grundvandet fra fabriksgrunden til Grindsted Å, fra /3/.*

Region Syddanmark har besluttet at igangsætte en udredning af mulighederne for at reducere påvirkningen af Grindsted Å. Helt konkret er det tanken at etablere et midlertidigt anlæg til oppumpning og rensning af grundvand på Renseanlæg Vest-grunden /2/.

Opgaven var oprindeligt opdelt i 4 faser:

- Fase 1 er udarbejdelsen af et afværgeprogram med beskrivelse og vurdering af mindst to løsningsmuligheder.
- Fase 2 er udarbejdelse af detailprojekt og udbudsmateriale for den valgte afværgeløsning, eventuelle supplerende undersøgelser og laboratorieforsøg samt indhentning af miljøtilladelser.
- Fase 3 omfatter tilsyn i forbindelse med etablering af det valgte afværgeanlæg samt opstart og indkøring af dette.
- Fase 4 omfatter første års drift af anlægget.

Resultat af fase 1

I afværgeprogrammet /2/ blev der gennemført en udredning af mulighederne for at etablere et midlertidigt anlæg til rensning af forurenet grundvand som strømmer ud i Grindsted Å. Der blev forudsat oppumpning af både drænvand og forurenet grundvand tæt på åen (i alt ca. 10 m³/time), hvor det forurenede vand renses i et overjordisk behandlingsanlæg.

Til at vurdere de mest kost effektive metoder til vandbehandling blev der udført en udvælgelsesproces som omfattede:

1. Indledende screening til identifikation af mulige afværgeløsninger.
2. Detaljeret screening med sammenligning af potentielt egnede afværgeløsninger.
3. Detaljeret analyse med en mere dybtgående vurdering af metoderne både teknisk og økonomisk.

På baggrund af denne udvælgelsesproces blev der udvalgt 4 løsninger som blev vurderet som de potentielt mest egnede. De fire løsninger omfatter alle avanceret vandrensning med AOP-reaktor (Avancerede OxidationsProcesser, AOP) – dvs. en kraftig iltning af forureningsstofferne, så de omdannes til uskadelige nedbrydningsprodukter (fx. kuldioxid og vand). De fire løsninger omfatter alle følgende procestrin:

1. Oppumpning af forurenet grundvand og drænvand som skal renses,
2. Forrensning gennem sandfilter for jern- og manganfjernelse.
3. AOP-behandling til nedbrydning af organiske miljøfremmede stoffer i en særlig AOP-reaktor. Der er foretaget detaljeret analyse af fire forskellige løsninger med AOP-processer:

3.1 Løsning A: $O_3$/Ozon

3.2 Løsning B: $O_3$/ Ozon + $H_2O_2$/brintperoxid

3.3 Løsning C: UV + $H_2O_2$/brintperoxid

3.4 Løsning D: Katalytisk $H_2O_2$ /brintperoxid

4 Efterfiltrering gennem kulfilter til fjernelse af rester af iltningsmidler og eventuelle restprodukter af miljøfremmede stoffer.

5 Bortskaffelse af renset vand enten til recipient, grundvandszonen eller spildevandssystem.

Forud for den endelige stillingtagen til hvilke(n) løsning(er) som er de(n) mest egnede, blev det foreslået at udføre laboratorieforsøg til vurdering af renseeffektivitet samt designparametre for fuldskalaløsning.

Denne rapport omhandler en del af fase 2 omfattende beskrivelse og rapportering af laboratorieforsøg med de 4 forskellige kommercielle oxidationsprocesser (Avancerede OxidationsProcesser, AOP) og tilhørende økotoksikologiske test på oppumpet grundvand fra boring DGU nr. 114.2567 (BE6) placeret på Renseanlæg Vest-grunden på adressen Svinget 12.

Krav og beskrivelser til laboratorieforsøgene blev formuleret i udbudsmaterialet /1/ og sendt i udbud. Det franske firma SUEZ vandt opgaven med tre af AOP-metoderne, det hollandske firma Water IQ en af metoderne og DHI stod for de økotoksikologiske tests.

Formål

Formålet med nærværende rapport er at beskrive og tolke resultaterne fra de udførte laboratorieforsøg og give anbefaling til hvilken metode, som vurderes at være den mest kosteffektive til rensning af det forurenede grundvand og drænvand.

De 4 testede rensemetoder inklusive efterbehandling med kul (GAC) er:

A: Ozon + GAC (SUEZ)

B: Ozon + $H_2O_2$, GAC (SUEZ)

C: UV + $H_2O_2$, GAC (SUEZ)

D: Forbehandling, katalytisk $H_2O_2$-filter, GAC (Water IQ)

DHI har udført økotoksikologiske test på een udvalgt prøve for hver testmetode efter kulrensning og på det ubehandlede råvand, svarende til i alt 5 prøver.

Formålet med test af rensningsgraden er at afklare hvilke(n) AOP-rensemetode der er bedst egnet til behandling af det forurenede grundvand med særlig fokus

på effektiviteten af rensningsgraden for chlorerede stoffer og Grindstedværkstofferne, som der ikke er så stor erfaring med hverken i Danmark eller udlandet.

Formålet med de økotoksikologiske tests er at vurdere økotoksiciteten af det behandlede vand fra AOP + GAC/kul med henblik på at vurdere mulighederne for at kunne udlede det rensede vand til Grindsted Å.

Testene skal anvendes som en støtte for beslutningen om valg af rensemetode for forurenet grundvand og skal anvendes ved kommunens behandling om tilladelse til udledning af renset vand. På baggrund af testresultaterne er det formålet at opdatere den metodebeskrivelse, som blev præsenteret i afværgeprogrammet /2/.

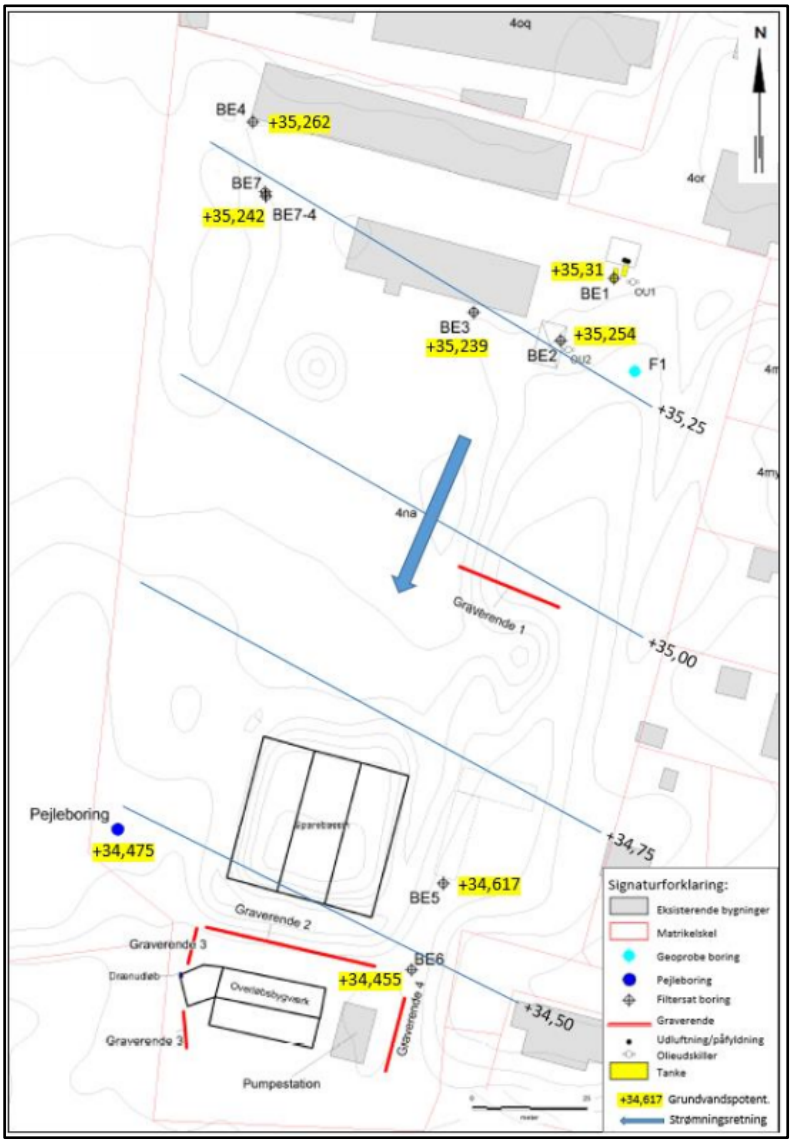
Udledningstilladelse og kravværdier

På nuværende tidspunkt foreligger der ikke en udledningstilladelse til Grindsted Å med krav for stoffer eller stofgrupper. Den 4. april 2019 har COWI og RSD afholdt et møde med Billund Vand og Billund Kommune omkring forventede krav til bortskaffelse af det rensede vand. Der blev ikke aftalt nogen eksakte værdier eller principper for fastlæggelse af kravværdier. Billund Vand og Billund Kommune forventede "meget lave kravværdier" for især vinylchlorid i en eventuel udledningstilladelse. For vinylchlorid er der en grænseværdi for overfladevand på 0,05 µg/l. For Grindstedværkstofferne er der generelt ikke eksisterende grænseværdier at gå ud fra bortset fra stoffet Sulfadiazin på 4,6 µg/l. Der sker en markant fortynding, hvis vandet ledes ud i åen. Spørgsmålet er hvordan fortyndingseffekten skal indregnes i fastlæggelse af kravværdier i en fremtidig udledningstilladelse. Det betyder, at der ikke på nuværende tidspunkt er grundlag for at vurdere, hvilken rensegrad, der er nødvendig for de enkelte stoffer eller stofgrupper før, der kan opnås en udledningstilladelse. I resultatvurderinger vil der derfor kun være en kvalitativ vurdering i forhold til en udledningstilladelse.

# 2 Oppumpning af repræsentativt vand til forsøg og organisering af prøveemballage

## 2.1 Oppumpning af grundvand

Repræsentativt for det vand som forventes at skulle renses i et fuldskalaanlæg, blev det af Regionen besluttet at anvende vand fra boring DGU nr. 114.2567 (BE6), hvis placering fremgår af Figur 2.1. Boringen ligger helt sydligt på grunden og ca. 65 m fra Grindsted Å. I Bilag A ses en detaljeret placering af boringer på Svinget 12 og analyseresultater fra andre boringer i området omkring det tidligere Renseanlæg Vest. Indledningsvis skal det nævnes, at tidligere analyser af grundvandet fra boringer i området ved det tidligere Renseanlæg Vest viser, at det ikke er de samme forureningsstoffer, der dominerer i alle boringer. Især for Grindstedværk-stofferne varierer indholdet – både mellem boringerne og over tid. Det var derfor ikke muligt at udtage grundvand til testene, der for alle stoffer fuldt ud afspejler forureningsfanen i området.




*Figur 2-1 Placering af boring DGU nr. 114.2567 (BE6) på Svinget 12.*

Boring DGU nr. 114.2567 (BE6) er forsynet med tre filtre i dybdeintervallerne 3-5 m u.t., 8-10 m u.t. og 13-15 m u.t. Vandet brugt til forsøgene er udtaget fra det midterste filter 8-10 m u.t., da dette filter klart har det højeste indhold af problemstofferne chlorerede komponenter og BTEX. Det højeste indhold af Grindstedværkstoffer er ikke fundet i det midterste filter, men i det dybeste filter hvor indholdet af Ethylcarbamat på 14 mg/l mod 5,7 mg/l i de mellemste filter gør den store forskel. Udtagningen af vand fra det midterste filter til testene er derfor et kompromis i forhold til forureningsindhold. I /3/ findes en oversigt over målte grundvandskoncentrationer i de tre forskellige filtre, samt boringens indretning.

Den 10. marts blev der oppumpet grundvand i 3 stk. 1000 liter plastpalletanke til henholdsvis SUEZ og Water IQ. Water IQ havde sendt en lastvogn med deres to palletanke (se Figur 2-2), som efter påfyldning blev kørt direkte til Holland. SUEZ's ene palletank blev afhentet senere og kørt til Zürich i Schweiz.

*Figur 2-2 Oppumpning af vand til Water IQ.*

Efter oppumpning af 0,8 m³ grundvand, som blev afledt til pumpestationens for rensning hos Billund Vand, blev der udtaget vandprøver til kemisk analyse hos laboratoriet ALS, så resultaterne af prøverne kunne danne udgangspunkt for forureningsgraden (baseline) inden laboratorietests (rensning) og dermed være sammenligningsgrundlag for alle testresultater. Desuden blev der udtaget en vandprøve, som blev sendt til økotoksikologisk test hos DHI. Prøverne blev udtaget af COWI A/S med en kombination af både MP1 grundvandspumpe og to mindre 12 v engangsdykpumper umiddelbart før opfyldningen af palletankene til forsøgene.

Da nogle af forsøgene udført af Water IQ måtte suppleres blev der udtaget yderligere 1 m³ vand den 6. april, som blev sendt med lastbil til Water IQ i Holland.

## 2.2 Prøveemballage ALS og DHI samt analyseprogram for råvand

Prøveemballage

Prøveemballage til analyse af råvand samt vandprøver fra hele programmet for forsøgene udført af Water IQ og SUEZ (i alt mere end 25 vandprøver med tilhørende analysepakker) blev udleveret til repræsentanter for SUEZ og Water IQ.

*Figur 2-3 Prøveemballage til SUEZ og Water IQ.*

Analyseprogram råvand

Fra DGU NR. 114.2567 (BE6) blev der udtaget vandprøver til følgende test:

- Økotoksikologisk test
- Dele af analysepakken "Hovedbestanddele (Boringskontrol)": $NH^{4+}$, Mn, Ca, Mg, K, Na, Fe, $NO_2$, $NO_3$, P, N, Cl, $SO_4$ $HCO_3$
- Kulbrinter og BTEX
- Chlorerede stoffer og deres nedbrydningsprodukter
- Metallerne: As, Pb, B, Cd, Cu, Ni og Zn
- Indampningsrest
- COD
- NVOC
- TOC
- Bromat
- Grindsted Pakke A med 36 forskellige Grindstedværkstoffer (barbiturater, sulfonamider m.m.)

## 2.3 Resultater for analyseret råvand

I Tabel 2-1 ses resultaterne for de kemiske analyser af råvandet udtaget den 11. marts fra DGU nr. 114.2567 (BE6). Resultaterne danner grundlag for sammenligning af alle andre resultater for de udførte laboratorieforsøg, hvilket betyder at resultaterne per definition er baseline for alle resultater uanset hvad SUEZ og Water IQ har udført af egne målinger før forsøgene. Analyserapporten fremgår af Bilag F.

*Tabel 2-1 Resultaterne for kemiske analyser af råvandet.*

| Komponent | Enhed | Koncentration |
|---|---|---|
| Ammonium+ammoniak, NH4+ | mg/l | 0,18 |
| Mangan, Mn | mg/l | 0,43 |
| Calcium, Ca++ | mg/l | 13 |
| Magnesium, Mg++ | mg/l | 5,9 |
| Kalium, K+ | mg/l | 1,1 |
| Natrium, Na+ | mg/l | 96 |
| Jern, $Fe^{++}$ | mg/l | 5,4 |
| Nitrit, NO2- | mg/l | <0,001 |
| Nitrat, NO3- | mg/l | 0,06 |
| TOC | mg/l | 4,9 |
| Total phosphor, P | mg/l | 0,014 |
| COD iltforbrug m. dichromat | mg/l | 16 |
| Total kvælstof, N | mg/l | 0,6 |
| Chlorid, Cl- | mg/l | 140 |
| Sulfat, SO4-- | mg/l | 32 |
| Hydrogencarbonat, HCO3- | mg/l | 71 |
| Aggressiv kuldioxid, CO2 | mg/l | 53 |
| Inddampningsrest | mg/l | 350 |
| NVOC, mgC/l | mg/l | 4,9 |
| Bromat | µg/l | <5,0 |
| Arsen, As | µg/l | 3,8 |
| Bly, Pb | µg/l | 0,12 |
| Bor, B | µg/l | <10 |

| Komponent | Enhed | Koncentration |
|---|---|---|
| Cadmium, Cd | µg/l | 0,0086 |
| Barium, Ba | µg/l | 160 |
| Chrom, Cr | µg/l | 0,51 |
| Kobber, Cu | µg/l | 0,8 |
| Nikkel, Ni | µg/l | 4,7 |
| Zink, Zn | µg/l | 12 |
| **BTEXN** | - | : |
| Benzen | µg/l | 520 |
| Toluen | µg/l | 5 |
| Ethylbenzen | µg/l | 0,64 |
| m/p-xylen | µg/l | 1,1 |
| o-xylen | µg/l | 1,2 |
| Xylener (o,-m- og p-xylen) | µg/l | 2,3 |
| Xylener (o,-m-, p-xylen og ethylben-zen) | µg/l | 2,9 |
| Naphtalen | µg/l | <0,020 |
| **Kulbrinter i vand, kulbrintefraktio-ner** | - | : |
| Kulbrinter n-C6 - n-C10 | µg/l | 270 |
| Kulbrinter >n-C10 - n-C15 | µg/l | <5,0 |
| Kulbrinter >n-C15 - n-C20 | µg/l | <5,0 |
| Kulbrinter >n-C20 - n-C35 | µg/l | <5,0 |
| Total kulbrinter (C6-C35) | µg/l | 270 |
| **Chlor. og nedbr.** | - | : |
| Trichlormethan (Chloroform) | µg/l | 0,3 |
| 1,1,1-trichlorethan | µg/l | <0,020 |
| Tetrachlormethan | µg/l | <0,020 |
| Trichlorethylen | µg/l | 22 |
| Tetrachlorethylen | µg/l | 48 |
| Chlorethan | µg/l | 35 |

| Komponent | Enhed | Koncentration |
|---|---|---|
| Vinylchlorid | µg/l | 7100 |
| 1,1-dichlorethylen | µg/l | 2 |
| trans-1,2-dichlorethylen | µg/l | 41 |
| cis-1,2-dichlorethylen | µg/l | 1400 |
| 1,2-dichlorethan | µg/l | <0,020 |
| 1,1-dichlorethan | µg/l | 0,27 |
| Dichlormethan | µg/l | <0,10 |
| Brom, Br Filt Felt | µg/l | 1460 |
| **Grindstedpakke A - Vand** | - | : |
| Acetylsulfaguanidin | µg/l | <0,10 |
| Acetylsulfanilsyre | µg/l | <0,10 |
| Aetallymal | µg/l | 2,5 |
| Allyl-n-butylbarbityrat | µg/l | 1,9 |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | µg/l | 9,2 |
| 5-allyl-5-(methylbutyl)-barbitursyre | µg/l | 12 |
| Barbital | µg/l | 15 |
| Butobarbital (N-butylethylbarbitur-syre) | µg/l | 23 |
| Butylbarbiturat | µg/l | 110 |
| 5,5-diallylbarbitursyre (Allobarbital) | µg/l | 230 |
| N-N-diethylnicotinamid | µg/l | 8,4 |
| Dipropenylamin | µg/l | 23 |
| 5-ethyl-5-sec-butylbarbitursyre (Bu-tabarbital) | µg/l | 19 |
| Ethylurethan | µg/l | 315 |
| Phtalylsulfathiazol | µg/l | <0,10 |
| Hexobarbital | µg/l | <0,10 |
| Isobutylbarbitursyre | µg/l | 150 |
| Isopropylbarbitursyre | µg/l | 86 |

| Komponent | Enhed | Koncentration |
|---|---|---|
| Meprobamat | µg/l | 61 |
| Methoxyproprionitril | µg/l | <0,10 |
| N-methyldiethylbarbitursyre (Metharbital) | µg/l | <0,10 |
| Monoethylbarbitursyre | µg/l | <0,10 |
| Pentobarbital | µg/l | 56 |
| Amobarbital | µg/l | 43 |
| Sulfanilamid | µg/l | 37 |
| Sulfaguanidine | µg/l | 0,5 |
| Sulfamethazin (Sulfadimidin) | µg/l | 110 |
| Sulfamethiazol | µg/l | 32 |
| Sulfadiazin | µg/l | 1,8 |
| Sulfanilsyre | µg/l | 65 |
| Sulfacetamid | µg/l | 200 |
| Sulfadoxin | µg/l | <0,050 |
| Sulfamerazin | µg/l | 9,1 |
| Sulfanilylurinstof | µg/l | 110 |
| Sulfapyridin | µg/l | <0,10 |
| Sulfathiazol | µg/l | 3,6 |

Af Tabel 2-1 ses det, at der er mange enkeltparametre at forholde sig til. I alt er der analyseret 91 parametre. I Tabel 2-2 er analyseresultaterne præsenteret for de organiske parametre inddelt i komponentgrupper og hvor stor en andel de udgør af det samlede påviste organiske indhold målt på µg/l.

*Tabel 2-2 Oversigt over organiske forbindelser i råvandet opdelt på stofgrupper*

| Komponent-gruppe | Koncentration (µg/l) | Andel af forureningsind-hold (%) |
|---|---|---|
| BTEX | 533 | 4,8 |
| Totalkulbrinter | 270 | 2,4 |
| Total chlorerede | 8649 | 78 |
| Total Grindsted-værk stoffer | 1673 | 15 |

| | | |
|---|---|---|
| **Samlet analyseret indhold** | **11125** | 100 |

Af Tabel 2-2 ses det, at det samlede påviste organiske indhold i råvandet er omkring 11,1 mg/l. BTEX udgør ca. 4,8 % mens indholdet af chlorerede stoffer står for ca. 78 % og Grindstedværkstofferne for ca. 15 %. BTEX-komponenterne består næsten udelukkende af benzen. Blandt de chlorerede stoffer er det klart vinylchlorid med 7,1 mg/l og cis 1,2-DCE med 1,4 mg/l, som udgør langt det meste. Blandt Grindstedværkstofferne er der større spredning blandt de 36 enkeltstoffer og i Tabel 2.3 ses de 6 mest dominerende komponenter og deres andel af de analyserede Grindstedværkstoffer.

*Tabel 2-3 Oversigt for de dominerende kemiske forbindelser blandt Grindstedværkstofferne.*

| Grindstedværk stof | Indhold (µg/l) | Andel Grindstedværk-stoffer (%) |
|---|---|---|
| Ethylurethan | 315 | 19 |
| 5,5-diallylbarbitursyre | 230 | 14 |
| Sulfacetamid | 200 | 12 |
| Isobutylbarbitusyre | 150 | 9 |
| Butylbarbiturat | 110 | 7 |
| Sulfadimidin | 110 | 7 |
| **Total** | **1115** | **67** |

Af Tabel 2-3 ses det, at ca. 2/3 af det samlede påviste indhold af Grindstedværk-stoffer udgøres af 6 ud af 36 komponenter, hvor stoffet ethylurethan (ethylcarbamat) er påvist i den højeste koncentration. Dette stof har været anvendt biomedicinsk indtil 1943, hvorefter man anså stoffet som potentielt kræftfremkaldende for mennesker. Stoffet anvendes stadig i dag som bedøvelsesmiddel i dyreforsøg grundet den langvarige effekt.

Med hensyn til indhold af uorganiske stoffer vurderes vandet som lettere anaerobt med et lavt nitratindhold, indhold af ammonium, et forhøjet jernindhold på 5,1 mg/l og et mindre manganindhold på 0,43 mg/l. Koncentrationerne af de 6 analyserede tungmetaller er alle meget lave og under kravene til overfladevand /5/.

Den overordnede vurdering af råvandet er, at der er et højt forureningsindhold af både BTEX, kulbrinter, chlorerede stoffer og Grindstedværk-stoffer, som gør vandet velegnet til de planlagte AOP-forsøg og dermed til vurdering af renseeffekten af de 4 forskellige AOP-metoder og kulforsøg af både råvand og efterpolering.

# 3 Udførte laboratorieforsøg

## 3.1 Generel beskrivelse og analyseprogram

Metoderne

I alt fire forskellige AOP-metoder er blevet undersøgt, og i Bilag B og Bilag C ses rapporterne fra henholdsvis Water IQ og SUEZ med en detaljeret beskrivelse af hvordan forsøgene er blevet udført. De tre metoder med henholdsvis $O_3$, $O_3$+$H_2O_2$ og UV+$H_2O_2$ er tre velkendte metoder til vandrensning, mens den katalytiske metode sammen med $H_2O_2$ er patenteret og kun kan leveres af firmaet Water IQ Eindhoven i Holland (Water IQ).

Forbehandling

Der har været fokus på om særlig forbehandling af vandet med fjernelse af især jern inden udførelse af selve forsøgene ville være nødvendigt. Water IQ har som en del af deres standardanlæg indbygget et særligt forfilter, der kan fjerne partikler og visse positive ioner (f.eks. jern og mangan) før den katalytiske proces. COWI har dog i samråd med Water IQ vedtaget, at vandet forbehandles i et sandfilter, hvor der oxideres med $H_2O_2$/brintperoxid. Omkostningerne til filteret er med i de økonomiske beregninger udført for metoden i kapitel 5. SUEZ havde i deres tilbud lagt en betingelse om jernfjernelse hvis, jernindhold i råvandet var over 5 mg/l. Da vandprøver udtaget fra filteret i DGU NR. 114.2567 (BE6) senest i oktober 2016 og af SUEZ selv i februar 2020 viste jernindhold omkring 2,5 mg/l blev det besluttet at udføre alle tre SUEZ-forsøg uden forbehandling af vandet. Under selve vandopfyldningen af tanke til forsøg, blev jernkoncentrationen løbende målt med testkit og målingerne viste her ikke højere koncentrationer end 3,4 mg/l. Analysen af råvandet viste dog et jernindhold på 5,4 mg/l, men forsøgene er udført uden nogen særskilt forbehandling først. Da resultatet for jernindholdet forelå vurderede SUEZ at de kunne gennemføre forsøgene uden forbehandling.

Forsøgsstrategi

Som udgangspunkt skulle der udføres tre typer af forsøg med forskellige doseringer af henholdsvis $O_3$ (ozon) og $H_2O_2$ (brintperoxid) (metode A og B) og $H_2O_2$ (metode C og D) for hver metode nemlig en beregnet optimal dosering, en underdosering og en klar overdosering. Denne forsøgsstrategi blev gennemført for forsøgene med $O_3$, $O_3$+$H_2O_2$ og UV+$H_2O_2$, men for den katalytiske metode viste det sig under forsøgene, at der var flere variable end kun $H_2O_2$ dosering. Da der både var variation i opholdstid i katalysatoren og tilsætning med jernsalt blev

det besluttet at gennemføre to nye forsøg. Der blev dog som planlagt genereret tre forsøg, der kunne betragtes som optimal dosering, underdosering og overdosering.

Kulrensning

Alle 12 prøver fra AOP-forsøgene samt råvandet blev behandlet med kul af SUEZ, for at afdække renseeffekten i et kulfilter. Der var tale om tilsætning af pulveriseret aktivt kul (PAC) og ikke et egentligt kulfilter, som i et fuldskalaanlæg, da PAC er mere velegnet til de batchforsøg, der blev foretaget. Det urensede vand (råvandet) fra boring DGU NR. 114.2567 (BE6) blev også behandlet med PAC af SUEZ, for at se hvor meget et kulfilter alene vil kunne rense på vandet.

Analyseprogram AOP

I nedenstående Tabel 3-1 ses en oversigt med det kemiske analyseprogram for de genererede prøver ved testene. Analyserne er udført af analyselaboratoriet ALS Danmark. Alle resultater ses i et samlet skema i Bilag E og samtlige analyserapporter for prøverne findes i Bilag F. Analyseprogrammet er nøje udvalgt i forhold til at kunne få et solidt grundlag for, hvordan metoderne har virket, deres effektivitet og eventuelle sideeffekter. Ud over de kemiske analyser hos ALS Danmark har SUEZ og Water IQ selv udført en lange række målinger under forsøgene og fået foretaget kemiske analyser på lokale laboratorier i Holland og Schweiz. Disse målinger fremgår af testrapporterne i Bilag B og Bilag C. Metode A, B og C er udført af SUEZ og D af Water IQ.

*Tabel 3-1 Oversigt over prøver og kemiske analyser.*

| Test beskrivelse | Prøvenavn | Kemiske analyser som udføres af ALS | | | | |
|---|---|---|---|---|---|---|
| | | Br + BrO3 | Metal | Uorganisk pakke | VOC + TPH, BTEXN * | Grindsted pharma pakke |
| PAC råvand | Baselin Grindsted | x | x | x | x | x |
| **A: Ozon** | | | | | | |
| Test 1-O3 dose1- Optimal | TA6-SF | x | x | x | x | x |
| Test 2-O3 dose2-Høj | TA7-SF | x | x | x | x | x |
| Test 3-O3 dose3-lav | TA8-Sf | x | x | x | x | x |
| 3 PAC tests | PAC-A6, A7 og A8 | | | | xxx | xxx |
| **B: Ozon+H2O2** | | | | | | |
| Test 1-O3/H2O2-Optimal | Test B1 | x | x | x | x | x |
| Test 2-O3/H2O2-Høj | Test B2 | x | x | x | x | x |
| Test 3-O3/H2O2-lav | Test B3 | x | x | x | x | x |
| 3 PAC tests | PAC-B1, B2 og B3 | | | | xxx | xxx |
| **C: UV+H2O2** | | | | | | |
| Test 1-H2O2-Optimal | TC6-SF | | x | x | x | x |
| Test 2-H2O2-Høj | TC7-SF | | x | x | x | x |
| Test 3-H2O2-lav | TC8-SF | | x | x | x | x |
| 3 PAC tests | PAC-C6, C7 og C8 | | | | xxx | xxx |
| **D: Katalystisk+H2O2** | | | | | | |
| Test 1-H2O2-Optimal | Run E | | x | x | x | x |
| Test 2-H2O2-Høj | Run B | | x | x | x | x |
| Test 3-H2O2-lav | Run F | | x | x | x | x |
| 3 PAC tests | PAC-E, B og F | | | | xxx | xxx |
| Total antal analyser | | 7 | 13 | 13 | 25 | 25 |

Økotoxtest

Til afdækning af eventuelle kortvarige økotoksikologiske effekter fra urenset og renset vand er der udført korttidstest med to arter af ferskvandsorganismer,

hhv. en grønalge og et krebsdyr. Begge er velkendte og anbefalede arter til den slags test i laboratoriet. De anvendte metoder er ligeledes begge internationalt accepterede standardmetoder (OECD-metoder). DHI har udarbejdet en rapport, som beskriver deres testarbejde og resultaterne af testene, som findes i Bilag D.

## 3.2 Ozon

Ved forsøgene med ozon blev anvendt en kolonne med vand, hvori der blev doseret ozonholdig gas i bunden. Vandet blev cirkuleret gennem kolonnen over et reservoir for at opnå en god opblanding. Det meste ozon optages i vandet under forsøget, hvor det udnyttes til at oxidere organiske stoffer. I toppen af kolonnen udledes gas til atmosfæren. Der vil stadigvæk være et lille restindhold af ozon i gassen, men der vil også kunne forekomme flygtige organiske forbindelser, der strippes fra vandet.

Der blev først lavet et blindforsøg, hvor man undersøgte i hvor høj grad de flygtige komponenter blev strippet af vandet. Dernæst lavede man et andet blindforsøg, hvor man undersøgte halveringstiden for ozonnedbrydningen i demineraliseret vand. Endelig udførte man nogle screeningstests, hvor man undersøgte hvor stor en del af den doserede ozon, der blev anvendt til at oxidere de organiske stoffer i det forurenede grundvand ved forskellige ozondoseringer. Ved screeningstesten blev det samtidig undersøgt, hvor stor omsætning af organisk stof, der blev opnået med forskellige doseringer.

Efter de indledende forsøg blev der gennemført tre endelige forsøg med forskellige ozon doseringer fastlagt på grundlag af screeningstesten, som det fremgår af Tabel 3-2

*Tabel 3-2 Oversigt over ozondosering i de tre endelige forsøg med ozon.*

| Prøve | Type | Ozondosering, mg/l |
|---|---|---|
| TA6 | Optimal dose | 13,1 |
| TA7 | Høj dose | 22,6 |
| TA8 | Lav dose | 7,6 |

Den optimale dosering blev valgt som den højeste dosering af ozon, som ikke gav dannelse af bromat i koncentrationer over 10 µg/l, som er grænseværdien i drikkevand. Der findes ikke grænseværdier for bromat i overfladevand. Den høje dosering var markant højere, og den lave dosering var tilsvarende markant lavere end den optimale. Det rensede vand fra de tre forsøg er efterfølgende renset med aktivt kul (PAC).

## 3.3 Ozon + $H_2O_2$

Forsøgsopstillingen er den samme, som blev anvendt til ozonforsøget, men der er yderligere et doseringssystem for $H_2O_2$. Risikoen for stripning af flygtige komponenter er også til stede med denne teknik, fordi der doseres ozon. Først gennemførtes to blindforsøg med demineraliseret vand, hvor der løbende blev tilsat ozon. Endvidere tilsættes en støkiometrisk mængde $H_2O_2$, og ved løbende at måle koncentrationen af $H_2O_2$ får man et mål for, hvor meget $H_2O_2$, der forsvinder. Denne mængde sættes lig med dannelsen af hydroxylradikaler.

Der blev herefter gennemført 3 screeningstest med forurenet grundvand for at finde frem til de optimale doseringer for henholdsvis ozon og brintperoxid. Også pH blev undersøgt ved screeningsforsøgene.

Efter de indledende undersøgelser blev der gennemført tre endelige forsøg, som det fremgår af Tabel 3-3.

*Tabel 3-3 Oversigt over doseringer i de tre endelige forsøg med ozon + $H_2O_2$,*

| Prøve | Type | Ozon $O_3$, mg/l | Brintperoxid $H_2O_2$, mg/l |
|---|---|---|---|
| TB6 | Optimal | 11,9 | 2,0 |
| TB7 | Høj | 22,9 | 4,1 |
| TB8 | Lav | 5,8 | 1,2 |

Som ved ozonforsøget blev den optimale ozonkoncentration valgt som den højeste, der kunne anvendes uden problematisk bromatdannelse. Den tilsvarende koncentration af $H_2O_2$ blev valgt 5-6 gange lavere. Begge doseringer er betydelig højere i høj-forsøget og betydelig lavere i lav-forsøget. Prøver af renset vand fra de tre forsøg er efterfølgende renset med aktivt kul (PAC).

## 3.4 UV + $H_2O_2$

Forsøgsanlægget bestod af et rør med 4 UV-lamper á 135W. Der var tilsluttet en cirkulationspumpe for at skabe bevægelse og opblanding i vandet. Vandmængden var på ca. 25 liter, hvoraf 2 liter var i cirkulationskredsløbet, mens 23 liter var i reaktoren, hvor der blev tilført UV-lys fra en eller flere af de 4 lamper. El-input til de enkelte lamper kunne formindskes, således at UV-doseringen til vandet blev reduceret tilsvarende.

UV-dosen i vandet aftager med afstanden fra lampeglasset samt UV-transmittansen (UV-T). Ved forsøgene observerede man, at UV-T var ret lav i starten af forsøgene, men i takt med, at flere organiske forbindelser blev nedbrudt, så steg UV-T betydeligt. Rensegraden for et anlæg med en given UV-effekt er derfor ikke en fast størrelse, da den er meget afhængig af, om vandet er tæt på UV-lampen, samt af det organiske indhold i vandet. Den er med andre ord meget afhængig af anlæggets udformning og vandkvaliteten.

Suez har lavet en beregningsmodel, så de kan angive den gennemsnitlige UV-dose i hvert forsøg. Denne størrelse sammen med data om UV-T kan en leverandør af UV-anlæg bruge til at beregne, hvilken renseeffekt der kan opnås med et af leverandørens egne anlæg, hvor UV-input og "vandtykkelsen" i reaktoren er kendt.

UV-input i vandet vil også være afhængig af, om lampeglasset er rent. Efterhånden dannes der belægninger på lampeglasset, og derfor er det vigtigt, at man har et system, der løbende kan rense lampeglasset, så man får størst mulig UV-input i vandet i forhold til el-input på lamperne.

Der blev først gennemført 3 blindforsøg med "syntetisk" grundvand – dvs. en vandblanding med de hovedkomponenter af salte, der findes i forureningsfanen fra det tidligere Grindstedværket. Her afprøvede man to forskellige doseringer af $H_2O_2$ og to forskellige UV-doser, og man fandt, at reduktionen af $H_2O_2$ var proportional med UV-dosen. Da fald i $H_2O_2$ svarer til dannelsen af hydroxylradikaler, betyder det, at dannelsen af hydroxylradikaler er proportional med UV-dosen.

Der blev herefter gennemført tre screeningsforsøg med det forurenede grundvand, hvor omsætningen af organisk stof blev undersøgt som funktion af UV-dosering og dosering af $H_2O_2$. Restkoncentrationen af organisk stof kunne med fordel måles som UV-absorptionen ved 254 nm. Måling af COD gav ikke samme brugbare resultat.

Ud fra erfaringerne fra blindforsøg og screeningsforsøg blev der herefter lavet de tre endelige forsøg. Forsøgsdata fremgår af Tabel 3-4.

*Tabel 3-4 Oversigt over doseringer i de tre endelige forsøg med UV + $H_2O_2$.*

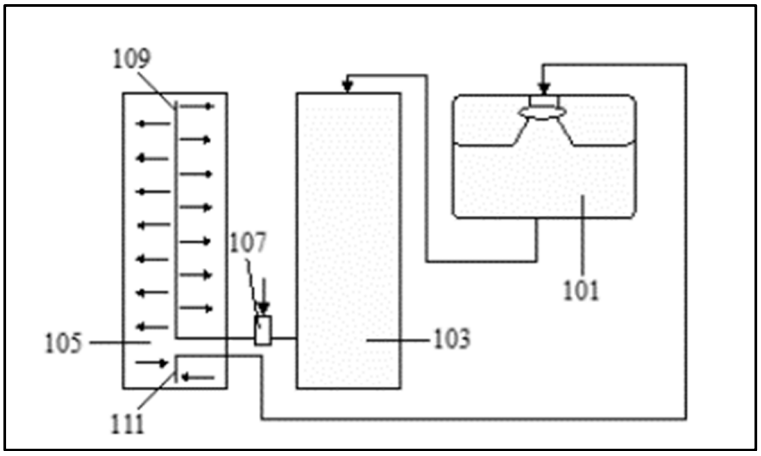
| Prøve | Type | $H_2O_2$, mg/l | UV-dose, mJ/cm$^2$ | El-input, W |
|---|---|---|---|---|
| TC6 | Optimal | 19,6 | 5211 | 135 |
| TC7 | Overdosering | 30,4 | 6367 | 135 |
| TC8 | Underdosering | 17,9 | 2289 | 67,5 |

Ud fra de indledende screeningsforsøg er de optimale UV-doser og $H_2O_2$-dosering beregnet og valgt. Specielt er UV-dosen vigtig, da det er den, som generer hydroxylradikaler ud fra $H_2O_2$. UV-dosen afhænger både af el-input, opholdstiden og UV-T. Ved overdosering er både UV-dosen og dosering af $H_2O_2$ forøget, og ved underdosering er begge formindsket. Prøver af renset vand fra alle tre forsøg er efterfølgende renset med aktivt kul (PAC).

## 3.5 Faststof katalysator + $H_2O_2$

Denne specielle patenterede metode er skematisk vist i Figur 3-1.

Vandet fra tanken (101) ledes igennem et forfilter (103) med keramisk materiale, som har til formål at fjerne fysiske urenheder og positivt ladede stoffer i vandet. Efter forfiltret tilsættes vandet ved (107) $H_2O_2$ og ioniseret ilt samt eventuelt katalysatoropløsning og ledes derefter ind i det katalytiske reaktionskammer (105) gennem et særligt injektionsrør (109) og særligt drænrør (111). I reaktionskammeret dannes hydroxyl radikaler, som oxiderer de organiske forbindelser.




*Figur 3-1 Principskitse for Water IQ rensemetode.*

Oprindeligt var forsøgene tænkt med variable indhold af $H_2O_2$ med optimal dosering, overdosering og underdosering. Men efter de første forsøg (A, B, C og D) var blevet udført stod det klart, at det var relevant at inddrage yderlige to parametre – nemlig opholdstiden i reaktionskammeret, og om der var tilsat en jernkatalysator eller ej. Resultater fra test C og D kunne ikke anvendes, da disse forsøg var kørt anderledes end planlagt, og resultaterne var misvisende. Det viste sig også, at tilsætningen af katalysatoropløsning gav en meget højt indhold af Fe i vandet i prøverne B, C og D, hvilket ikke blev vurderet hensigtsmæssig i forhold til en forventet efterpolering med kul.

Derfor blev det besluttet at udføre to nye tests (E og F) uden anvendelse af flydende katalysator men med fast $H_2O_2$ koncentration og variabel opholdstid. Da al vandet var blevet brugt til den første forsøgsrunde, måtte der udtages yderlige 1 m³ vand fra boring DGU NR. 114.2567 (BE6), som blev transporteret til Holland sammen med ny prøveemballage til de kemiske analyser. I Tabel 3-5 ses en oversigt over de 6 forsøg og forsøgsbetingelserne

*Tabel 3-5 Oversigt over forsøg og prøver udført af Water IQ.*

| Prøve | Type | Opholdstid (min) | Dosering: $H_2O_2$ mg/l) | Katalysator (jernsalt) |
|---|---|---|---|---|
| Run A | Efter forfilter | 0 | 0 | Nej |
| Run B | Overdosering | 7,5 | 825 | Ja |
| Run C | Fuld rensning | 5 | 825 | Ja |
| Run D | Fuld rensning | 5 | 825 | Ja |

| | | | | |
|---|---|---|---|---|
| Run E | Underdosering | 10 | 100 | Nej |
| Run F | Optimal dosering | 20 | 100 | Nej |

Efter udførelse af forsøgene blev det besluttet at lade Run B gå videre til PAC forsøg som overdoseringsprøven, Run E til PAC forsøg som underdosering og Run F til PAC forsøg som optimal dosering. Årsagen til at betragte Run F som optimal dosering skyldes, at opholdstiden på 20 minutter ligner den opholdstid, som man forventelig ville anvende på et fuldskala-anlæg.

## 3.6 Økotoksikologiske tests

Til bestemmelse af det rensede grundvands giftighed i forhold til levende organismer er der udført korttidstest med to arter af ferskvandsorganismer, hhv. en grønalge (Raphidocelis subcapitata) og et krebsdyr (Daphne magna). Begge er velkendte og anbefalede arter til den slags test i laboratoriet. De anvendte metoder er ligeledes begge internationalt accepterede standardmetoder (OECD-metoder).

Følgende prøver er blevet testet for påvirkning af grønalge og krebsdyr af DHI og deres rapport ses i Bilag D:

- Ubehandlet råvand fra DGU NR. 114.2567 (BE6)
- PAC-A6-SF (optimum ren ozon og PAC)
- PAC-B6-SF (optimum ozon+$H_2O_2$ og PAC)
- PAC-C6-SF (optimum UV+$H_2O_2$ og PAC)
- PAC-F-SF (optimum katalytisk+$H_2O_2$ og PAC)

Af hensyn til tidsplanen var det på forhånd besluttet, at de beregnede optimumprøver skulle udvælges til økotoksikologisk test, før de kemiske analyseresultater var kendt og dermed før den opnåede renseeffekt var kendt.

Testene foregår ved at bestemme ved hvilken fortyndningsgrad/koncentration der ses en væksthæmmende effekt på henholdsvis 10 % og 50 % af organismerne. Det betyder, at jo lavere koncentration der giver en væksthæmning jo kraftigere påvirkes testorganismerne.

Testene foregår over en måned, og det er derfor kun relative korttidseffekter, som bliver afdækket i testen. Langtidseffekter som f.eks. kræftudvikling eller akkumulerende effekter, som f.eks. påvirkning af organismernes nervesystem afdækkes ikke ved testene. I Bilag D ses rapporten fra DHI, som beskriver anvendte testmetoder og resultater.

# 4 Resultat og vurdering af laboratorieforsøg

I de følgende afsnit præsenteres og kommenteres resultaterne fra de gennemførte forsøg. For overskuelighedens skyld, har vi samlet de forskellige kemiske forbindelser i fire komponentgrupper, da renseeffekten er nogenlunde den samme for kemiske forbindelser, der ligner hinanden rent kemisk. Det gælder ikke for Grinstedværkstofferne, som indeholder mange kemiske forbindelser, der ikke ligner hinanden. For Grindstedværkstofferne bliver man således nødt til at se nærmere på, hvordan de specifikke stoffer fjernes ved renseprocessen.

Opdeling i organiske stofgrupper, som der er analyseret for:

- Chlorerede opløsningsmidler
- BTEX
- Total kulbrinter
- Grindstedværkstoffer
- Sum af organiske stoffer

I Bilag E ses en samlet oversigt med alle resultater af de kemiske analyser.

Det skal nævnes, at der er udtaget een råvandsprøve, som benævnes baseline. Prøven er udtaget den 11. marts, samtidig med der blev udtaget testvand til Suez og Water IQ. Råvandsprøven er straks sendt til analyse hos ALS, og resultaterne af denne prøve betragtes som udgangspunkt for alle AOP-forsøgene, selv om vi udmærket er klar over, at der kan forsvinde især flygtige komponenter, når prøverne håndteres ved renseforsøgene hos Suez og Water IQ. COWI vurderer, at det ikke har den store betydning for, hvor stor restkoncentration, der opnås for de dominerende flygtige komponenter, vinylchlorid og cis-DCE. Erfaringen viser, at hvis man med en given rensemetode kan reducere indholdet af et givet stof med en given procent, så vil restkoncentrationen af stoffet ikke blive dramatisk lavere, hvis startkoncentrationen f.eks. kun er det halve.

## 4.1 Underleverandørernes arbejde

COWI har koordineret arbejdet med de tre underleverandører - Suez, Water IQ og DHI samt med analyselaboratoriet ALS Denmark. Der har været en betydelig mailkorrespondance samt adskillige Skypemøder, hvor foreløbige resultater er præsenteret og diskuteret, og det videre arbejde er aftalt. COWI vurderer, at de tre underleverandører har løst den aftalte opgave, selv om vi efterfølgende kan se, at enkelte forhold som nok burde være udført lidt anderledes, fordi man fik nogle erfaringer, som først blev synliggjort efter, at forsøgene var udført, og alle analyseresultater var tilgængelige.

Suez

Suez har haft en meget systematisk tilgang til forsøgene, hvor de har præsenteret nogle gode oplæg til Skypemøderne, så det kunne besluttes, hvordan de følgende forsøg skulle udføres. Suez har også præsenteret en god orienterende målemetode, så man i løbet af forsøgene kunne vurdere effekten af de forskellige behandlingstrin. Det viste sig nemlig, at TOC og COD mod forventning ikke var særlig anvendelig hertil, fordi disse parametre ikke ændrede sig ret meget undervejs. Derimod kunne man med en spektrofotometrisk UV-målemetode (254 nm) tydeligt følge omdannelsen/nedbrydningen af de organiske stoffer, der fandt sted under oxidationsprocessen.

Ved UV-forsøgene blev der ikke diskuteret og kommunikeret undervejs, og set i bakspejlet kan man se, at der burde have været lavet forsøg med en større UV-dosering, da alt tyder på, at man kunne have få destrueret mere organisk materiale med en større UV-dosering. Suez havde et meget specielt UV-anlæg med 4 lamper, hvoraf man kunne benytte en eller flere med fuld styrke eller nedsat effekt. Suez havde udviklet et beregningsprogram, så de kunne beregne den UV-dose, som vandet har fået i gennemsnit. Til gengæld var det ikke muligt at se, hvor meget elektricitet, der var benyttet ved de enkelte forsøg. El-forbruget vil være meget afhængigt af vandets sammensætning og transmittans samt anlæggets udformning og effektiviteten af de anvendte UV-lamper.

COWI har haft en del mailkorrespondance med Suez også efter levering af deres rapport for at afklare de nærmere forsøgsomstændigheder og beregninger af UV-doseringen. Disse oplysninger fik vi efterfølgende bearbejdet af det danske firma UltraAqua, som herefter kunne beregne anlægsstørrelse og renseeffektivitet for et fuldskala-anlæg. UltraAqua kunne ud fra Suez-målinger af vandets transmittans og deres eget beregningsværktøj beregne den forventede renseeffekt for vinylchlorid, cis-DCE og benzen. Beregningsresultatet lå i øvrigt tæt ved de forsøgsresultater, som Suez havde opnået med deres lampestyrke, hvilket indicerer, at beregningsværkstøjet er brugbart til beregning af nedbrydning af de tre stoffer ved forskellig dosering af UV og $H_2O_2$ og dermed metodens potentiale.

Mail- korrespondancen med Suez omfatter blandt andet:

- Detaljeret beskrivelse af UV forsøgsanlægget
- Hvilke beregningsprincipper har Suez anvendt til beregning af UV-dosering

- Hvordan har Suez målt transmittans ved forsøgene. Transmittansen er afgørende for beregning af UV-dosen

- Spørgsmål om udlevering af detaljerede beregninger af omkostninger ved de forskellige AOP-metoder

Det er COWIs vurdering, at der sandsynligvis kunne være anvendt mere PAC ved de afsluttende renseforsøg med aktivt kul, som blev lavet hos Suez. Formålet var at finde ud af, om restprodukterne fra AOP-rensningen overhovedet kunne fjernes med aktivt kul. Det var ikke planlagt, at man skulle bestemme kullenes kapacitet ved disse forsøg.

Slutrapporten fra Suez blev afleveret med en lille uges forsinkelse i forhold til planerne, hvilket bl.a. skyldes forsinkelser p.g.a. corona situationen. Rapporten indeholder en del anbefalinger og økonomiske beregninger for renseomkostninger, som ikke var en del af udbudsmateriale. Dette arbejde er noteret, men ikke nødvendigvis anvendt som grundlag for COWIs vurderinger.

Water IQ

Forsøgsplanen blev diskuteret og aftalt. Skriftlig procedure (udarbejdet af Suez) for fjernelse af $H_2O_2$ overskud blev fremsendt til Water IQ, og forsøgene blev sat i gang medio marts. Da Water IQ havde udført de første 4 forsøg (A, B, C og D) modtog COWI en foreløbig rapport (23.03.2020), som gav anledning til en nøjere drøftelse af de gennemførte forsøg. I forsøg A havde man helt som planlagt undersøgt effekten af forfilteret. I forsøg B havde man doseret alt for meget $H_2O_2$ og opholdstiden var kun det halve af den normale opholdstid i et fuldskalaanlæg, og så var der tilsat en flydende katalysator, som vi ikke var bekendt med. I forsøg C og D behandlede man vandet to gange for at opnå længere opholdstid, og der blev stadigvæk overdoseret med $H_2O_2$. På grund af stor tilsætning af jernsalt i C og D blev der dannet meget jernslam, og et sandfilter blev tilføjet til efterfiltrering. Der var tilsyneladende en kontaminering af vandet i forsøg C og D, så disse prøver kunne af flere forskellige grunde ikke anvendes, da de ikke levede op til, det vi havde beskrevet i udbudsmaterialet.

Det blev herefter aftalt, at der skulle køres to nye forsøg med længere opholdstid og mindre dosering af $H_2O_2$ og der skulle ikke benyttes flydende katalysator. Forsøgene blev uden diskussion straks gennemført, og vi fik den 21.04.2010 de foreløbige resultater, som var blevet lavet på et hollandsk laboratorium. Resultaterne så troværdige ud, og det blev aftalt, at der skulle sendes prøver af renset vand til både ALS (kemisk analyse) og til Suez (PAC-forsøg). Water IQ fik ved alle forsøg udført hurtige analyser hos et hollandsk laboratorium, så man straks kunne se, hvor effektiv rensningen var for chlorerede opløsningsmidler, BTEX og kulbrinter.

Water IQ konserverede prøverne korrekt og fjernede forskriftsmæssigt overskud af $H_2O_2$, før de blev sendt til kemisk analyse hos ALS. Desværre blev overskud af $H_2O_2$ ikke fjernet i de prøver, som blev sendt videre til Suez, hvor der skulle udføres forsøg med efterrensning med PAC. Det har dog ingen betydning for den endelige vurdering af PAC-rensningen på prøverne fra Water IQ, da koncentrationen af alle stoffer efter AOP var ekstrem lav, hvilket er hovedårsagen til det meget gode renseresultat med PAC.

Efter modtagelse af den endelige forsøgsrapport fra Water IQ har COWI stillet en række spørgsmål på mail til brug for den endelige rapportering. Water IQ har svaret meget hurtigt og fyldestgørende på disse mails.

Spørgsmålene omfatter blandt andet:

- Behov for ekstra forfiltrering ud over det keramiske filter i anlægget
- Årsag til pH-stigning i forsøg E og F
- Anbefalet opholdstid i et fuldskalaanlæg til rensning af 10 $m^3/h$
- Overslagspris på et fuldskala-anlæg til rensning af forurenet grundvand fra det tidligere Grindstedværket.
- Specifikation over forbrug af el og vand samt driftsudgifter for det beskrevne fuldskala-anlæg.
- Fremstilling af ioniseret ilt
- Dosering af flydende katalysator
- Forventet holdbarhed af den katalytiske coatning samt filtercoatningen
- Forslag til servicekontrakt – herunder fjernovervågning af fuldskala-anlæg
- Leveringstid på et fuldskala-anlæg
- Forventet dosering af $H_2O_2$

DHI

Da den anvendte metode til de økotoksikologiske test er standardiseret, har det ikke været nødvendigt at skulle tage stilling til forhold, som har haft betydning for testene i forløbet. Det vurderes, at DHI har udført deres arbejde som aftalt og i henhold til udbudsmaterialet. Deres rapport er også vurderet fyldestgørende for dokumentation for det udførte arbejde. DHI har deltaget i en del af koordineringsmøderne af hensyn til timing for, hvornår de ville få vandprøverne til testene.

## 4.2 Effekt af kulfiltrering på urenset råvand

I Tabel 4-1 ses resultaterne fra kulforsøget på det urensede råvand fordelt på komponentgrupperne chlorerede forbindelser, BTEX, total kulbrinter og Grindstedværkstoffer.

*Tabel 4-1 Resultater af kulforsøg på råvandet.*

| Komponenter | Baseline (µg/l) | Restkoncentration (µg/l) | Rensegrad (%) | Dominant |
|---|---|---|---|---|
| Chlorerede forbindelser | 8648 | 257 | 97,0 | Vinylchlorid |
| BTEX | 533 | 3,12 | 99,4 | Benzen |
| Totalkulbrinter | 270 | <5 | 100 | Ingen |
| Grindstedværkstoffer | 1673 | 209 | 87,5 | Ethylurethan |
| Sum af org. stof | 11125 | 466 | 96 | |

Af Tabel 4-1 ses det, at der med kulbehandling alene sker en markant reduktion af forureningsindholdet for både Grindstedværkstoffer, chlorerede forbindelser, BTEX og kulbrinter. Den samlede rensegrad er omkring 96 % og restindholdet på 466 µg/l domineres af de tre komponenter vinylchlorid, benzen og ethylurethan. Det er også disse stoffer der er dominerende i det urensede vand. Rensegraden er størst for totalkulbrinter og BTEX og mindst for Grindstedværkstofferne. Der kan derfor forventes en god effekt med efterbehandling i et kulfilter i et fuldskala-anlæg. Man kan dog ikke forvente de samme procentvise renseeffekter, når PAC anvendes til efterrensning, da udgangskoncentrationen her vil være noget mindre.

Selv om PAC alene giver en ganske stor fjernelse af adskillige komponenter i vandet, så viser forsøget også, at restkoncentrationen af visse stoffer er forholdsvis høj efter kulrensningen, så metoden med stor sandsynlighed ikke kan anvendes som eneste rensemetode, hvis der skal opnås en udledningstilladelse. Den forventes derimod at være velegnet til efterrensning efter AOP. Det kan ikke udelukkes, at der kan opnås en endnu bedre renseeffekt end det fremgår af Tabel 4-1, såfremt man havde doseret mere PAC ved forsøget. Det betyder dog også, at kulstofforbruget sandsynligvis vil blive meget stort.

## 4.3 Ozon

Ved denne metode blæses der ozon i luftform i en kolonne, hvor der ud over en oxidation af organiske komponenter også vil ske en stripning af flygtige komponenter i et eller andet omfang. I et fuldskala-anlæg vil der derfor også være brug for rensning af stripningsluften i f.eks. et kulfilter, inden den ledes ud i atmosfæren. En anden ulempe ved anvendelse af ozon er omdannelse af bromid til det giftige stof bromat.

Overdosering

I Tabel 4-2 ses resultatet af forsøget TA7-SF udført af SUEZ med ozon.TA7-SF er udført med en overdosering af ozon for at afdække metodens maksimale rensningseffekt.

*Tabel 4-2 Resultat fra forsøg med ozon rensning "overdosering" (TA7-SF).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 15,23 | 0,90 | 99,82 | 99,99 |
| BTEX | 20,04 | 0,48 | 96,24 | 99,91 |
| Totalkulbrinter | 20 | <5 | 92,59 | 100 |
| Grindstedværkstoffer | 221 | 152,8 | 86,79 | 90,87 |
| sum af org. stof | 276 | 153,7 | 97,51 | 98,61 |
| Bromat | 65 | i.a. | | |

I Tabel 4-2 ses det, at der stort set sker en fuldstændig rensning efter kul for chlorerede forbindelser, BTEX og totalkulbrinter, mens der stadig er 152,8 µg/l tilbage af Grinstedværkstofferne. Det er næsten udelukkende stoffet ethylurethan, der er tilbage efter kulbehandling, og det er også det stof, der er det dominerende Grindstedværkstof i det ubehandlede vand. Der ses markant dannelse af bromat i forsøget, og det er ikke overraskende. Ved screeningstesten konstaterede man, at bromatkoncentrationen blev > 10 µg/l, hvis man doserede mere end 13,1 mg/l ozon. Derfor valgte man at anvende en ozondosering på 13 mg/l i det optimale forsøg (så holder man bromat < 10 µg/l). Ved overdoseringsforsøget er ozondoseringen på 22,6 mg/l. Da bromat ikke forventes adsorberet på kul er der ikke analyseret for det efter kulbehandlingen.

Det skal i øvrigt bemærkes, at restindholdet af chlorerede forbindelser efter ozonrensningen overvejende består af chlorethan, og BTEX består overvejende af benzen. Ved kulrensningen fjernes chlorethan helt, men der er stadig en lille rest af vinylchlorid tilbage efter kulrensning.

Under dosering

I Tabel 4-3 ses resultaterne fra prøve TA8-SF, der betragtes som en underdosering med ozon.

*Tabel 4-3 Resultater fra forsøg med ozon "underdosering" (TA-8 SF).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 824,8 | 8,99 | 90,5 | 99,89 |
| BTEX | 171,6 | 2,92 | 67,8 | 99,45 |
| Totalkulbrinter | 210 | <5 | 22,22 | 100 |
| Grindstedværkstoffer | 421,3 | 175,7 | 74,8 | 89,50 |

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Sum af org. stof | 1628 | 184,7 | 85,37 | 98,34 |
| Bromat | <2,5 | | | |

I Tabel 4-3 ses det, at der med lav dosering af ozon opnås en ret lav renseeffekt. Selvom den samlede renseeffekt er 98,34 % efter kulbehandling, sker en stor del af rensningen i kulfilteret. Efter kulbehandling er det især Grindstedværkstofferne, der er tilbage og igen er det ethylurethan, som klart dominerer indholdet. Den lave dosering betyder også, at bromatindholdet ligger under detektionsgrænsen, hvilket er ønskeligt.

Efter ozonbehandlingen er der stadig ret store mængder cis-DCE og vinylchorid i det rensede vand. Vinylchlorid fjernes næsten fuldstændigt med PAC, mens restindholdet af chlorerede forbindelser efter PAC overvejende består af cis-DCE. Der er også en stor rest af kulbrinter i vandet efter ozonrensningen, men kulbrinterne fjernes fuldstændig ved kulrensningen. Efter ozonrensningen er der forholdsvis stort restindhold af ethylurthan samt adskillige barbitalforbindelser, men efter rensning med PAC er der stort set kun ethylurethan tilbage samt små mængder af barbitalforbindelser. Koncentrationen af ethylurethan er dog uforklarlig højere efter PAC end før PAC.

Optimal dosering

I Tabel 4-4 ses resultatet af den beregnede optimale dosering med ozon (TA6-SF). Den optimale dosering er fastlagt som den højeste ozondosering, man kan anvende, så bromatkoncentrationen holdes under 10 µg/l. Forsøget er en test af renseeffekten, når den kritiske bromatkoncentration lige netop ikke forventes at overskrides.

*Tabel 4-4 Resultater fra forsøg med ozon "optimal" dosering (TA6-SF).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 41,04 | 17,98 | 99,53 | 99,79 |
| BTEX | 121 | 1,95 | 77,3 | 99,63 |
| Totalkulbrinter | 150 | <5 | 44,44 | 100 |
| Grindstedværkstoffer | 378,3 | 165,5 | 77,39 | 90,11 |
| Sum af org. stof | 690 | 183,4 | 93,80 | 98,35 |
| Bromat | 9,1 | i.a. | | |

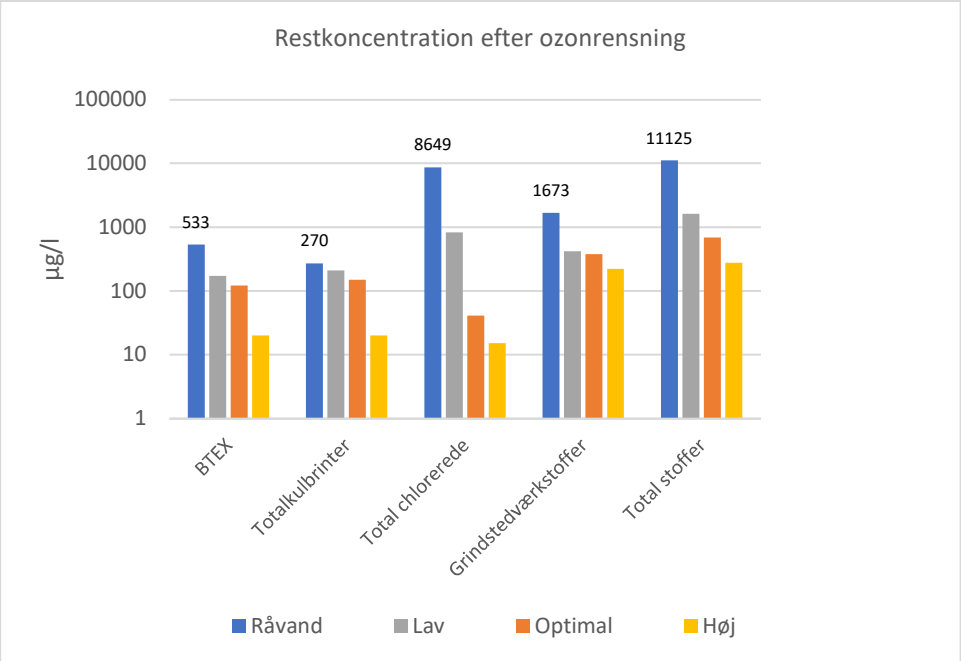
I Tabel 4-4 ses det, at man med optimal dosering af ozon opnår en bedre renseeffekt for alle stoffer end ved underdosering, men til gengæld er renseeffekten dårligere end ved overdosering, og denne sammenhæng er helt som forventet. Den samlede effekt er 98,35 % efter kulbehandling, men en stor del af rensningen sker i kulfilteret. Efter kulbehandling er det især Grindstedværk-stofferne, der er tilbage, og igen er det ethylurethan, som klart dominerer indholdet. Den optimale ozondosering betyder også, at bromatindholdet ligger på 9,1 µg/l og under drikkevandskriteriet.

Efter ozonrensningen er chlorethan og cis-DCE de dominerende chlorerede forbindelser, mens det er cis-DCE og vinylchlorid der domineret billedet efter PAC-rensning. Vinylchlorid er her til stede i en højere koncentration end før kulrensningen, hvilket er uforklarligt. Kulbrinterne er til stede i høj koncentration efter ozonrensningen, men kulbrinterne fjernes helt ved kulrensningen. Efter ozonrensningen er der først og fremmest store mængder meprobamat og ethyleurethan samt små mængder barbiturater. Ved kulrensningen fjernes meprobamat fuldstændigt, men koncentrationen af ethylurethan stiger på uforklarlig vis ved kulrensningen.

**Sammenligning af de tre forsøg**

I Figur 4-1 har vi sammenlignet restkoncentrationerne af stoffer før og efter ozonrensning. For overskuelighedens skyld ser vi på stofgrupper i stedet for enkeltstoffer. Det fremgår tydeligt, at man når ned på de laveste restkoncentrationer ved høj dosering (overdosering), og der er næppe tvivl om, at man kan nå betydelig længere ned, hvis man doserer endnu mere ozon. To forhold modarbejder dog denne mulighed. Større ozondosering giver mere stripning af flygtige komponenter. Forsøgene har vist, at ca. 50 % af vinylchlorid fjernes ved stripning og ikke ved destruktion. Derimod blev der ikke fundet væsentlig stripning af cis-DCE og benzen ved stripningsforsøget. Større ozondosering betyder også en kraftig stigning i bromatdannelsen, hvilket ikke er hensigtsmæssigt. Derfor må man nøjes med den renseeffekt, der kan opnås med den optimale dosering.

Figur 4-1 viser, at ozon er god til at destruere BTEX og chlorerede forbindelser. Ozon er knap så effektiv til at destruere kulbrinter, og den er ikke særlig effektiv til destruktion af Grindstedværks-stoffer. Renseeffekten stiger som nævnt ved øget dosering af ozon.




*Figur 4-1 Sammenligning af restkoncentrationer før og efter rensning med ozon i forhold til baseline.*

I Tabel 4-5 er alle resultater fra kulrensning (efter ozonrensning) vist, og ved det optimale forsøg er det stadigt muligt at fjerne 4,55 % af det resterende organiske stof fra ozonrensningen. Selv efter kulrensningen er der stadig store koncentrationer af Grindstedværkstoffer samt forholdsvis store restkoncentrationer af chlorerede forbindelser.

*Tabel 4-5 Samlet resultat fra ozonforsøget efter rensning med aktivt kul (PAC).*

| Komponenter | Restindhold efter kul TA6 optimum (µg/l) | Restindhold efter kul TA7 overdosering (µg/l) | Restindhold efter kul TA8 underdosering (µg/l) |
|---|---|---|---|
| Chlorerede forbindelser | 17,98 | 0,90 | 8,99 |
| BTEX | 1,95 | 0,48 | 2,92 |
| Totalkulbrinter | <5 | <5 | <5 |
| Grindstedværkstoffer | 165,5 | 152,8 | 175,7 |
| Sum af org. stof | 183,4 | 153,7 | 184,7 |
| Renseforbedring ved kul % | 4,55 | 1,1 | 12,97 |
| Bromat | 9,1 | 65 | <2,5 |

## 4.4 Ozon + $H_2O_2$

Ved denne metode blæses der ozon i luftform ind i en kolonne og samtidig tilsættes der $H_2O_2$ i forskellige doser for at forbedre effekten i forhold til at bruge ren ozon. Udover en oxidation af organiske komponenter sker der også her en stripning af flygtige komponenter i et eller andet omfang. I et fuldskala-anlæg vil der derfor også være brug for rensning af stripningsluften i f.eks. et kulfilter, inden den ledes ud i atmosfæren. En anden bivirkning ved anvendelse af ozon er omdannelse af bromid til det giftige stof bromat. Ved forsøgene har man varieret doseringen af ozon og $H_2O_2$ svarende til overdosering, optimal dosering og underdosering.

Overdosering

I Tabel 4-6 ses resultatet af forsøget TestB2-SF udført af SUEZ med ozon og $H_2O_2$. TestB2-SF er udført med en overdosering af ozon og $H_2O_2$ for at afdække metodens maksimale rensningseffekt.

*Tabel 4-6 Resultat af forsøg med ozon og $H_2O_2$ (TestB2-SF/overdosering).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 33,84 | 0,29 | 99,61 | 99,99 |
| BTEX | 39,15 | 0,14 | 92,65 | 99,97 |
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindstedværkstoffer | 203 | 119,5 | 87,87 | 92,83 |
| Sum af org. stof | 276 | 119,8 | 97,51 | 98,92 |
| Bromat | 19 | i.a. | | |

Af Tabel 4-6 ses det, at der stort set sker en fuldstændig rensning efter kul for chlorerede forbindelser, BTEX og totalkulbrinter, men der stadig er 119,5 µg/l tilbage af Grindstedværkstofferne. I forsøget dannes helt som forventet en del bromat, hvor koncentrationen kommer over 10 µg/l, som er den maksimale værdi, der søges overholdt ved forsøgene. Efter AOP-rensningen er der stadig lidt chlorerede forbindelser i vandet, først og fremmest dichlorethan og cis-DCE. Disse fjernes dog næsten fuldstændigt med PAC. BTEX fjernes nogenlunde med AOP, men der er stadig noget benzen i det rensede vand. Det fjernes dog let med PAC. Fjernelse af Grindstedværkstofferne er moderat ved AOP-rensninger, som har vanskeligt ved at fjerne ethylurethan, meprobamat og enkelte barbiturater. Meprobamat fjernes dog fuldstændigt med PAC, hvilket ikke er tilfældet med ethylurethan og visse barbiturater. Faktisk stiger ethylurethan lidt og helt uforklarligt ved rensning med PAC, hvilket også var tilfældet ved forsøgene med ren ozonrensning.

Under dosering

I Tabel 4-7 ses resultaterne fra prøve TestB3-SF, der betragtes som en underdosering med ozon.

*Tabel 4-7 Resultat af forsøg med ozon og $H_2O_2$ (TestB3-SF/underdosering).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 1485 | 10,71 | 82,83 | 99,88 |
| BTEX | 171,6 | 2,1 | 67,8 | 99,61 |
| Totalkulbrinter | 21 | <5 | 92,22 | 100 |
| Grindstedværkstoffer | 374 | 156,9 | 77,64 | 90,62 |
| Sum af org. stof | 2052 | 167,6 | 81,56 | 98,49 |
| Bromat | <2,5 | i.a. | | |

Af Tabel 4-7 ses det, at der opnås en ret lav renseeffekt med lav dosering af ozon og brintperoxid, men også den efterfølgende rensning med PAC er overraskende lav.

Efter AOP er vinylchlorid og cis-DCE de helt dominerende komponenter blandt de chlorerede forbindelser, og efter kulrensningen er det især cis-DCE, som er tilbage i det rensede vand. BTEX (benzen) fjernes moderat ved AOP, men langt det meste benzen fjernes efterfølgende med PAC. I modsætning til det rene ozonforsøg, så fjernes kulbrinterne betydelig bedre med ozon + $H_2O_2$, og den sidste rest fjernes effektivt med PAC. Grindstedværkstofferne fjernes ikke særlig effektivt ved denne AOP-rensning, hvor der er ret høje koncentrationer af ethylurethan og meprobamat i det rensede vand – endda mere end i råvandet (kan ikke forklares). Der er desuden små koncentrationer af forskellige barbiturater. Meprobamat fjernes dog fuldstændigt med PAC, og visse barbiturater fjernes delvis med PAC. Til gengæld stiger koncentrationen af ethylurethan på uforklarlig vis ved rensning i kulfilteret. Det har vi også set ved de andre ozonforsøg.

Optimal dosering

I Tabel 4-8 ses resultatet af den beregnede optimale dosering med ozon (TestB1-SF) og $H_2O_2$. Doseringen er fastlagt således, at bromatkoncentrationen forventes at være under 10 µg/l.

*Tabel 4-8 Resultat af forsøg med ozon og $H_2O_2$ (TestB1-SF/optimaldosering).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 564,7 | 59,70 | 93,47 | 99,31 |
| BTEX | 71,57 | 0,91 | 86,57 | 99,83 |

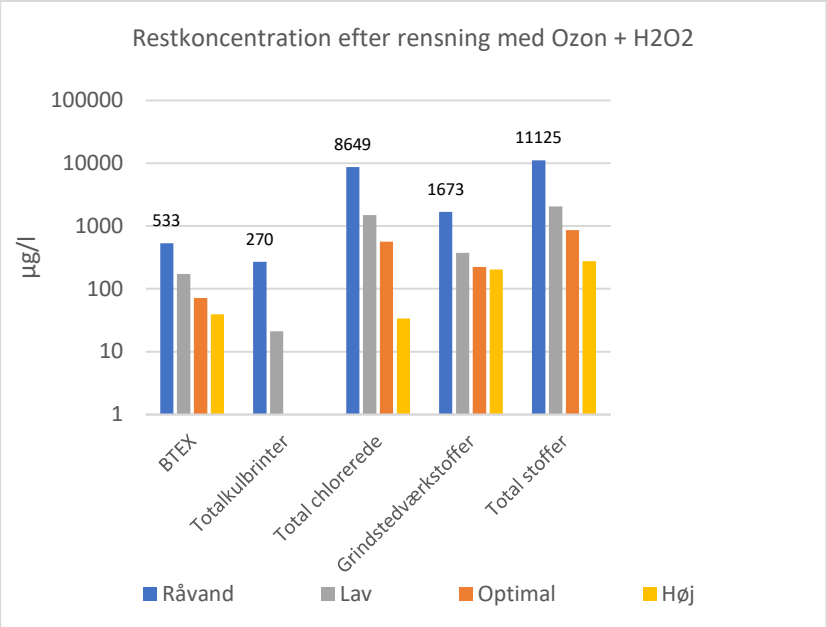
| | | | | |
|---|---|---|---|---|
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindsted-værkstoffer | 224,4 | 141 | 86,57 | 91,63 |
| Sum af org. stof | 861 | 200,7 | 92,26 | 98,20 |
| Bromat | <2,5 | i.a. | | |

Af Tabel 4.6, 4.7 og 4.8 ses det, at der med beregnet optimal dosering af ozon og brintperoxid opnås en renseeffekt efter PAC, som ligger mellem under- og overdosering. Den forholdsvis lave dosering betyder også, at bromatindholdet ligger lavt og under 10 µg/l. Tilsyneladende kunne man godt have doseret mere uden at overskride bromatgrænseværdien.

Også ved dette forsøg er vinylchlorid og cis-DCE de dominerende chlorerede forbindelser efter AOP-rensningen. I modsætning til de øvrige forsøg med denne AOP-metode, så fjernes disse to stoffer ikke særlig godt ved den efterfølgende PAC-rensning. Benzen (BTEX) fjernes nogenlunde ved AOP og derefter næsten fuldstændigt med PAC. Kulbrinterne fjernes effektivt ved AOP-rensningen i modsætning til forsøg med ren ozon. Grindstedværk-stofferne fjernes kun moderat med denne AOP-metode, og det er igen ethylurethan og meprobamat der dominerer i det rensede vand sammen med små koncentrationer af visse barbiturater. Meprobamat fjernes herefter fuldstændigt med PAC, mens koncentrationen af barbituraterne reduceres lidt med PAC. For ethylurethan stiger koncentrationen ved PAC-rensningen helt uforklarligt igen ligesom ved de andre ozonforsøg.

**Sammenligning af de tre forsøg**

I Tabel 4-2 har vi sammenlignet koncentrationerne af stoffer før og efter rensning med ozon + $H_2O_2$. For overskuelighedens skyld ser vi på stofgrupper i stedet for enkeltstoffer. Det fremgår tydeligt, at man når ned på de laveste restkoncentrationer ved høj dosering (overdosering), og der er næppe tvivl om, at man ville kunne nå betydelig længere ned, hvis man doserede mere ozon og $H_2O_2$. To forhold modarbejder dog denne mulighed. Større ozondosering giver mere stripning af flygtige komponenter. Forsøgene har som tidligere nævnt vist, at ca. 50 % af vinylchlorid fjernes ved stripning og ikke ved destruktion. Større ozondosering betyder også en kraftig stigning i bromatdannelsen, hvilket ikke er hensigtsmæssig. Derfor må man nøjes med den renseeffekt, der kan opnås med den optimale dosering.




*Figur 4-2 Sammenligning af koncentrationer før og efter rensning med ozon + $H_2O_2$.*

Samlet vurdering

I Tabel 4-9 ses en sammenligning af forsøgene med ozon og $H_2O_2$. Forsøgene viser, at selv efter kulbehandling og en overdosering med ozon og brintperoxid er der stadig over 119 µg/l af de analyserede stoffer tilbage, og det er igen særligt Grindstedværkstoffet ethyturethan, som ikke kan fjernes uanset, hvor høj dosering, der anvendes. Ved overdosering opnås generelt den bedste renseeffekt. Ligesom ved ozon alene sker der en væsentlig forbedring af renseeffekten med aktivt kul specielt for de chlorerede forbindelser og BTEX. Ved de anvendte doseringer dannes der kun problematiske indhold af bromat ved overdoseringen. Det skal også noteres, at man med ozon + $H_2O_2$ kan destruere kulbrinter, hvilket ikke var tilfælde med ozon alene.

*Tabel 4-9 Samlet resultat for ozon tilsat brintperoxid forsøget med restindhold efter kul.*

| Komponenter | Restindhold efter kul TestB1 optimum (µg/l) | Restindhold efter kul TestB2 overdosering (µg/l) | Restindhold efter kul TestB3 underdosering (µg/l) |
|---|---|---|---|
| Chlorerede | 59,70 | 0,29 | 10,71 |
| BTEX | 0,91 | 0,14 | 2,1 |
| Totalkulbrinter | <5 | <5 | <5 |
| Grindstedværk-stoffer | 141 | 119,5 | 156,9 |
| Total | 200,7 | 119,8 | 167,6 |
| Renseforbed-ring ved kul % | 5,94 | 1,41 | 8,42 |
| Bromat | <2,5 | 19 | <2,5 |

Det er ret overraskende, at der ikke opnås en væsentlig forbedring af renseeffekten med ozon, når der tilsættes brintperoxid. Normalt vil man forvente en bedre oxidation, fordi tilsætning af brintperoxid vil generere hydroxylradikaler. COWI har ikke nogen umiddelbar forklaring på, at man ikke opnår en forbedret rensning med ozon + $H_2O_2$ i forhold til rensning med ozon alene, og i rapporten fra Suez, er der heller ikke givet nogle mulige forklaringer herpå

## 4.5 UV + $H_2O_2$

Ved de tre forsøg med UV + $H_2O_2$ undersøges effekten af UV-doseringen, som ved forsøget bestemmes af opholdstiden og antal tændte lamper og deres effekt. Dosering af brintperoxid tilpasses, så der er et passende overskud.

Overdosering

I Tabel 4-10 ses resultatet af forsøget TC7-SF udført af SUEZ med UV + $H_2O_2$ TC7-SF er udført med en overdosering af UV for at afdække metodens maksimale rensningseffekt.

*Tabel 4-10 Resultat af forsøg med UV og $H_2O_2$ (TC7-SF/overdosering).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 83,48 | 1,88 | 99,03 | 99,98 |
| BTEX | 5,2 | 0,082 | 99,02 | 99,98 |
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindstedværkstoffer | 25,12 | 9,82 | 98,50 | 99,41 |
| Sum af org. stof | 114 | 11,7 | 98,98 | 99,89 |

Af Tabel 4-10 ses det, at der er høj grad af rensning efter kul for chlorerede forbindelser, BTEX og totalkulbrinter. Derimod er der stadig en vis restkoncentration af Grindstedværkstoffer.

Efter AOP-rensningen er de dominerende chlorerede stoffer vinylchlorid, cis-DCE og chlorethan, men alle disse stoffer fjernes stort set med PAC. BTEX fjernes næsten ved AOP, og den lille restkoncentration af benzen fjernes fuldstændigt med PAC. Efter AOP er der stort set kun ethylurethan i det rensede vand, og størstedelen af det fjernes med PAC.

Underdosering

I Tabel 4-11 ses resultaterne fra prøve TC8-SF, der betragtes som en underdosering med UV.

*Tabel 4-11 Resultat af forsøg med UV og $H_2O_2$ (TC8-SF/underdosering).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede | 790 | 10,07 | 90,86 | 99,88 |
| BTEX | 53,4 | 0,25 | 89,98 | 99,95 |
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindstedværkstoffer | 388,9 | 43,88 | 76,75 | 97,38 |
| Samlet | 1232 | 54 | 88,93 | 99,51 |

Af Tabel 4-11 ses det, at der med lav UV-dosering opnås en ret lav renseeffekt før kulbehandling, hvorefter kullene fjerner en stor del af rest-forureningen.

Efter AOP-rensningen er de dominerende chlorerede forbindelser vinylchlorid og cis-DCE samt en lille mængde trans-DCE. Efter rensning med PAC er der stadigvæk en del cis-DCE tilbage i det rensede vand. En stor del af BTEX (benzen) fjernes ved AOP-rensningen, og det resterende benzen fjernes næsten fuldstændigt med PAC. Kulbrinter fjernes fuldstændigt ved AOP-rensningen. Efter AOP-rensningen er der stadig et ret stort restindhold Grindstedværkstoffer - monoethylbarbitursyre, ethylurethan, meprobamat og barbital i nævnte rækkefølge. Efter rensning med PAC er der kun rester af ethylurethan og barbital tilbage i det rensede vand.

Optimal dosering

I Tabel 4-12 ses resultatet af den optimalt estimerede dosering med UV og $H_2O_2$ (TC6-SF). Hvis doseringen er beregnet korrekt, så bør der ikke være den store forskel i effekt i forhold til overdoseringen.

*Tabel 4-12 Resultat af forsøg med UV og $H_2O_2$ (TC6-SF/optimal dosering).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 48,92 | 41,68 | 99,43 | 99,52 |
| BTEX | 1,1 | 0,066 | 99,79 | 99,99 |
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindstedværkstoffer | 101,95 | 37,74 | 93,91 | 97,74 |
| Sum af org. stof | 152 | 79,4 | 98,63 | 99,29 |

Af Tabel 4-12 ses det, at der med optimalt estimeret UV-dosering opnås en renseeffekt, som er meget lig overdoseringen og væsentlig bedre end underdoseringen. Efter kul er der mærkeligt nok et samlet indhold højere end både over- og underdosering, hvilket skyldes et ekstraordinært stort indhold af vinylchlorid, som er meget højere efter PAC end før PAC.

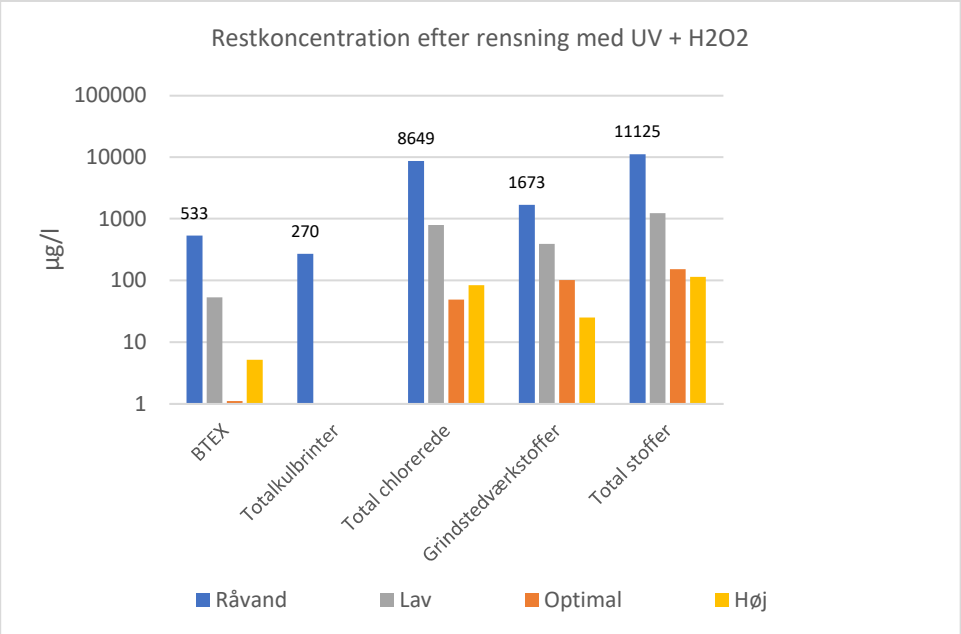
Efter AOP-rensningen er de dominerende stoffer blandt de chlorerede forbindelser cis-DCE, vinylchlorid og chorethan, ligesom man har fundet ved de andre forsøg med denne metode. Ved rensning med PAC fjernes chlorethan og noget cis-DCE men vinylchlorid stiger betydelig på uforklarlig vis i forhold til koncentrationen før PAC. BTEX fjernes næsten fuldstændigt ved AOP, og kulbrinterne fjernes fuldstændigt. Grindstedværk-stoffer reduceres betydeligt ved AOP-rensningen, hvorefter det væsentligste indhold er ethylurethan, monoethylbarbitursyre, mepromabat og barbital. Efter PAC-rensning er der stort set kun ethylurethan tilbage i vandet.

**Sammenligning af de tre forsøg**

Samlet vurdering

Det fremgår af Figur 4-3, at man med UV+$H_2O_2$ kan nedbryde alle kulbrinter i vandet. Også nedbrydningen af BTEX er nogenlunde god ved både det optimale forsøg og ved overdosering. De chlorerede forbindelser kan nedbrydes med mindst 99 % ved optimal dosering og overdosering, men det er dog overraskende, at der fjernes mest ved den optimale dosering, og det er vinylchlorid, der er afgørende. Vi er i forsøgene dog nede i nogle meget lave koncentrationer efter rensning og derfor kan denne situation godt forekomme.

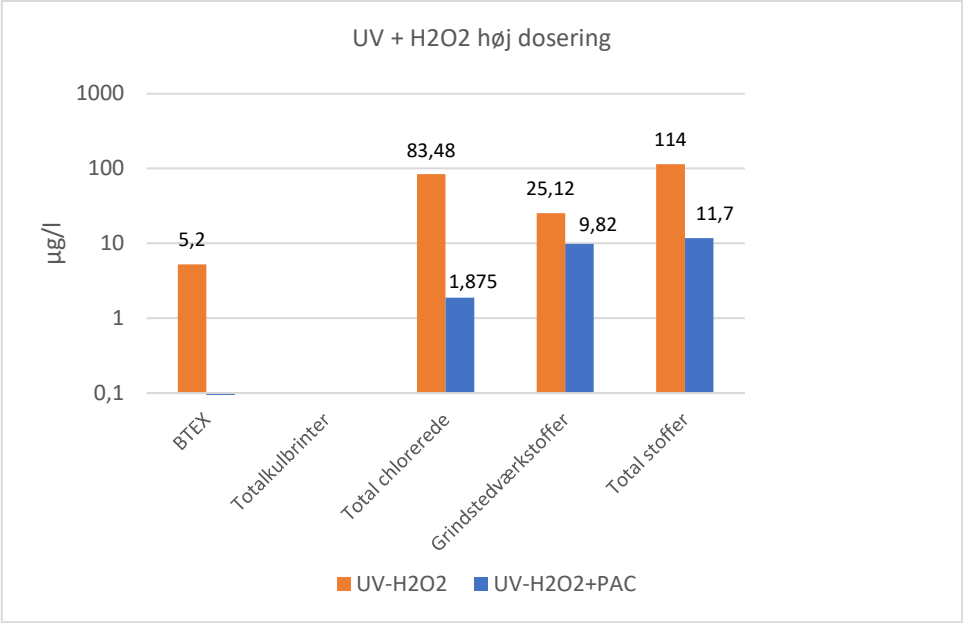
Også Grindstedværk-stofferne kan nedbrydes mere end 90 % ved overdosering og optimal dosering. Da nedbrydningen forøges ved en forhøjelse af UV-doseringen, tyder meget på, at man kunne opnå betydelig større nedbrydning af både chlorerede forbindelser og Grindstedværk-stoffer, hvis man havde tilsat en endnu større UV-dose. Det danske firma, UltraAqua, har ved en modelberegning på det aktuelle vand beregnet, at man kan nedbryde 85-90 % af restkoncentrationer af de chlorerede forbindelser, der findes i det optimale forsøg, ved at udbygge anlægget med ekstra 33 % UV-lampe effekt. Som nævnt ovenfor tyder det på, at det også vil give en betydelig større nedbrydning af Grindstedværk-stofferne.



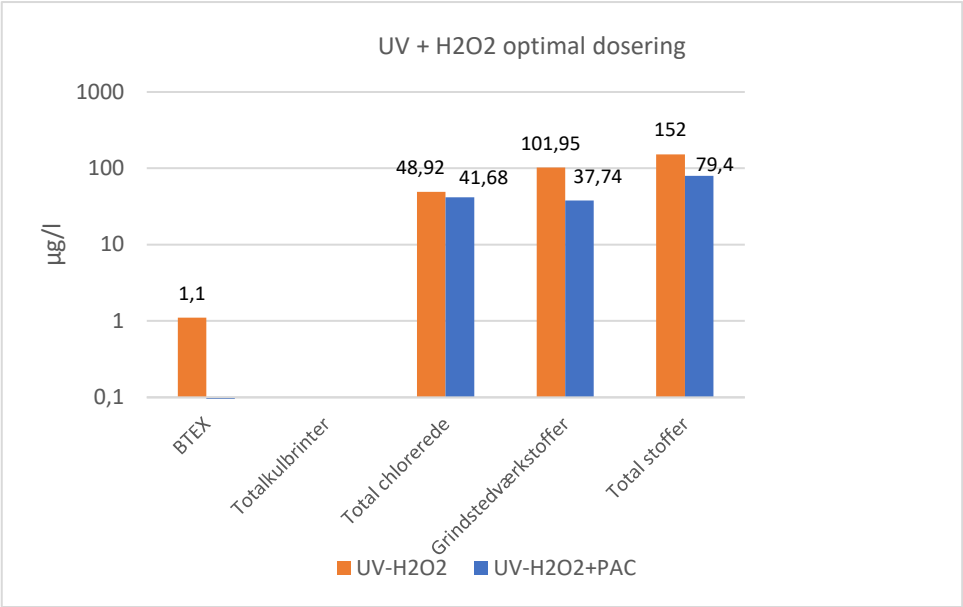

*Figur 4-3* *Sammenligning af restkoncentrationer ved de tre renseforsøg med UV + $H_2O_2$.*

*Tabel 4-13* *Samlet resultat for UV + $H_2O_2$ forsøget med restindhold efter kul.*

| Komponenter | Restindhold efter kul TC6 optimum (µg/l) | Restindhold efter kul TC7 overdosering (µg/l) | Restindhold efter kul TC8 underdosering (µg/l) |
|---|---|---|---|
| Chlorerede | 41,68 | 1,88 | 10,07 |
| BTEX | 0,066 | 0,082 | 0,25 |
| Totalkulbrinter | <5 | <5 | <5 |
| Grindstedværk-stoffer | 37,74 | 9,82 | 43,88 |
| Total | 79,4 | 11,7 | 54 |
| Renseforbed-ring ved kul % | 0,66 | 0,91 | 10,58 |




*Figur 4-4 Restkoncentrationer af de organiske stoffer i overdoseringsforsøget.*




*Figur 4-5 Restkoncentration af organiske stoffer i det optimale forsøg.*

Tabel 4-13 samt Figur 4-4 og Figur 4-5 giver et samlet overblik over, hvad der er opnået ved renseforsøgene med UV + $H_2O_2$. Ved overdosering efterfulgt af kulrensning har man helt fjernet kulbrinter og BTEX. De chlorerede opløsnings-midler er nede på ca. 2 µg/l, mens Grindstedværk-stofferne ligger på ca. 10 µg/l. I det optimale forsøg ligger restkoncentrationerne af Grindstedværksstof-ferne som forventet mellem under- og overdosering, mens dette ikke er tilfældet for de chlorerede og særligt vinylchlorid. Årsagen til at indholdet af vinylchlorid ikke ligger som forventet kan være håndteringen af PAC-behandlingen. Det er sandsynligt, at det kan være meget vanskeligt at reproducere forsøgsresultater for de meget flygtige forbindelser, da der er risiko for at miste en del af de flyg-tige komponenterne under forsøgene og ved håndtering af prøverne.

Som tidligere nævnt tyder meget på, at rensningen kan forbedres væsentlig ved et øge UV-doseringen. Det skal endvidere fremhæves, at der ikke dannes bromat ved denne metode, og der er heller ingen stripning af flygtige komponenter.

## 4.6 Faststof katalysator + $H_2O_2$

Overdosering

I Tabel 4-14 ses resultatet af forsøget Run B udført med den katalytiske metode af Water IQ. Run B er udført med en overdosering med $H_2O_2$ og med tilsætning af jernsalt, hvilket repræsenterer noget af det mest effektive, der kan opnås med teknologien.

*Tabel 4-14 Resultater fra den katalytiske metode B (overdosering).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede | 0,037 | 0,043 | 100 | 100 |
| BTEX | 0,021 | 0,043 | 100 | 100 |
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindstedværkstoffer | 0,15 | <0,1 | 100 | 100 |
| Samlet | 0,21 | 0,22 | 100 | 100 |

Af Tabel 4-14 ses det, at der stort set sker en fuldstændig fjernelse af alle de analyserede stoffer, så det samlede indhold er under 1 µg/l efter AOP-rensningen. Restindholdet består af isobutylbarbitursyre samt meget små mængder trichlormethan og xylen. Ved den efterfølgende rensning med PAC fjernes isobutylbarbitursyre men ikke xylen. Derimod finder man mystisk nok lidt dichlormethan, selv om det ikke fandtes i vandet efter AOP-rensningen. Grundet tilsætningen af jernsaltskatalysatoren har det rensede vand også et meget højt indhold af jern på 42 mg/l, og pH værdien er af Water IQ selv målt til 3,5 (katalysatoropløsningen indeholder syre). Der er tale om en meget effektiv rensning, men med en væsentlig bivirkning i form af et højt jernindhold og en lav pH-værdi, hvilket kræver filtrering før kulrensning og neutralisering af det behandlede vand før udledning.

Under dosering

I Tabel 4-15 ses resultaterne fra prøve Run E, der betragtes som en underdosering, da tilsætning af $H_2O_2$ er lavere end i overdoseringsforsøget, og opholdstiden er lav i forhold til et normalt fuldskalaanlæg. Der er ikke tilsat flydende katalysator.

*Tabel 4-15 Resultater fra den katalytiske metode E (underdosering) ikke tilsat flydende katalysator.*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 15,97 | 0,44 | 99,82 | 99,99 |
| BTEX | 0,037 | 0,093 | 99,99 | 99,98 |
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindstedværkstoffer | 10,6 | 1,9 | 99,37 | 99,89 |
| Sum af org. stof | 27 | 2,3 | 99,76 | 99,98 |

Af Tabel 4-15 ses det, at selv med en meget lavere dosering af $H_2O_2$ end i Run B og en relativ lav opholdstid samt ingen anvendelse af katalysator, så er der en meget stor renseeffekt med en restkoncentration af organisk stof på 27 µg/l efter AOP. Restindholdet består overvejende af vinylchlorid, ethylurethan og TCE samt mindre mængder cis-DCE og sulfanilsyre. Det meste fjernes med PAC, hvorefter der kun er lidt ethylurethan og vinylchlorid tilbage i det rensede vand. Jernindholdet er kun på 0,6 mg/l og pH værdien har Water IQ målt til omkring 10 efter AOP, hvilket ifølge Water IQ skyldes, at der dannes OH- ved nedbrydning af overskud af $H_2O_2$.

Optimal dosering

I Tabel 4-16 ses resultatet af Run F forsøget, hvor opholdstiden var 20 minutter og $H_2O_2$ dosering var lige så lav som i E og uden tilsætning af katalysator. Opholdstiden ligger her tæt på opholdstiden for et normalt fuldskala-anlæg. Dosering af $H_2O_2$ er 8 gange mindre end i run B men stadigvæk noget højere end normalt. Denne parameter skal senere optimeres, men i første omgang ønskede Water IQ at være sikker på, at der var nok $H_2O_2$ til stede.

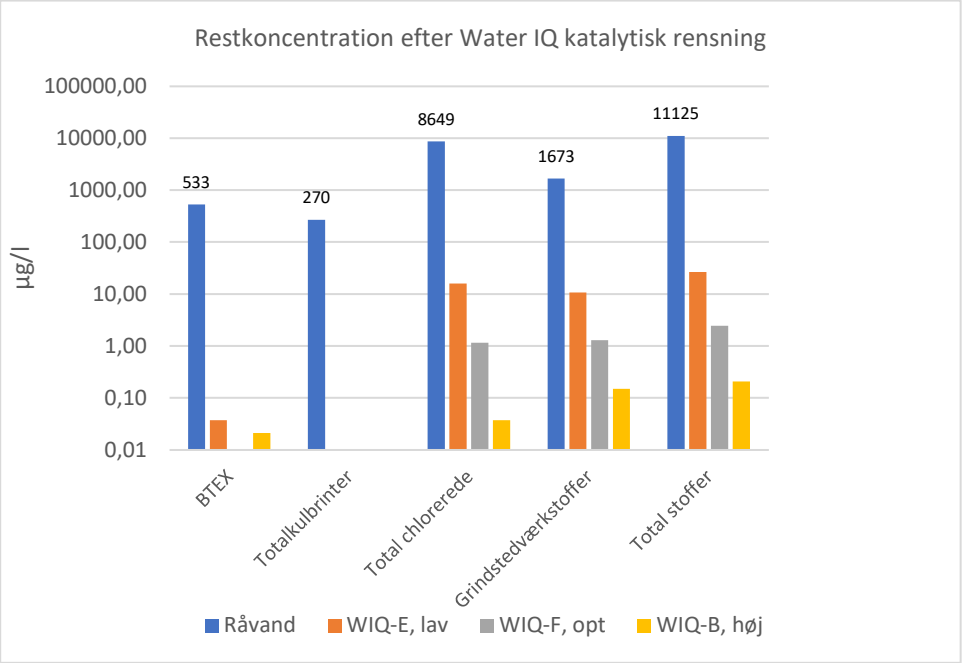
*Tabel 4-16 Resultater fra den katalytiske metode F (optimal).*

| Komponenter | Restindhold før kul (µg/l) | Restindhold efter kul (µg/l) | Rensegrad før kul (%) | Rensegrad efter kul (%) |
|---|---|---|---|---|
| Chlorerede forbindelser | 1,15 | 0,34 | 99,99 | 100 |
| BTEX | <0,06 | 0,091 | 100 | 99,99 |
| Totalkulbrinter | <5 | <5 | 100 | 100 |
| Grindstedværkstoffer | 1,29 | <0,1 | 99,37 | 100 |
| Sum af org. stof | 2,4 | 0,43 | 99,98 | 100 |

Af Tabel 4-16 ses det, at der sker en oprensning ved AOP på næsten 100 %, og efter rensning med aktivt kul er der et samlet restindhold af organisk stof på under 1 µg/l. Efter AOP er de dominerende komponenter i det rensede vand sulfanilsyre, TCE, chlorethan og ethylurethan. Efter yderligere rensning med PAC er der kun 0,43 µg/l organisk stof i det rensede vand med lidt chlorethan og dichlormethan. Indholdet af jern efter AOP-rensning var 0,76 mg/l og Water IQ målte en pH værdi på ca. 10 i det rensede vand fra AOP.

Samlet vurdering

I Figur 4-6 har vi sammenlignet restkoncentrationen af forskellige organiske stofgrupper ved de tre katalytiske forsøg samt i forhold til koncentrationerne i det urensede vand. Det fremgår, at kulbrinter fjernes fuldstændigt ved den katalytiske metode, men også BTEX, chlorerede opløsningsmidler og Grindstedværkstoffer fjernes ganske effektivt ved den optimale dosering og opholdstid. Ved en detaljeret gennemgang af analyserne kan man se, at også jern og mangan fjernes ret effektivt i det specielle forfilter, der findes i anlægget.




*Figur 4-6 Sammenligning af restkoncentrationer før og efter katalytisk rensning.*

Konklusionen er at restkoncentrationerne efter rensning er meget lave for de analyserede organiske stoffer og efter PAC ligger indholdet for alle de analyserede organiske stoffer under eller lige omkring detektionsgrænsen. I forhold til de kendte kvalitetskriterier for organiske forbindelser i overfladevand /5/ er der ingen overskridelser, hvilket er et godt udgangspunkt for en udledningstilladelse. Det står dog klart, at anvendelse af jernsalt ikke er aktuelt grundet det høje jernindhold. Det vurderes at pH-værdien ikke vil være et problem i et fuldskalaanlæg, da indholdet af $H_2O_2$ kan justeres ind med et lavere overskud og dermed også indholdet af $OH^-$.

## 4.7 Økotoksikologiske tests

I tabel 4.17 ses resultaterne af de økotoksikologiske korttidstest. Resultaterne angiver tilsætningsmængder (ml/l) til det vandmedie algerne og krebsdyrene lever i. Tilsætningsværdierne for NOEC (ingen observeret påvirkning) og LOEC (laveste tilsætning med effekt) er angivet sammen med tilsætningsværdier, hvor 10 % af organismerne (EC10) og 50 % af organismerne er påvirket (EC50). Som forklaret nedenfor vurderes EC10 resultaterne, som den bedste værdi til at vurdere størrelsen af en negativ økotoksikologisk effekt. Hvis det kun er EC10, som påvirkes er der tale om en mindre effekt og hvis der er tale om en påvirkning ved EC50 er der tale om en væsentlig effekt. Forskellen på de to testorganismer er at algerne reproducerer sig selv mange gange i løbet at de 21 dage testen foregår i. Det betyder, at algerne er mere sensitive overfor langtidseffekter end krebsdyrene og er derfor en god test af langtidseffekter. DHI oplyser også, at de udførte test generelt anvendes i forbindelse med udledningstilladelser og at testenes omfang danner grundlag for disse.

*Tabel 4-17 Resultater for de økotosikologiske test*

| Sample | DHI ID No. | Algal growth inhibition test with *Raphidocelis subcapitata* (mL/L) | | | | Immobilisation test with *Daphnia magna* (mL/L) | |
|---|---|---|---|---|---|---|---|
| | | NOEC | LOEC | EC10 | EC50 | EC10 | EC50 |
| Contaminated raw water sample | 20-1242 | 800[1)]<br>500[2)] | >800[1)]<br>>500[2)] | >800[1)]<br>>500[2)] | >800[1)]<br>>500[2)] | >900 | >900 |
| PAC-A6-SF | 20-1245 | 500 | 800 | 483<br>(393-572) | >800 | >900 | >900 |
| PAC-B6-SF | 20-1246 | 500 | 800 | 544<br>(• - •)[3)] | >800 | >900 | >900 |
| PAC-F-SF | 20-1247 | 200 | 300 | 257<br>(204-310) | >800 | >900 | >900 |
| PAC-C6-SF | 20-1248 | 300 | 500 | 305<br>(222-389) | >800 | >900 | >900 |

1) With pH-adjustment of the sample before initiation of the test
2) Highest test concentration without pH-adjustment of the sample
3) Data did not allow statistical calculation of the 95% confidence interval

Råvand

Resultaterne af testen viser, at der ikke ses nogen akut væksthæmning for det forurenede råvand, selv ved de maksimale tilsætninger på henholdsvis >800 ml/l for algerne og >900 ml/l for krebsdyrene. Det kan virke overraskende, at så kraftigt forurenet vand ikke har en akut påvirkning på de testede organismer. En af hovedkomponenterne vinylchlorid er under mistanke for at være kræftfremkaldende, men det er ikke det samme som at stoffet vil kunne påvirke testorganismerne negativt i forsøgsperioden.

Ozon (PAC-A6-SF)

For det ozonrensede vand ses der ingen påvirkning af krebsdyrene ved den maksimale tilsætning på >900 ml/l, men ved en tilsætning på 483 ml/l, ses der en effekt på 10 % af algerne. Der ses derfor en mindre påvirkning fra det ozonbehandlede vand.

| | |
|---|---|
| Ozon+$H_2O_2$ (PAC-B6-SF) | For det ozon+$H_2O_2$-rensede vand ses der ingen påvirkning af krebsdyrene ved den maksimale tilsætning på >900 ml/l, men ved en tilsætning på 544 ml/l, ses der en effekt på 10 % af algerne. Der ses derfor en mindre påvirkning fra det Ozon+$H_2O_2$ behandlede vand. |
| UV+$H_2O_2$ (PAC-C6-SF) | For det UV+$H_2O_2$-rensede vand ses der ingen påvirkning af krebsdyrene ved den maksimale tilsætning på >900 ml/l, men ved en tilsætning på 305 ml/l, ses der en effekt på 10 % af algerne. Der ses derfor en mindre påvirkning fra det UV+$H_2O_2$ behandlede vand. |
| Katalyse+$H_2O_2$ (PAC-F-SF) | For det katalyse+$H_2O_2$-rensede vand ses der ingen påvirkning af krebsdyrene ved den maksimale tilsætning på <900 ml/l, men ved en tilsætning på 257 ml/l, ses der en effekt på 10 % af algerne. Der ses derfor en mindre påvirkning fra det katalyse+$H_2O_2$ behandlede vand. |
| Samlet vurdering | Alle fire typer af behandlet grundvand udviser en vis, om end ikke stor, akut giftighed over for algerne, som er den mest sensitive overfor langtidseffekter. Det ses også at jo mere effektivt vandet er renset jo kraftigere er den negative effekt. Det er COWIs opfattelse, at det er EC10-værdien, der er den mest relevante at se på i denne sammenhæng. Den udtrykker ved hvilken koncentration (fortynding), der kan forventes at forekomme begyndende signifikante akutte effekter - eller mere præcist: toksiske effekter på 10 % af testorganismerne - og er en beregnet værdi i modsætning til LOEC (Lowest Observed Effect Concentration), der er den laveste af de i forsøget testede tilsætninger, hvor der blev observeret en effekt i det udførte korttidsforsøg. EC10-værdien vurderes at give et mere præcist bud på, ved hvilken koncentration giftvirkningen begynder at indtræffe.<br><br>Det ses af tabel 4.17, at for de to rensemetoder med ozon og ozon + $H_2O_2$, ligger grænsen for begyndende signifikante akutte effekter ved ca. en 2-ganges fortynding af det rensede vand. For metoderne med UV+$H_2O_2$ og katalyse+$H_2O_2$ skal der 3-4 ganges fortynding til af det rensede vand, førend det kommer under grænsen for begyndende akutte effekter. Det vurderes, at der er tale om en ret beskeden giftighed, og der skal derfor blot en fortynding på 3-4 gange til, så vil vandet ikke kunne give en uacceptabel økotoksikologisk påvirkning i åen.<br><br>På nuværende tidspunkt kan der ikke peges på en årsag til hvorfor det rensede vand har en mindre negativ økotoksikologisk påvirkning af de testede alger. Umiddelbart udelukkes det, at der skulle være et indhold af $H_2O_2$, ozon eller frie radikaler, som kan være årsagen, da det vurderes, at de vil forsvinde ved PAC-behandlingen. Det udelukkes også, at pH kan spille en rolle, da prøverne er pH-justeret inden forsøgene. Som beskrevet i afsnit 4.9 kan det ikke udelukkes, at der er dannet nogle nye stoffer ved spaltning, som ikke er omfattet af analyseprogrammet. Hvis det er tilfældet, kan det ikke udelukkes at disse stoffer kan have en indvirkning. |
| Fortynding i Grindsted Å | For at kunne vurdere fortyndingseffekten, hvis det rensede vand udledes til Grindsted Å er medianminimumsvandføringen i åen blevet gransket med data fra /4/. De laveste registrerede vandføringer uden bidrag af spildevand i området omkring Grindsted By ligger omkring 1,3 m³/s eller mere end 4500 m³/t. På |

nuværende tidspunkt vurderes den sandsynlige ydelse af behandlet vand at ligge på omkring 10 m³/t. Dette vil give en fortynding på mere end 400 gange, hvilket betyder, at det rensede vand uanset metode ikke vil kunne påvirke åen med en negativ økotoksikologisk korttidseffekt.

## 4.8 Sammenligning og vurdering af AOP-metoderne

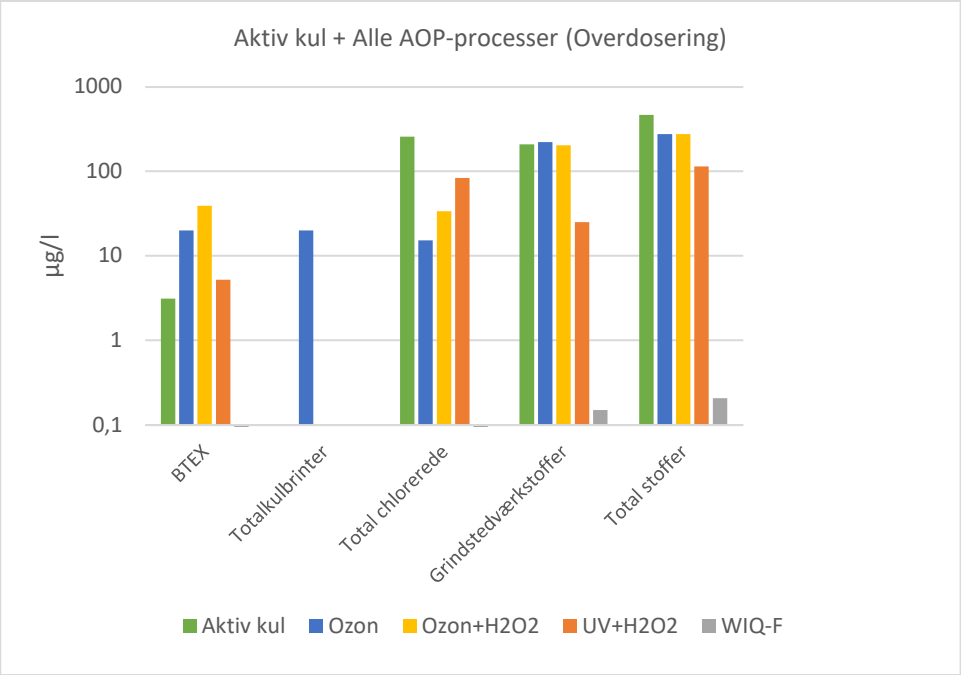
I Tabel 4-18 ses en sammenligning af de fire metoder før kulbehandling med angivelse af hvilken effektforbedring kulbehandlingen giver.

De samme værdier er afbildet i Figur 4-7, hvor resultaterne også sammenlignes med den rensning, der opnås ved at rense råvand direkte med aktivt kul (PAC)

For metoderne ozon, ozon+$H_2O_2$ og UV+$H_2O_2$ er overdoseringsforsøgene vist, da vi ønsker at sammenligne de bedste resultater med hver metode. For den katalytiske metode anvendes dog resultater fra optimum-forsøget, da det er det mest realistiske forsøg, og det giver stort set de samme resultater som overdoseringsforsøget dog med en relativ høj pH-værdi omkring 10.

*Tabel 4-18 Sammenligning af de fire AOP-metoder før kulbehandling.*

| Komponenter | Ozon restindhold overdosering (µg/l) | Ozon+$H_2O_2$ overdosering (µg/l) | UV+$H_2O_2$ restindhold overdosering (µg/l) | Katalytisk restindhold optimum (µg/l) |
|---|---|---|---|---|
| Chlorerede | 15,23 | 33,84 | 83,48 | 1,15 |
| BTEX | 20,04 | 39,15 | 5,2 | <0,06 |
| Totalkulbrinter | 20 | <5 | <5 | <5 |
| Grindstedværkstoffer | 221 | 203 | 25,12 | 1,29 |
| Total | 276 | 276 | 114 | 2,4 |
| Renseforbedring ved kul % | 1,1 | 1,41 | 0,91 | 0,02 |




*Figur 4-7* *Restkoncentration af organiske stoffer efter rensning ved de 4 AOP-metoder. Til sammenligning er vist restkoncentrationen, der opnås, når råvandet renses med PAC/kulfiltering.*

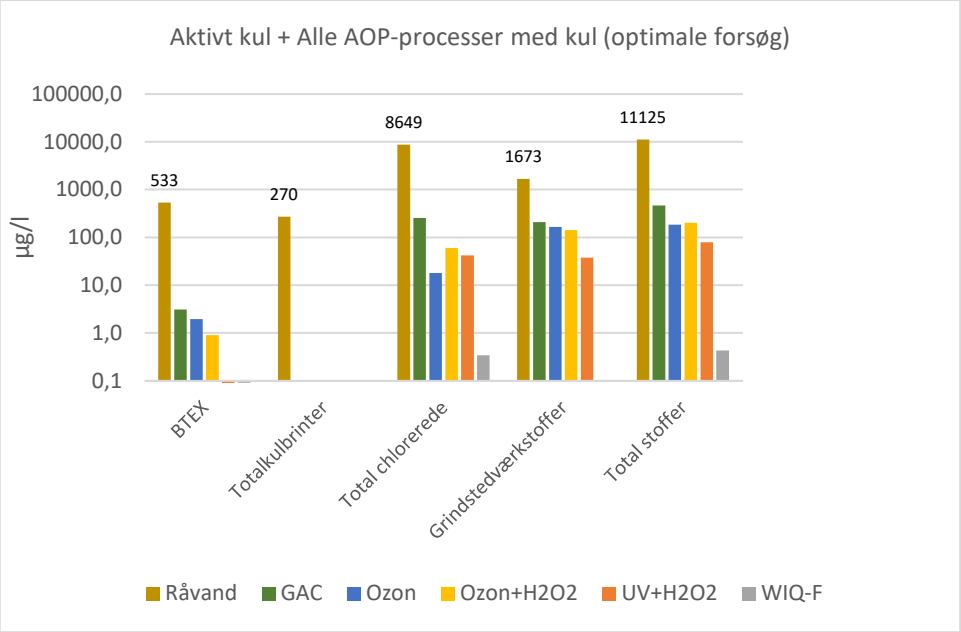
Det fremgår, at den mest effektive AOP-metode vurderet på forsøgsresultaterne før kulbehandling er den katalytiske metode. Ingen af de andre metoder har tilnærmelsesvis samme effektivitet. Metoden fjerner tilsyneladende så meget organisk stof, at kulbehandlingen stort set ikke forbedrer rensningen. Der er dog flere grunde til, at man alligevel bør efterrense med aktivt kul. Aktivt kul kan destruere overskud af $H_2O_2$, og det giver en ekstra sikkerhed for, at de sidste rester af organisk forurening bliver fjernet. Samtidig ved vi fra UV-forsøgene, at aktivt kul kan fjerne over 50% af de ukendte organiske stoffer i råvandet, som stadig er til stede efter en AOP-rensning.

I Tabel 4-19 ses resultatet for ovenstående prøver efter kulbehandling, så metoderne også her kan sammenlignes. Resultaterne er også illustreret i Figur 4-8, hvor råvandets sammensætning er vist tillige med rensning af råvand med aktivt kul alene. Vinylchlorid er det stof, som er til stede i størst koncentration i råvandet, og det er formentlig samtidig det stof, som har den laveste grænseværdi i overfladevand. Derfor har vi valgt at se nærmere på, hvordan vinylchlorid fjernes i de 4 optimale forsøg, og det er vist i Figur 4-9.

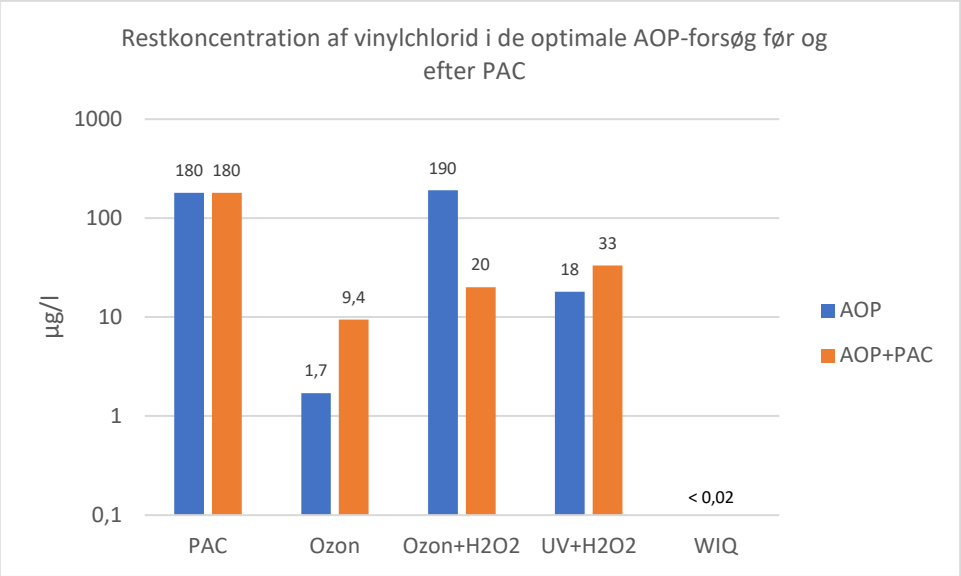
*Tabel 4-19* *Sammenligning af de fire AOP-metoder efter kulbehandling.*

| Komponenter | Ozon restindhold over-dosering (µg/l) | Ozon+H2O2 restindhold over-dosering (µg/l) | UV+H2O2 rest-indhold overdo-sering (µg/l) | Katalytisk rest-indhold optimum (µg/l) |
|---|---|---|---|---|
| Chlorerede | 0,90 | 0,29 | 1,88 | 0,34 |
| BTEX | 0,48 | 0,14 | 0,082 | 0,091 |

| Komponenter | Ozon restindhold over-dosering (µg/l) | Ozon+H2O2 restindhold over-dosering (µg/l) | UV+H2O2 rest-indhold overdo-sering (µg/l) | Katalytisk rest-indhold optimum (µg/l) |
|---|---|---|---|---|
| Totalkulbrinter | <5 | <5 | <5 | <5 |
| Grindstedværk-stoffer | 152,8 | 119,5 | 9,82 | <0,1 |
| Total | 153,7 | 119,8 | 11,7 | 0,43 |
| Renseforbed-ring ved kul % | 1,1 | 1,41 | 0,91 | 0,02 |




*Figur 4-8 Koncentration af organiske stoffer i råvand samt efter rensning med PAC alene og efter AOP-rensning med efterrensning i PAC.*



*Figur 4-9: Restkoncentration af vinylchlorid efter AOP-rensning og efterrensning med PAC*

Det fremgår af figur 4.8, at de to metoder med ozon ikke er i stand til at fjerne Grindstedværkstofferne særlig effektivt, selv ikke ved efterrensning med PAC. Ozon metoderne fjerner i kombination med kul ret effektivt de flygtige komponenter, når der anvendes en overdosering, men har svært ved at fjerne den genstridige komponent ethylurethan. Det er også sandsynligt, at en stor del af renseeffekten på de flygtige komponenter (først og fremmest vinylchlorid) ved ozonmetoderne skyldes stripning. Forsøgene viser også at den kraftigste renseeffekt giver problematiske indhold af bromat i det rensede vand. Anvendes mindre ozon (optimal dosering) vil der stadigvæk være et forholdsvis stort restindhold af flygtige komponenter i vandet, selv efter PAC-rensning.

Med hensyn til metoden UV og brintperoxid vurderes det, at den maksimale oprensningseffekt ikke er opnået i forsøgene. Ved forsøget med overdosering registreres en forbedret rensning af alle stoffer i forhold til optimal dosering og underdosering. Det indicerer, at der kan opnås en endnu bedre rensning for alle stoffer ved at forøge UV-doseringen yderligere. Derfor vurderes det, at metoden ikke kan afskrives til rensning af vandet til et niveau svarende til den katalystiske metode, selvom det ikke er dokumenteret ved forsøgene.

Ved den katalytiske metode er opnået særdeles fine resultater, hvor stort set alle stoffer fjernes helt. Således er vinylchlorid < 0,02 µg/l efter AOP-rensningen, og metoden er klart den mest effektive metode til destruktion af Grindstedværkstoffer. I kombination med PAC fjernes Grinstedstofferne fuldstændigt (under detektionsgrænsen). Med hensyn til den ret høje pH værdi, som ses i prøve F, så vurderes det at i et fuldskalaanlæg er løsningen at justere $H_2O_2$-doseringen, så der ikke er for meget overskud og så vil pH-værdien blive mere neutral og nærme sig værdien 7.

For alle forsøgene udført af SUEZ vurderes det generelt, at overdoseringsforsøgene ikke nødvendigvis er udtryk for, hvad der maksimalt kan nedbrydes af organiske stoffer med disse metoder. For begge ozonmetoder kan der ved større ozondosering opnås betydelig større nedbrydning af organiske stoffer, end der er opnået i de optimale forsøg. Problemet er bare, at der dannes bromat, hvis ozondoseringen øges ud over det optimale. Ved UV-metoden tyder det også på, at der kan opnås betydelig større nedbrydning af chlorerede forbindelser og Grindstedværk-stoffer, hvis der doseres mere UV-lys, men det blev desværre ikke afdækket fuldt ud ved forsøgene.

Det vurderes derfor, at fokus for metodevurderingen med prissætning etc. skal ligge på de to metoder katalytisk og UV begge med tilsætning af brintperoxid. Vi er klar over at SUEZ har peget på metode B, som den metode de tror mest på. Den konklusion er vi ikke enige i grundet renseeffektivitet, stripningsproblemet og bromatdannelsen.

## 4.9 Mineralisering, spaltning og delvis oxidation

De udførte forsøg viser at de analyserede stoffer fjernes i forskelligt omfang afhængig af metode og doseringer. Spørgsmålet er om det også er ensbetydende med at stofferne mineraliseres, spaltes eller bliver delvis oxideret. Der er udført nogle NVOC-analyser på det rensede vand fra de tre UV-forsøg. Oprindeligt var det ikke med i analyseplanen, men da vi under gennemgang af forsøgsresultaterne fandt, at NVOC-analyserne kunne være nyttige ved en samlet vurdering af en AOP-rensning med efterfølgende rensning med PAC, fik vi lavet 6 NVOC-analyser. På det tidspunkt var alle andre tilsvarende prøver kasseret hos ALS, så derfor har vi kun NVOC-analyser fra UV-forsøgene, og resultaterne fremgår af Tabel 4-20.

*Tabel 4-20: NVOC-analyser af renset vand fra UV+$H_2O_2$ (før PAC) og efter PAC.*

| | NVOC, mg/l | NVOC, mg/l | Reduktion, % |
|---|---|---|---|
| | Før PAC | Efter PAC | |
| Råvand | 4,9 | | |
| C6, optimal dosering | 5,5 | 2,3 | 58% |
| C7, overdosering | 4,4 | 1,9 | 57% |
| C8, underdosering | 5,4 | 2,2 | 59% |

Ved vurdering af resultaterne vil det være nyttigt at se på råvandets kulstofbalance, som fremgår af Tabel 4-21.

*Tabel 4-21: Kulstofbalance for råvandsprøven.*

| Råvand: | Kulstof andel | Analyse, mg/l | mgC/l |
|---|---|---|---|
| Flygtige stoffer (VOC): | | | |
| Vinylchlorid | 0,384 | 7,1 | 2,73 |
| cis-DCE | 0,247 | 1,4 | 0,35 |
| Benzen | 0,923 | 0,52 | 0,48 |
| Kulbrinter | 0,75 | 0,27 | 0,20 |
| Sum, flygtige stoffer | | | 3,75 |
| Ikke-flygtige stoffer: | | | |
| NVOC-analyse | | 4,9 | 4,9 |
| Grindstedværkstoffer | 0,479 | 1,673 | 0,80 |

| | | |
|---|---|---|
| Ukendt kulstofkilde (NVOC-GVS) | | 4,10 |
| Beregnet TOC = VOC + NVOC | | 8,65 |

Ud fra kulstofbalancen fremgår det, at NVOC i råvandet er 4,9 mgC/l, og VOC er 3,75 mgC/l. Den kendte andel af NVOC udgøres af Grindstedværk-stofferne, som bidrager med 0,8 mgC/l. Der er således 4,1 mgC/l i råvandet, som vi ikke ved, hvorfra det stammer. Det er oplagt at forvente, at der er en del humusstoffer i vandet, da det er grundvand, men der kan også være andre organiske stoffer eller kemikalier, der ikke er analyseret for. Til orientering kan oplyses, at COWI har fundet en drikkevandsanalyse fra Grindsted udtaget den 13.06.2018, og i den er NVOC = 0,98 mgC/l. NVOC-resultater fra en række grundvandsprøver ved Bekkasinvej og ved Svinget varierer ganske meget afhængig af dybden fra 0,3 til 13 mg/l.

Ser vi på NVOC-analyserne i Tabel 4-20, så giver de nogle interessante oplysninger. Man skal dog huske på, at den relative analyseusikkerhed for NVOC er ± 15%. Derfor må vi sige, at forskellen mellem de tre resultaterne efter AOP ikke nødvendigvis er så store, som det fremgår af tabellen. Det kunne dog se ud til, at NVOC falder en smule ved overdoseringsforsøget, mens det stiger lidt ved de to andre forsøg.

Normalt kan man forvente en mineralisering af vinylchlorid, cis-DCE og benzen, når man anvender UV+$H_2O_2$. I så fald bør NVOC ikke stige ved forsøget. Det gør det tilsyneladende ved den optimale dosering og ved underdosering, og det kan måske forklares ved, at UV-dosingen ikke har været stor nok til at opnå en fuldstændig mineralisering til vand og kuldioxid. I så fald vil der være nogle organiske nedbrydningsprodukter i det rensede vand, hvilket kan forklare en lille stigning i NVOC. De forventede nedbrydningsprodukter af vinylchlorid og cis-DCE før endelig mineralisering er formaldehyd, chloreddikesyre og chloracetaldehyd. Chloreddikesyre er ikke særlig flygtig og forventes at bestemmes som NVOC. Chloracetaldehyd er mere flygtig (damptryk = 0,139 bar), og det er tvivlsomt, om bidrager til NVOC. Formaldehyd er meget flygtig og forventes ikke at bidrage til NVOC.

Det synes indiskutabelt, at over 50% af det organiske stof (målt som NVOC) fjernes med aktivt kul. Dette resultat kan sammenlignes med, at man ved rensning af drikkevand med NVOC erfaringsmæssigt kan reducere NVOC-koncentrationen med 50-65%. Når man ikke kan fjerne NVOC i drikkevand 100%, skyldes det, at de stoffer, som normalt udgør NVOC i drikkevand, ikke alle kan absorberes på aktivt kul. Vi er i den samme situation her, hvor der tilsyneladende kun kan fjernes knap 60% af de resterende organiske stoffer, som findes i vandet efter en AOP-rensning. Vi har desværre ikke nogen analyser, der viser, hvilke stoffer der er tilbage i vandet efter rensning med PAC. Det kan være humusstoffer eller andre naturlige stoffer i grundvandet, men det kan også i mindre omfang være nedbrydningsprodukter af Grindstedværkstoffer.

Her skal dog nævnes, at Grindstedværkstofferne kun udgør 0,8 mgC/l, og da vandet efter kulrensning indeholde ca. 2 mgC/l, så kan restindholdet ikke alene bestå af nedbrydningsprodukter af Grindstedværkstofferne. Det vil kræve en større analytisk undersøgelse af vandet at finde frem til den kemiske sammensætning af de resterende organiske stoffer.

Ved oxidation og nedbrydning af vinylchlorid kan vi forvente:

- Normalt opnås en komplet mineralisering til: $H_2O_2$ + $CO_2$ + HCl
- Alternativt vil der kunne dannes formaldehyd, chloracetaldehyd, og chloreddikesyre

Ved oxidation og nedbrydning af cis-DCE kan vi forvente:

- Normalt opnås en komplet mineralisering til: $H_2O_2$ + $CO_2$ + HCl
- Alternativt vil der kunne dannes chloracetaldehyd, og chloreddikesyre

Ved nedbrydning af benzen kan vi forvente:

- Phenol, myresyre, eddikesyre, propionsyre og carbonylforbindelse

Det er straks mere kompliceret at forudse, hvad der sker, når Grindstedværkstofferne bliver oxideret med et kraftigt oxidationsmiddel. Vi forventer egentlig, at der dannes de samme slutprodukter hvad enten man bruger UV+$H_2O_2$ eller katalytisk $H_2O_2$ forudsat, at oxidationen gennemføres fuldt ud. De fleste Grindstedværstoffer er molekyler med en molvægt på ca. 200 g/mol. I Tabel 4-22 kan man se nogle data for de stoffer, som forekommer i største koncentration i råvandet. Stofferne indeholder typisk 6 til 12 kulstofatomer og 1 til 3 kvælstofatomer. Det bemærkes, at stoffet ethylurethan, som har vist sig at være vanskeligt nedbrydeligt, adskiller sig fra de andre ved at have en lav molekylvægt og kun 3 kulstofatomer i et molekyle. Den mest almindelige stofgruppe er barbiturater, men der er også flere sulfastoffer.

*Tabel 4-22: Udvalgte Grinstedværkstoffer med de højeste koncentrationer i råvandet*

| **Udvalgte Grindstedværkstoffer** | µg/l | Empirisk formel | M, g/mol | C-andel |
|---|---|---|---|---|
| Amobarbital | 43 | C11H18N2O3 | 226,3 | 0,424 |
| Butylbarbiturat | 110 | C8H11N2O3 | 183 | 0,525 |
| 5,5-diallylbarbitursyre (Allobarbital) | 230 | C10H12N2O3 | 208,2 | 0,576 |
| Ethylurethan | 315 | C3H7NO2 | 89 | 0,404 |
| Isobutylbarbitursyre | 150 | C8H12N2O3 | 184 | 0,522 |
| Isopropylbarbitursyre | 86 | C7H10N2O3 | 170 | 0,494 |
| Meprobamat | 61 | C9H18N2O4 | 218,3 | 0,495 |
| Pentobarbital | 56 | C11H18N2O3 | 226,3 | 0,583 |
| Sulfamethazin (Sulfadimidin) | 110 | C12H14N2O2S | 278,3 | 0,517 |
| Sulfanilamid | 37 | C6H8N2O2S | 172,2 | 0,418 |
| Sulfanilsyre | 65 | C6H5N2O3S | 173,2 | 0,416 |
| Sulfacetamid | 200 | C8H10N2O3S | 214 | 0,449 |
| Sulfanilylurinstof | 110 | C7H9N3O3S | 215 | 0,391 |
| Sum | 1530 | | Middel | 0,479 |

Ved oxidation af Grindstedværkstofferne kan man forestille sig en svag oxidation ved et eller flere kulstofatomer, hvorved der dannes en alkoholgruppe. Ved yderligere oxidation kan alkohol oxideres videre til en aldehydgruppe eller en ketongruppe, som igen kan oxideres videre til an caboxylsyregruppe (-COOH). Der kan under visse forhold også ske en fraspaltning, så der dannes et mindre molekyle. Hvis der er kulstof-kulstof dobbeltbindinger vil de kunne brydes under dannelse af en carbonylgruppe. Det vil kræve en avanceret MS-analyse at få identificeret mellemprodukter eller nedbrydningsprodukter, og slutresultatet af en oxidation vil blandt andet afhænge af oxidationsmidlets art og styrke samt reaktionstiden.

Resultaterne fra de tre UV-forsøg kunne tyde på, at man ved underdosering og optimaldosering har fået tilført organisk stof (NVOC) – måske fordi reaktionstiden har været for kort til at opnå en total mineralisering af de flygtige komponenter.

Der findes faktisk to andre resultater fra run A (special forfilter) og run B (overdosering) ved Water IQ-forsøgene. Ved Run A formindskes NVOC fra 4,9 mgC/l i råvandet til 4,0 mgC/l efter forfilteret. Vi kan samtidig se, at ca. halvdelen af Grindstedværkstofferne fjernes ved Run A, hvilket svarer til en reduktion af NVOC på ca. 0,4 mgC/l. Noget kunne tyde på, at der måske også er fjernet lidt af nogle andre organiske stoffer i forfilteret, så vi på den måde får NVOC ned på 4,0 mgC/l. Vi kan også se, at NVOC stiger fra 4,9 til 5,5 i Run B. Det kan skyldes analyseusikkerheden, men det kan måske også forklares med, at en mindre del af de flygtige organiske forbindelser er blevet omdannet organiske nedbrydningsprodukter, der påvises som en øget NVOC-koncentration.

Alt i alt må vi konkludere, at AOP-processerne tilsyneladende ændrer lidt på NVOC-koncentrationen i vandet. Det synes ganske sikkert, at man kan fjerne en stor del af NVOC (knap 60%) ved en PAC-rensning af renset vand fra AOP-processen. Vi forventer, at det også vil gælde de andre AOP-forsøg, men vi har desværre ingen analyseresultater, som bekræfter det.

Vort analyseprogram kan entydigt påvise, hvilke stoffer der forsvinder ved rensning med AOP og PAC, og man kan se hvilke restkoncentrationer af de enkelte stoffer, man kommer ned på i det rensede vand. Analyseprogrammet kan desværre ikke dokumentere, hvilke nedbrydningsprodukter, der måtte opstå og derfor findes i det rensede vand. Som det fremgår af ovenstående, så er der dog visse indicier for, at de flygtige organiske forbindelser nedbrydes helt ved de to anbefalede metoder - UV+$H_2O_2$ og katalytisk $H_2O_2$ – når oxidationen forløber fuldt ud. Det er derimod umuligt at sige noget mere præcist om, hvad der sker med Grindstedværkstofferne under oxidationen.

## 4.10 Resultatvurdering

Der foreligger rigtig mange forsøgsresultater, og de fleste resultater er fremkommet ved kemiske analyser hos ALS Danmark. Nogle resultater er ulogiske

ud fra forsøgsomstændighederne, men der er er flere muligheder for fejl. Specielt for de meget flygtige komponenter (vinylchlorid, cis-DCE og benzen), som er til stede i store koncentrationer i råvandet, er der nogle uventede resultater, som er vanskelige at forklare.

**Er resultaterne pålidelige?**

Der er ingen tvivl om, et der er stor risiko for at der forsvinder flygtige komponenter, når man skal håndtere vandprøverne. Det gælder udtagning af råvandsprøverne, og det gælder opbevaring og håndtering af råvandet i laboratoriet. Også ved selve forsøgene og efterfølgende håndtering af det rensede vand er der risiko for, at de flygtige komponenter fordamper i et vist omfang.

Endvidere er der risiko for, at der kan ske en kemisk oxidation i prøverne, hvis ikke overskud af oxidationsmiddel er helt fjernet. Denne risiko er dog ikke så stor. Hydroxylradikaler vil ikke forekomme. Brintperoxid er ikke særlig effektivt som oxidationsmiddel alene. Ozon har en meget begrænset levetid (halveringstid mellem 20 og 30 minutter). I prøver, der skal analyseres, er overskud af oxidationsmiddel fjernet. På grund af en misforståelse har man dog ikke fjernet overskud af $H_2O_2$ i prøver fra Water IQ til PAC-forsøg hos Suez. COWI vurderer, at det ikke har nogen væsentlig betydning for resultaterne fra PAC-forsøgene, da prøverne fra Water IQ kun indeholdt meget små mængder organisk stof. Et af disse stoffer var ethylurethan, som har vist sig at være vanskeligt at nedbryde ved AOP, så det er ret utænkeligt, at det kan nedbrydes bare med $H_2O_2$ alene.

Suez har afvigende resultater i 6 kategorier:

A. Hvis der er målt moderate højere restkoncentrationer ved høj dosering end ved lavere dosering, hvor resultaterne ligger inden for analyseusikkerheden.

B. Hvis der er målt moderate højere restkoncentrationer ved høj dosering end ved lavere dosering, hvor resultaterne ligger uden for analyseusikkerheden, og her kan være mange forklaringer, som er vanskelige at få verificeret, når resultaterne meddeles fra laboratoriet.

C. Påvisning af komponenter efter rensning ved AOP og/eller PAC, hvor komponenter ikke er påvist i råvandet. Det kan være måleusikkerhed, kontaminering af prøver eller en anden årsag.

D. Højere resultater af visse komponenter efter rensning ved AOP og/eller PAC, end der findes i råvandet. Afvigelsen ligger dog inden for analyseusikkerheden.

E. Højere måleresultater for visse komponenter efter AOP, end der findes i råvandet. Afvigelsen ligger uden for analyseusikkerheden.

F. Højere måleresultater for visse komponenter efter PAC, end der findes før PAC. Afvigelsen ligger uden for analyseusikkerheden.

Afvigelser af kategorien A, C og D er ikke særlig store og vil ikke påvirke konklusionen af forsøgene. Afvigelser af kategorien B, E og F er betydelige og kan sløre konklusionen for enkelte forsøg, men det er COWIs vurdering at ingen af disse større afvigelser har afgørende betydning for den samlede konklusion af forsøgene, og det er desværre ikke muligt på nuværende tidspunkt at finde frem til årsagen til disse afvigelser, men i enkelte tilfælde kan opstilles nogle sandsynlige hypoteser.

Vinylchlorid: Opfører sig uventet i de tre typer AOP-forsøg, som Suez har udført. Normalt vil man forvente, at man har den dårligste rensning ved underdosering, resultater skulle blive noget bedre ved den optimale rensning, og det bedste resultat opnås måske ved overdosering, men sådan er det ikke ved AOP-rensningen og heller ikke ved den efterfølgende PAC-rensning. Der er ikke noget entydigt mønster, og noget tyder på, at det måske kan skyldes, at vinylchlorid er ekstrem flygtig, og der forsvinder noget ved håndtering af vandet og prøverne. For Water IQ-forsøgene er tendensen i resultaterne dog som forventet.

Cis-DCE: Her er de fleste forsøg som forventet, men et enkelt forsøg afviger.

Grindstedværkstoffer: Tendensen i resultaterne er generelt som forventet. For et enkelt stof, mepromabat, er der dog fundet mindst dobbelt så meget i det rensede vand ved Suez forsøgene, som der er fundet i råvandet. Det har vi ikke nogen umiddelbar forklaring på. For Water IQ-forsøgene er billedet et andet, idet man kan fjerne mepromabat ganske effektivt med den metode. Efterrensning med PAC kan næsten fjerne mepromabat fuldstændigt.

Analyse af råvandet:

Umiddelbart forekommer analysen af råvandet hos ALS at være ganske pålidelig. Ganske vist har det hollandske laboratorium fundet noget lavere koncentrationer af de mest flygtige komponenter (vinylchlorid, cis-DCE og benzen), hvilket kan forklares ved, at en del af disse komponenter er fordampet ved håndtering af palletanke og prøvetagning i Holland.

COWI er ret sikre på, at der ikke er fordampet væsentlige mængder opløsningsmidler fra de prøver, som er udtaget til analyse den 11. marts samtidig med, at der blev udtaget vandprøver til både Suez og Water IQ. Derfor anvendes resultaterne fra COWIs prøve som baseline for råvandets sammensætning. Det har nemlig ikke særlig stor betydning for vurdering af resultaterne, om koncentrationen af de mest flygtige komponenter er lidt mindre end i baseline prøven, da det kun har begrænset indflydelse på den præcise størrelse af de restkoncentrationer, der er tilbage i vandet efter AOP-rensning.

Suez og Water IQ har fået leveret vand i palletanke. Når man tapper vand af en palletank, så vil der være stadig mere luft i palletanken, og den luft mættes ret hurtigt med flygtige organiske forbindelser. Vinylchlorid er den mest flygtige forbindelse (Henrys konstant er 1,14), så man kan forvente, at der mistes rigtig meget vinylchlorid fra vandet til luften i en palletank.

Man kan teoretisk beregne, hvor meget vinylchlorid-koncentrationen vil være i vandfasen, når palletanken er halv fyldt med vand. Hvis startkoncentrationen af vinylchlorid var 7100 µg/l, så vil koncentrationen i vandfasen kun være 2650 µg/l, når der er blevet aftapper 500 liter vand, og der er 500 liter tilbage i tanken. COWI ved, at Water IQ har tømt palletankene og fyldt vandet på dunke, da de modtog prøverne i Holland. I den forbindelse tømmer man løbende palletanken, og man vil alligevel få en situation, som minder meget om vores beregningseksempel. Det kan forklare, at det hollandske laboratorium finder mindre værdier for vinylchlorid. Det hollandske analyselaboratorium finder også mindre værdier for cis-DCE og benzen, men her er forskellen i forhold til baseline prøven noget mindre end for vinylchlorid. Det stemmer fint med, at Henrys konstant er noget mindre for cis-DCE og benzen.

Ved vurdering af råvandet kan det være nyttigt at se på en kulstofbalance. Den fremgår af Tabel 4-21. Den ser ganske rimelig ud. COWI har også lavet en kvælstofbalance for råvandet, og den fremgår af Tabel 4-23. Det fremgår heraf, at Grindstedværkstoffer udgør ca. 40% af det kvælstof, som der findes i vandet, men der er en ukendt kvælstofkilde, der udgør 32% af kvælstoffet. Selv om der er betydelig usikkerhed på bestemmelsen af total-N, så ser kvælstofbalancen også ganske rimelig ud.

*Tabel 4-23: Kvælstofbalance i råvandet*

| Kvælstofbalance | Kvælstof andel | Analyse, µg/l | µgN/l |
|---|---|---|---|
| Total-N | 1,000 | 600 | 600 |
| Nitrat, $NO_3$ | 0,226 | 60 | 14 |
| Ammonium, $NH_4$ | 0,778 | 180 | 140 |
| Grindstedværkstoffer | 0,150 | 1673 | 251 |
| Ukendt N-kilde (difference) | | | 195 |

Det skal nævnes, at ALS i første omgang havde fundet TOC = NVOC = 4,9 mg/l i råvandet. Det kan naturligvis ikke være korrekt, da man har store mængder flygtige forbindelser med kulstof (måles som VOC). Konfronteret hermed, har ALS meddelt, at vi skal se bort fra TOC-resultatet, men NVOC er korrekt.

**Konklusion**

Det er konstateret, at der nogle analyseresultater og forsøgsresultater, som ikke stemmer helt med forventningerne, da de ikke følger den logiske vej. Nogle afvigelser kan forklares, men der er også enkelte resultater, som ikke kan forklares. Det er dog COWIs opfattelse, at resultaterne kan benyttes til at vurdere rensemetodernes effektivitet, da helhedsbilledet er ganske klart.

# 5 Detaljeret analyse af løsninger til on site-vandrensningsmetoder

I dette afsnit vil vi se på de to udvalgte metoder (C og D), som skal vurderes nærmere med henblik på at finde den bedste egnede rensemetode til et fuldskala-anlæg. I afsnit 3 har vi tidligere beskrevet, at de to ozonmetoder (A og B) ikke kan anbefales til et fuldskala-anlæg, da de giver den mindste rensning af de undersøgte metoder, og under selve renseprocessen sker der en betydelig stripning af vinylchlorid, hvilket er uacceptabelt. Desuden er dannelse af de uønskede stof bromat også et problem. Vi mener derimod, at UV+$H_2O_2$ og katalytisk $H_2O_2$ begge skal vurderes nærmere. De to metoder er blandt de fire, som er beskrevet i afværgeprogrammet i 2019 /2/. Alle 4 metoder er detaljeret beskrevet i Bilag G. Her vil vi kun se nærmere på de to udvalgte rensemetoder.

De to løsninger omfatter:

- Løsning C: Sandfilter + UV + $H_2O_2$ + GAC
- Løsning D: Sandfilter + keramisk coated forfilter + katalytisk $H_2O_2$ filter + GAC

Begge løsninger omfatter følgende procestrin:

- Oppumpning af forurenet grundvand og drænvand. Vand ledes gennem rørføring til vandbehandlingsanlæg. Oppumpning af grundvand samt opsamling af drænvand er det samme for begge renseløsninger. Oppumpning er nærmere beskrevet i /2/. I det økonomiske overslag er der forudsat oppumpning af 10 $m^3$/time som skal behandles.
- Vandet forrenses i et sandfilter, hvor der doseres brintperoxid. Herved iltes jern, og det udfælder som brunt ferrihydroxid, $Fe(OH)_3$, der fjernes i sandfilteret. Overskud af $H_2O_2$ kan efterfølgende udnyttes i AOP-processen. Metoden kan ikke fjerne mangan. Analyser af råvandet har vist, at der er et meget lavt manganindhold, som ikke nødvendigvis skal fjernes i et forfilter. I det katalytiske anlæg findes der et særligt forfilter, som kan fjerne mangan og andre tungmetaller. Sandfilteret skal returskylles med passende mellemrum. Til returskylning anvendes renset grundvand. Returskyllevan-

det vil typisk udgøre ca. 5 % af den filtrerede vandmængde. Returskyllevandet kan renses ved en sedimentation, hvor det brune jernslam samles på bunden. Det forventes, at jernslammet kan udledes til kloak. Vandfasen fra returskyllevandet bør behandles i AOP-renseanlægget. I Bilag H står der mere om forrensemetoder.

- De to AOP-metoder benytter begge brintperoxid, som aktiveres og danner hydroxylradikaler, som er et meget stærkt oxidationsmiddel, der kan nedbryde de fleste organiske forbindelser.
- Løsning C: UV + $H_2O_2$ → 2 •OH
- Løsning D: Katalytisk filter + $H_2O_2$ → 2 •OH
- Efterfiltrering gennem kulfilter til fjernelse af rester af iltningsmidler og eventuelle restprodukter af miljøfremmede stoffer. Vi anbefaler, at anlægget bliver udført med to kulfiltre i serie. På den måde kan man få optaget maksimal mængde organisk stof, uden at det går ud over renseeffektiviteten, fordi vandet til sidst løber igennem et næsten rent kulfilter. Når det første filter er helt mættet, skal det udskiftes, hvorefter man bytter om på rækkefølgen, så det helt nye filter bliver placeret til sidst. Kulforbruget er vanskeligt at forudsige præcist. Kulforbruget hænger bl.a. sammen med, hvor meget organisk stof, der nedbrydes ved AOP samt ved destruktion af brintperoxid. Ud fra kendskab til restkoncentrationen af organisk stof, som skal fjernes, kan det beregnes, at kulforbruget bliver af størrelsesorden 4500 kg/år. Det gælder begge metoder, da det er baggrundskoncentrationen af organisk stof, som er den mest afgørende faktor. I Bilag I er der en mere uddybende beskrivelse af efterfiltrering med aktivt kul.
- Bortskaffelse af renset vand enten til overfladevand, grundvandszonen eller spildevandssystem, se beskrivelse i /2/. Det anbefales, at der vælges en løsning med udledning til Grindsted Å, da dette er den mest enkle og billigste løsning.

Detaljeret analyse

I den detaljerede analyse er metoderne vurderet både teknisk og økonomisk. I den tekniske vurdering er løsningerne vurderet på følgende punkter, som er opstillet i et skema, som fremgår af Bilag G. Det bør prioriteres højt, at selve AOP-metoden skal kunne destruere de organiske forbindelser til et meget lavt niveau, så kulfilteret belastes mindst muligt.

- Teknisk metodebeskrivelse med principdiagram af anlæg
- Udviklingsstadium
- Kommercielt tilgængelig
- Renseeffekt
- Kapacitet ($m^3/h$)
- Energiforbrug
- Kemikalieforbrug

- Forventet holdbarhed af udstyr
- Forurenet overskudsjord som skal bortskaffes efter etablering
- Metodens tekniske begrænsninger
- Behov for supplerende oplysninger/tests/undersøgelser?
- Fordele
- Ulemper
- Referencer

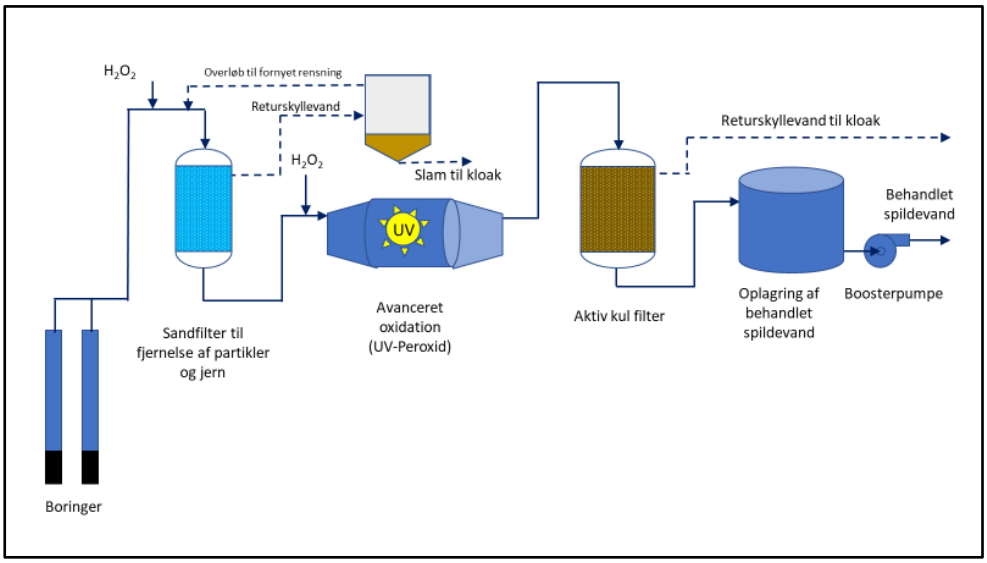
I de følgende afsnit gives der en kort beskrivelse af de to løsningsforslag. For detaljer henvises til Bilag G.

## 5.1 C: Oppumpning og vandrensning med Sandfilter, UV + $H_2O_2$ + GAC

AOP-processer med UV-lys kaldes ofte for fotokemisk oxidation. Den mest almindelige fotokemiske oxidationsproces er en proces med brintperoxid ($H_2O_2$) og UV-lys. Her dannes hydroxylradikaler, se nedenstående reaktionsligning (1). Til denne proces skal der ud over brintperoxid også bruges elektricitet.

(1) $H_2O_2$ + UV-lys $\rightarrow$ 2 •OH

AOP med UV og brintperoxid vurderes at have samme oxidationspotentiale som løsning B og højere end løsning A. Principdiagram af et muligt anlæg fremgår af Figur 5-1.




*Figur 5-1 Principdiagram af Løsning C: UV + $H_2O_2$.*

Først fjernes partikler og jern i sandfilteret. I AOP-reaktoren tilsættes brintperoxid til vandet, efterfulgt af bestråling af vandet via UV-lamper i AOP-reaktoren, som er designet til at give den korrekte kontakttid (flow) og blanding

til vandbehandlingen. UV- og brintperoxid-doserne skal optimeres for den specifikke vandkvalitet, der skal behandles. Variationer i vandkemien for drænvand og oppumpet grundvand vurderes ikke at medføre væsentlige problemer med AOP-behandlingen.

UV-lamper skal rengøres regelmæssigt for at forhindre belægninger, da disse reducerer UV-intensiteten. Kommercielle anlæg er normalt altid forsynet med et automatisk system til rengøring af lamperne, idet rensningen igangsættes automatisk.

I det tidligere afværgeprogram i 2019 /2/ omtales et forholdsvis stort strømforbrug til frembringelse af UV-doser i vandet som én af ulemperne ved metoden. Her var det forudsat brug af mellemtrykslamper (MP-lamper) som er det normale i USA, der giver lys med en bred bølgelængde. Erfaringen viser imidlertid, at UV-lys ved 254 nm er mest effektiv til dannelsen af hydroxylradikaler og nedbrydning af organiske forbindelser. Derfor vil det være en fordel at anvende lavtrykslamper (LP-lamper), som giver UV-lys ved 254 nm. Det er efterhånden lykkedes at fremstille LP-lamper med stor effekt og effektiv omdannelse af el-input til UV-energi output. Med den teknik kan det danske firma UltraAqua fremstille meget effektive UV-anlæg (LP) med et forholdsvis lavt strømforbrug. Strømforbruget for anlæg med LP-lamper er væsentligt mindre end for anlæg med MP-lamper. Flere andre danske firmaet sælger UV-anlæg primært til desinfektion af vand, men der er ikke mange danske firmaer, som har ekspertise og erfaring med fotokemisk oxidation

Resultater af laboratorietest

Resultaterne fra laboratorietestene viste at man med UV+$H_2O_2$ kan nedbryde alle kulbrinter og BTEX'er i vandet. Metoden kan nedbryde mindst 99% af de chlorerede forbindelser og mere end 90% af Grindstedværkstofferne. Resultaterne tyder på, at man kunne opnå betydelig større nedbrydning af både chlorerede forbindelser og Grindstedværkstoffer, hvis man havde tilsat en større UV-dose. Det fremgår nemlig af de tre UV-forsøg, at nedbrydningen af Grindstedværkstofferne øges med stigende UV-dosering. Med efterbehandling i et kulfilter blev der opnået en rensegrad for Grindstedværkstoffer på ca. 98 %.

De væsentligste fordele ved metoden er:

- Metoden er den billigste i etableringsomkostninger af de to AOP-metoder.
- Metoden gav generelt bedre rensning end ozon-metoderne ved de udførte laboratorieforsøg, og meget tyder på, at fjernelsen af organiske stoffer kan blive betydelig bedre end ved laboratorieforsøgene, hvis der tilsættes en noget større UV-dose end ved forsøgene.
- Bromid vil ikke kunne iltes til det kræftfremkaldende stof bromat. Desuden skal der ikke etableres anlæg til generering af ozon, som udgør en risiko for arbejdsmiljøet.
- Det er simplere og mere sikkert at håndtere brintperoxid end f.eks. ozon.

- AOP med UV og brintperoxid til behandling af grundvand er en velafprøvet metode i USA. I Danmark har COWI deltaget i to projekter med fotokemisk oxidation, der blev anvendt i en simpel udgave med stor succes i 1990´erne. I det ene tilfælde rensede man i flere år stærkt trichlorethylen-forurenet grundvand på en virksomhed i Søborg. Omdannelsen af trichlorethylen var tilsyneladende en komplet mineralisering, idet man kunne måle alt det frigivne chlorid i det rensede vand. I det andet tilfælde rensede man stærk phenolforurenet spildevand fra fremstilling af tagpap hos en virksomhed på Amager. Da alt phenol var nedbrudt, var COD blevet reduceret med ca. 50%, og der fandtes store mængder lave flygtige syrer i vandet (eddikesyre, propionsyre og smørsyre. Herefter kunne spildevandet udledes til offentligt renseanlæg, hvor restprodukterne i spildevandet blev renset og nedbrudt biologisk. Ved behandling med UV+$H_2O_2$ skete der således ikke nogen total mineralisering af phenol, men der blev dannet en række organiske nedbrydningsprodukter i form af lave flygtige syrer.

De væsentligste ulemper ved metoden er:

- Der kan dannes belægninger på lampeglasset, som svækker lysgennemgangen. UV-anlægget skal derfor være forsynet med automatisk rensesystem for lampeglassene.

- Lampernes lysstyrke reduceres med alderen. Det måles løbende med en UV-intensitetsmåler.

- Der blev ikke opnået en fuldstændig rensning af forsøgsvandet ved laboratorieforsøgene. Der er derfor stadig en mindre usikkerhed på, om der kan opnås en komplet rensning af vandet fra forureningsfanen fra det tidligere Grindstedværket.

- Anvendes mellemtrykslamper vil strømforbruget være meget betydeligt

- Der er ingen erfaring med farmaceutiske stoffer i Danmark

Sammenfatning

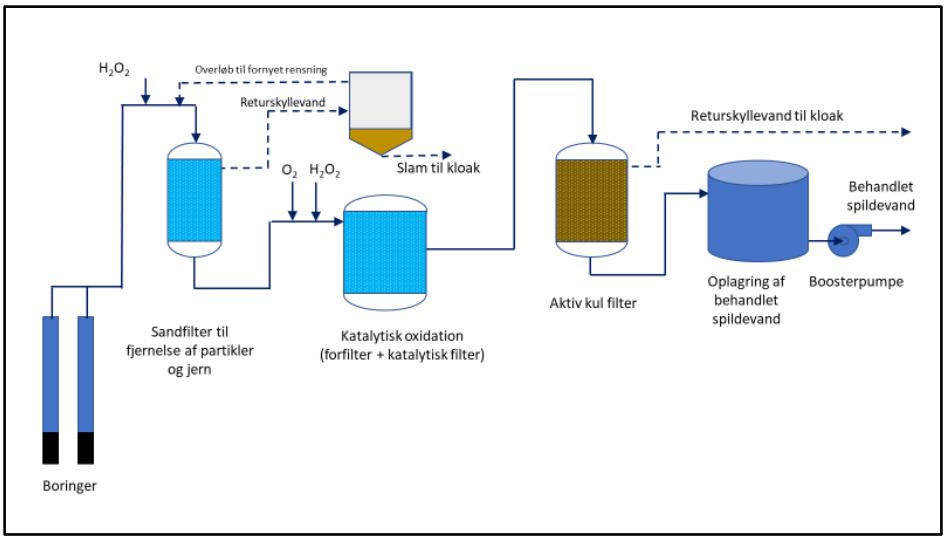
Samlet set vurderes denne løsning at være en potentiel fuldskala løsning til at rense grundvandet fra forureningsfanen fra det tidligere Grinstedværket. Forsøgsresultaterne fra Suez´s forsøg kan dog ikke bekræfte, hvor effektivt vandet kan renses med denne metode. Derfor er det nok tvivlsomt, om man på det foreliggende grundlag kan få leverandører til at give tilbud på et sådant anlæg med en passende detaljeret funktionsgaranti. Den manglende dokumentation vil med stor sandsynligvis kunne fremskaffes ved nogle få supplerende forsøg med passende stor UV-dosering.

## 5.2 D: Oppumpning og vandrensning med sandfilter, katalytisk $H_2O_2$ filter + GAC

Det er også muligt at generere hydroxylradikaler ud fra $H_2O_2$ ved en katalytisk proces med et fast stof. Metoden er udviklet af det hollandske firma Water IQ, som har taget patent på metoden.

Anlægget består af to filtre. Det første filter er et keramisk filter med en særlig coatning, så filteret både kan fjerne partikler og positive ioner. Selv om dette filter i princippet kan fjerne jern, blev det, i samråd med Water IQ valgt at anvende et sandfilter foran Water IQ´s anlæg, da COWI er skeptisk over for, om det coatede forfilter i praksis uproblematisk kan håndtere de meget store jernmængder i råvandet. Det andet filter er et keramisk filter, hvor filtermaterialet er coated med en katalysator, der er i stand til at aktivere brintperoxid. Før gennemløb af dette filter doseres brintperoxid og ioniseret ilt til vandet, og ved kontakt med katalysatorkammeret aktiveres brintperoxid under dannelsen af hydroxylradikaler.

Katalysatoren forbruges/inaktiveres langsomt, og derfor skal den katalytiske coatning i begge filtre fornyes 2-4 gange årligt. Man kan eventuelt også tilsætte en flydende katalysator til vandet, så den oxiderende effekt bliver endnu kraftigere. COWI kender ikke den kemiske sammensætning af den flydende katalysator, men vi ved at den indeholder en del jernsalt samt formentlig mindre mængder af andre tungmetalsalte. Ved laboratorieforsøgene blev der tilsat flydende katalysator i det første forsøg, mens der ikke blev tilsat flydende katalysator i de to andre forsøg (E og F). Det viste sig, at man kunne opnå en meget effektiv fjernelse af alle organiske stoffer uden bruge af flydende katalysator, blot opholdstiden i det katalytiske filter var lang nok. Principdiagram fremgår af Figur 5-2




*Figur 5-2 Principdiagram af Løsning D: Katalytisk brintperoxid-filter.*

Metoden er forholdsvis ny, og der er ingen anlæg af denne type i drift i Danmark. Metoden minder om løsning B og C (Suez), da alle disse tre metoder danner hydroxylradikaler ud fra brintperoxid. Water IQ har fået denne anlægstype godkendt i Holland til fjernelse af pesticider i gartnerivand.

Resultater af laboratorietest

Resultaterne af laboratorieforsøgene viste, at en løsning med katalytisk $H_2O_2$ kan rense grundvandet næsten fuldstændigt. Efter rensning med aktivt kul er der et samlet restindhold af organisk stof på under 1 µg/l bestående af chlorethan og dichlormethan samt meget små mængder toluen og xylen. Metoden

fjerner også effektivt den genstridige komponent ethylurethan, som de andre afprøvede metoder har svært ved at fjerne.

De væsentligste fordele ved metoden er:

- Ved laboratorieforsøgene var denne metode den mest effektive AOP-metode, da den næsten 100 % kunne nedbryde alle typer organiske stoffer.
- Det er simplere og mere sikkert at håndtere brintperoxid end f.eks. ozon, og der er ikke risiko for dannelse af bromat.
- Den katalytiske proces kræver ikke løbende kemikalietilsætning ud over brintperoxid og ilt, og selve processen forbruger ingen strøm.

De væsentligste ulemper ved metoden er:

- Der er tale om en forholdsvis ny metode, så erfaring med metoden er relativt begrænset. I Danmark er metoden ikke afprøvet.
- Metoden anvendes i Holland til rensning af pesticider i vand fra gartnerier. Metoden har, efter vores viden, ikke være anvendt til rensning af vand med komponenter som findes i forureningsfanen fra det tidligere Grindstedværket. Water IQ har dog lavet forsøg med forurenet grundvand i Hertogenbosch, hvor vandet indeholdt høje koncentrationer af TCE og cis-DCE samt mindre mængder vinylchlorid.
- Katalysatoren forbruges og skal fornyes 2-4 gange årligt.
- Der dannes små mængder spildevand, når filtrene reaktiveres. Muligheder for bortskaffelse af spildevand skal nærmere belyses fx. i et detailprojekt.
- Ved forsøg E og F blev pH i det rensede vand ca. 10,5. Water IQ mener, at det skyldes spaltning af $H_2O_2$, og det er en mulighed. I så fald vil man formentlig kunne undgå en høj pH-værdi, hvis man optimerer doseringen af $H_2O_2$, så man undgår et stort overskud.

Sammenfatning

Samlet set vurderes denne løsning at være en potentiel fuldskala-løsning til at rense grundvand fra forureningsfanen fra det tidligere Grinstedværket. Selv om Water IQ ved forsøgene har demonstreret en meget stor renseeffekt, så er det dog tvivlsomt, om de på det foreliggende grundlag tør give tilbud på et fuldskalaanlæg med en tilstrækkelig detaljeret funktionsgaranti. I rapporten fra Water IQ anbefales det, at der bør laves pilotforsøg for at få endelig fastlagt, hvor stor opholdstid, der bør anvendes, og hvor meget $H_2O_2$, der bør doseres samt om der eventuelt bør anvendes en flydende katalysator. Anbefalingen er givet på trods af, at Water IQ har masser af erfaringer fra fuldskala-anlæg til rensning af gartnerispildevand, men det er tydeligt, at man ønsker bedre designgrundlag, end man har opnået ved forsøgene med det lille specielle forsøgsanlæg

## 5.3 Økonomisk overslag

I dette afsnit gives økonomisk overslag over udgifter til etablering og drift af selve renseenhederne.

Forudsætninger

Forudsætningerne for prisoverslag er følgende:

- Der skal behandles 10 m³/time.
- Der sker oppumpning af 5,5 m³/t grundvand fra 2 boringer og opsamling af 4,5 m³/t drænvand fra 2 drænstrenge.
- Det rensede vand ledes til Grindsted Å.
- Overslag er uden omkostninger til forundersøgelser.
- Der er jf. oplysning fra Region Syddanmark regnet med en elpris på 1,47 kr./kWh ekskl moms.
- Årlig monitering:
  Der er forudsat periodevis analyse af indløbsvand fra de 2 pumpeboringer og de 2 drænstrenge samt analyse af det rensede vand (der er regnet med prøvetagning hver anden måned med årlige udgifter til analyser på 100.000 kr.). Herved kan det kontrolleres, at det rensede vand overholder de krævede rensekriterier. Desuden kan der beregnes, hvor meget forurenings-masse der løbende fjernes.

  Der er efter aftale med Regionen ikke medtaget udgifter til monitering af grundvand eller overfladevand.
- Der er ikke medregnet ekstra deponeringsafgifter for deponering af eventuel opgravet/opboret jord fra bore- og installationsarbejder, mens udgifter til bortskaffelse af de 12 m³ slam/returskyllevand er indregnet.
- Prisniveau er 2020 priser.

I Tabel 5-1 fremgår økonomiske overslag for de 2 løsninger. Økonomi er opgjort som et interval (lavt og højt estimat). Spænd i interval angiver usikkerhed i omkostningerne, som er henholdsvis -10 og + 30% i forhold til overslagsberegningerne.

*Tabel 5-1 Overslag over udgifter til etablering og drift af renseenheder. Udgifter til forundersøgelser er ikke medtaget i tabellen. Alle beløb er kr. ekskl. moms.*

| LØSNING | | PROJEKTERING OG ETABLERING | | DRIFT, ÅRLIGE UDGIFTER | |
|---|---|---|---|---|---|
| | | LAVT ESTIMAT | HØJT ESTIMAT | LAVT ESTIMAT | HØJT ESTIMAT |
| C | Sandfilter + Brintperoxid + UV, GAC | 4.800.000 | 6.900.000 | 1.100.000 | 1.600.000 |
| D | Sandfilter, Brintperoxid/Katalysator + GAC | 7.700.000 | 11.100.000 | 1.000.000 | 1.400.000 |

Følgende kan udledes af prisoverslagene:

- Løsning C med UV + brintperoxid er den billigste løsning mht. etablering. Antages en driftstid på fx. 5 år er løsning C samlet set den billigste løsning, når man indregner alle udgifter – både etableringsudgifter og driftsudgifter.

- Løsning D med katalytisk brintperoxid er den billigste løsning med hensyn til drift, men etableringsudgifterne er højere end for løsning C. Antages en driftstid på fx. 5 år er løsning D er dyrere end C, når man indregner alle udgifter – både etableringsudgifter og driftsudgifter.

Såfremt vandet ikke kan udledes til recipient, anbefales det at søge om at få tilladelse til reinfiltration. I så fald vil der være ekstra udgifter til reinfiltration til grundvandszonen. Såfremt der heller ikke opnås tilladelse til reinfiltration er sidste mulighed at lede vandet til et offentligt spildevandssystem:

Afledning til spildevandssystem

Eventuelle udgifter til afledning til spildevandssystem vil være ca. 9 kr./m³, såfremt vandet skal afledes som risikovand. Med en udledning på 10 m³/time (88.000 m³/år) vil det give årlige afledningsudgifter på i størrelsesordenen 0,8 mio. kr. Hvis vandet kan afledes som alm. grundvand er prisen ca. 4 kr./m³, svarende til ca. 352.000 kr.

Reinfiltration til grundvandszonen

Ved eventuel reinfiltration til grundvandszonen skal der etableres ca. 4 boringer til ca. 10-15 m u.t. (ned til, hvor redoxforholdene skifter til reducerede forhold med tilstedeværelse af jern), eller evt. en billigere løsning med faskiner samt ledningsføringer, styring og drift af reinfiltration. Det vurderes, at udgifter til anlæg til reinfiltration vil være ca. 200-400.000 kr. (afhængig af, om der vælges løsning med boringer eller faskiner). Årlige driftsudgifter med regenerering af boringer og styring af reinfiltration vil være ca. 100.000 kr.

## 5.4 Usikkerheder ved etablering af afværge ved nuværende vidensniveau

AOP-rensning

I Tabel 5-2 ses en sammenligning af de parametre, som er vurderet vigtigst for de to metoder og som afspejler de væsentligste usikkerheder i vidensniveau for at etablere et effektivt afværgeanlæg.

*Tabel 5-2 Sammenligning af vigtige parametre for de to rensemetoder.*

| Emne | UV+$H_2O_2$ (Metode C) | Katalytisk+$H_2O_2$ (Metode D) |
|---|---|---|
| Renseeffekt | Maksimal effekt endnu ikke dokumenteret | Maksimal renseeffekt dokumenteret |
| Etableringsomkostninger | Laveste | Højeste |
| Driftsomkostninger | Højeste | Laveste |
| Teknologi | Anerkendt og velafprøvet teknologi | Patenteret metode af Water IQ |
| Udbyder af teknologi | Flere forskellige firmaer både i og udenfor DK | Tilbydes kun af Water IQ |
| Dimensioneringsgrundlag | Ikke helt fastlagt | Fastlagt men ikke optimeret |
| Afprøvet i DK | Ja, flere anlæg | Aldrig |
| Sideeffekter | Ingen kendte | Høj pH |
| Driftsstabilitet | Kendte driftsudfordringer: Belægninger på UV-lampeglasset reducerer effekten | Ukendt |
| Servicering/reservedele | Kendt servicering, mulighed for reservedele i DK | Kun reservedele og service af Water IQ i Holland |

Det vurderes, at den største usikkerhed for metode C på nuværende tidspunkt er om, der kan opnås den samme renseeffekt før kul som ved metode D. Der er også usikkerhed, om hvilke problemer der kan blive med driften af UV-lamperne, men en fordel er, at det rensende vand er meget blødt (Ca-indhold 13 mg/l) svarende til hårdhed 2 og manganindholdet er lavt (0,43 mg/l). Hvis en forøgelse af UV-effekten kan forbedre renseeffekten tilfredsstillende, så viser beregningerne at metode C også vil være den billigste, når man ser på de samlede udgifter over en periode på 5 år.

Metode D er meget effektiv og med den målte rensegrad vurderes der at være gode muligheder for at kunne opnå en udledningstilladelse til Grindsted Å. En ulempe ved metoden er, at der kun er een udbyder, og hvis WATER IQ går konkurs, kan der være udfordringer med fortsat drift og servicering af anlægget. Der er heller ikke driftserfaringer under danske forhold med den meget komplekse forureningssammensætning og eventuelle driftsudfordringer er vanskelige at vurdere på det nuværende grundlag.

Oppumpet grundvand

Følgende forhold ved Renseanlæg Vest, Svinget 12 er ikke velbelyst:

- Forureningens detaljerede horisontale og vertikale udbredelse. Det er derfor usikkert, hvor pumpeboringer mest optimalt bør placeres, og hvor de filtersættes.
- Redoxforhold og geokemi i grundvandet, særligt forventede forhold i oppumpet vand samt beliggenheden af eventuelle redoxgrænser.
- De detaljerede hydrauliske parametre (hydraulisk ledningsevne, transmissivitet og magasintal), så der kan beregnes pumpeydelse og indfangningsbredden af oppumpningen.  i alt er der i de økonomiske overslag forudsat at der behandles 10 $m^3$/time. I praksis opsamles alt drænvand og der "spædes" op med oppumpning af grundvand så der i alt behandles 10 $m^3$/time.
- Den detaljerede geologiske opbygning i indsatsområde for oppumpning, her specielt vidensniveauet omkring lavpermeable aflejringer i grundvandsmagasinet (brunkul/ler), som kan have betydning for den vertikale forureningsudbredelse. Det er eksempelvis afgørende om lerlagene omkring ca. 10 m u.t. er gennemgående da dette kan have betydning for valg af filtersætning i pumpeboringer, for at finde det mest forurenede vand der skal supplere drænvandet.
- Flow i dræn og variationer i flowet samt drænkort.

Udledning af renset vand

Følgende er ikke afklaret:

- Mulighed for tilladelse til, at det rensede grundvand ledes direkte til recipient eller evt. til reinfiltration til grundvandszonen.
- Der findes kun vandkvalitetskrav for ét af Grindstedværk-stofferne. For de øvrige Grindstedværk-stoffer findes der ikke vandkvalitetskrav ved udledning til recipient. Der er derfor usikkerhed til krav til renseniveau for disse stoffer.

### 5.4.1 Tekniske usikkerheder ved de to rensemetoder C og D

Selv om laboratorieforsøgene har vist noget om renseeffektiviteten ved metoderne og afdækket en række vigtige problemstillinger, er der stadigvæk en række tekniske og økonomiske usikkerheder for en fuldskala-løsning baseret på

enten UV+$H_2O_2$ eller katalytisk+$H_2O_2$ begge forsynet med efterrensning med aktivt kul. Disse usikkerheder ser vi nærmere på.

## UV + $H_2O_2$:

- Renseeffekten ved laboratorieforsøgene var ikke så stor som man kunne ønske sig. Det skyldes med stor sandsynligvis, at man ikke tilsatte tilstrækkelig stor UV-dose. Modelberegninger har efterfølgende vist, at man kan destruere ca. 90 % mere af restindholdet af de chlorerede forbindelser ved 33 % ekstra UV-dose. De tre gennemførte UV-forsøg viser, at de mest genstridige Grindstedværkstoffer kan fjerens mere effektivt jo højere UV-dosering der anvendes. Derfor er der en begrundet formodning om, at man med 33% ekstra UV-dosering også vil kunne reducere restkoncentrationen af Grindstedværkstoffer ganske betydeligt ved at optimere UV-dosen i et fuldskala-anlæg.

- Ved de økonomiske beregninger har vi forudsat en UV-dose, der er 33 % større end ved det optimale lab-forsøg, som Suez har udført. Såfremt UV-beregningerne er korrekte, svarer det til et el-forbrug på ca. 30 % af de totale driftsudgifter. Viser det sig nødvendigt med endnu højere UV-dosering vil el-forbruget stige tilsvarende. Det er en usikkerhed, der ikke afklares uden at afprøve denne anlægstype i et supplerende lab-forsøg eller pilotforsøg.

- Metoden er almindelig anvendt i USA, men her anvender man især mellemtrykslamper (MP-lamper), der har et meget højt strømforbrug. COWIs økonomiske beregninger er baseret på anvendelse af lavtrykslamper (LP-lamper) ved 254 nm. Disse lamper bruger langt mindre strøm end MP-lamperne, fordi de kun udsender den bølgelængde, der skal benyttes til den katalytiske aktivering af brintperoxid. Selv om danske firmaer kan levere LP-anlæg, som anvendes i stor udstrækning til desinfektion af vand, så er der ikke den store erfaring herhjemme med at anvende disse UV-anlæg til rensning af forurenet grundvand.

- Ved de økonomiske beregninger er forudsat en lampelevetid på 2 år. Ofte estimeres levetiden lidt mindre på denne type anlæg, men da et total lampeskift kun udgør ca. 8 % af de årlige udgifter, har det ikke så stor indflydelse på driftsøkonomien.

- Ved laboratorieforsøgene har man ikke undersøgt, hvor hurtigt lampeglassene smudses til med belægninger, og om disse belægninger let kan fjernes mekanisk. Normalt leveres denne type anlæg med automatisk mekanisk renseudstyr. Da grundvandet indeholder meget lidt kalk, forventes der ikke at opstå særlige problemer med belægninger, så lampeglassene vil med stor sandsynlighed kunne holdes rene ved hjælp af det automatiske rensesystem.

- Det er forudsat, at man anvender et sandfilter til forrensning, da det er vigtigt, at fysiske partikler/urenheder og jern fjernes før UV-anlægget. Jern fjernes ved at ilte vandet med brintperoxid, og den proces er velkendt fra

flere industrielle applikationer. Så vidt COWI ved, har metoden dog ikke været anvendt til afjerning af grundvand. Metoden anvendes i stedet for en traditionel afjerning, hvor vandet iltes med luft, men den traditionelle metode kan ikke anvendes her, da den vil medføre, at store mængder flygtige organiske forbindelser vil strippes af vandet og emitteres til atmosfæren. Ved afjerningsmetoden med brintperioxid fjernes ikke mangan, som findes i små koncentrationer i grundvandet. Der er risiko for at mangan udfældes på lampeglassene sammen med kalk og andre stoffer, men det forudsættes at disse belægninger kan fjernes med det automatiske renseudstyr. Det skal bemærkes, at kalkindholdet er meget lavt i dette vand.

## Katalysator + $H_2O_2$:

- Resultaterne fra laboratorieforsøgene viste, at man med denne metode i princippet kunne destruere alle organiske forureninger i vandet, hvis opholdstiden var passende lang og dosering af $H_2O_2$ var tilstrækkelig. Der er dog ingen erfaringer i hverken Danmark eller udlandet med rensning af grundvand med denne type anlæg, for den meget komplekse forurenings-sammensætning der findes i forureningsfanen fra det tidligere Grindstedværkets fabriksgrund. Water IQ har dog i Holland lavet et laboratorieforsøg, hvor man med succes rensede grundvand, der var forurenet med store mængder TCE og cis-DCE samt små mængder vinylchlorid.

- Det afprøvede anlæg er fra det hollandske firma Water IQ, og det benytter en patenteret teknologi, hvor brintperoxid aktiveres til hydroxylradikaler i et filter, der er coated med en katalysator. Så vidt COWI bekendt kan tilsvarende anlæg ikke leveres fra andre firmaer, hvilket kan blive at problem, hvis det hollandske firma lukker. Det er nemlig forudsat, at de yder online support samt laver servicebesøg 2-4 gange om året, hvor man bl.a. reaktiverer katalysatoren.

- Anlægget indeholder et specielt forfilter, som kan tilbageholde mekaniske urenheder og positive stoffer (bl.a. $Fe^{2+}$ og $Mn^{2+}$). Da COWI er usikker på, om filteret kan rumme de meget store jernmængder, der skal fjernes fra vandet, har vi i samråd med Water IQ indsat et ekstra sandfilter, hvor der fjernes jern efter iltning med $H_2O_2$. Det er samme forrensning som for løsning C.

- Ved processen doseres der også ioniseret ilt, der ifølge Water IQ opløses i vandet, hvor det medvirker til oxidationen. Der er ifølge Water IQ ingen udluftning af gasser fra anlægget, så der burde ikke være risiko for stripning af flygtige komponenter til atmosfæren.

- Renseeffekten kan forbedres ved dosering af flydende katalysator. Laboratorieforsøgene har vist, at det ikke er nødvendigt at tilsætte flydende katalysator for at opnå en stor renseeffekt. Det ville også være uønsket, da katalysatoren indeholder jern, der udfældes som jernhydroxid, der i så fald skulle frafiltreres inden kulfilteret. Det ville være en ekstra renseproces og en ekstra omkostning, som med stor sandsynlighed ikke blive nødvendig.

- Et fuldskala-anlæg tænkes placeret i en 20 fods container, hvilket er forudsat i den økonomiske beregning.

- Dosering af brintperoxid var ved det optimale laboratorieforsøg 100 mg/l $H_2O_2$. Noget tyder på, at doseringen kan reduceres, hvilket må afklares ved et eventuelt pilotforsøg eller ved indkøring af et fuldskala-anlæg. Ved lavere dosering af $H_2O_2$ vil man måske også kunne undgå en kraftig pH-stigning i det rensede vand.

# 6 Konklusion og anbefaling

## 6.1 Konklusion

Det udførte laboratoriearbejde giver følgende konklusioner:

- Det oppumpede vand fra DGU NR. 114.2567 (BE6) indeholder forurening i et omfang, som gør det egnet som testvand til forsøgene.
- Alle de planlagte forsøg udført af Water IQ, Suez og DHI er blevet gennemført.
- Hvis råvandet alene renses med aktivt kul opnås en renseeffekt på 96 % svarende til en reduktion fra 11.125 µg/l til 466 µg/l for alle komponenter.
- I AOP-forsøgene med henholdsvis ozon og ozon+$H_2O_2$ kan der ikke opnås nær så god renseeffekt, som man kan opnå med de to andre metoder, desuden ses en uhensigtsmæssig stripning af specielt vinylchlorid.
- Skal renseeffekten for de to ozonmetoder forøges vil det kræve en højere ozondosering og deraf dannelse af en uacceptabel høj koncentration af bromat og stripning af vinylchlorid.
- I forsøgene med UV+$H_2O_2$ opnås der i overdoseringsforsøget en reduktion af forureningskomponenter fra 11.125 µg/l til 114 µg/l før kulbehandling og til 11,7 µg/l efter kulbehandling.
- I forsøgene med katalytisk+$H_2O_2$ opnås der i optimumforsøget en reduktion af forureningskomponenter fra 11.125 µg/l til 2,4 µg/l før kulbehandling og til 0,43 µg/l efter kulbehandling.
- Generelt er det cis-DCE, vinylchlorid og Grindstedværkstoffet ethylurethan, som ikke kan fjernes fuldstændigt ved rensningen uanset metode.
- COWI er ikke enig i Suez anbefaling om at metode B er den mest lovende metode.

- På det foreliggende datagrundlag er det metoden katalytisk+$H_2O_2$, som er den mest effektive AOP-teknologi, hvor stort set alle analyserede stoffer ligger omkring eller under detektionsgrænserne.
- Det vurderes, at den maksimale renseeffekt for UV+$H_2O_2$ før kulbehandling ikke er blevet fuldstændigt afdækket ved forsøgene.
- Det vurderes som sandsynligt, at hvis der anvendes et kraftigere UV-anlæg, så kan denne metode sandsynligvis blive lige så effektiv som den katalytiske metode og billigere over en periode på 5 år.
- Forsøgene tyder på, at man med passende stor UV-dosering kan få nedbrudt de chlorerede forbindelser fuldstændigt til vand, kuldioxid og saltsyre.
- Der er ikke umiddelbart noget der tyder på, at alle Grindstedværkstofferne bliver fuldstændig mineraliseret ved rensning med UV+$H_2O_2$ eller med de andre AOP-metoder.
- NVOC-analyserne tyder på, at der er en hel del organiske stoffer i råvandet ud over Grindstedværkstofferne.
- Resultatet af de økotoksikologiske test på det urensede vand fra DGU NR. 114.2567 (BE6) viser ingen negative korttids-effekter i testperioden.
- Det rensede vand viser for alle AOP-metoderne en lille negativ økotoksikologisk effekt, som dog vil forsvinde ved en fortynding på 4 gange.
- På det foreliggende grundlag kan det ikke afvises, at AOP-metoderne har dannet andre organiske stoffer, som ikke er omfattet i analyseprogrammet og som kan have haft betydning for den observerede lille negative økotoksikologiske effekt.
- Ledes det rensede vand ud i Grindsted Å, vil der ske en fortynding på mere end 400 gange.
- Det vurderes, at der er flere forhold, som skal afklares, inden et fuldskalaanlæg kan færdigdimensioneres, etableres og sættes i drift.
- På nuværende tidspunkt foreligger der ikke en udledningstilladelse og betingelserne for en sådan er ikke fastlagt.

## 6.2 Anbefaling

De udførte forsøg viser, at det er muligt at fjerne de analyserede stoffer i vandet fra DGU NR. 114.2567 (BE6) til et niveau, som giver et godt grundlag for at forhandle en udledningstilladelse til Grindsted Å. For metode D ses alle koncentrationer af de analyserede organiske stoffer under eller omkring detektionsgrænserne efter behandling med kul. Resultaterne for den organiske kulstofbalance

skaber dog usikkerhed om, i hvilket omfang der er dannet andre organiske forbindelser som følge af AOP og om disse kan være årsag til den lille negative økotoksikologiske påvirkning, der ses på de testede alger. Dog vurderes denne negative påvirkning at være så beskeden, at den ikke bør være afgørende for det videre forløb for en vandbehandlingsløsning. De udførte økotoksikologiske test vurderes som udgangspunkt at være dækkende for grundlaget for en udledningstilladelse.

Derfor anbefales det at igangsætte tilvejebringelsen af en udledningstilladelse, afklaring af boringsplacering og filtersætning, fanebredde, grundvandspotentialeforhold, magasinparametre samt en verificering af den maksimale renseeffekt og dimensioneringsgrundlag for UV+$H_2O_2$.

Det anbefales at udtage mere vand fra DGU NR. 114.2567 (BE6) og få et firma som f.eks. UltraAqua i Aalborg til at udføre nogle supplerende forsøg med større UV-dosering, end Suez anvendte ved UV-forsøgene. Disse supplerende forsøg vil give endeligt svar på, om det kan lade sig gøre at rense vandet lige så effektivt før kulbehandling som metode D. Forsøgene vil også give de endelige dimensioneringsparametre for et UV-anlæg, som er nødvendige for udarbejdelse af et godt udbudsmateriale. Det vurderes at forsøgene kan udføres i løbet af 4 måneder. I forbindelse med forsøgene bør analyseomfanget udvides for de behandlede prøver for at finde ud af hvilke organiske stoffer, der eventuelt er blev dannet som følge af AOP. Her tænkes særligt på de stoffer, som der potentielt er peget på i kapitel 4.9.

Hvis forsøgene viser, at en forøget UV-dosering ikke kan give en tilstrækkelig renseeffekt, så bliver metode D BAT (Best Available Technology). Hvis det er tilfældet, så er næste skridt et pilotforsøg udført med Water IQs mobile anlæg, hvor vand pumpes direkte fra DGU NR. 114.2567 (BE6) ind i behandlingsanlægget og der udtages prøver både før og efter rensning. Formålet med pilottesten er tilvejebringelse af de nødvendige dimensioneringsparametre for et fuldskalaanlæg og dermed et bedre grundlag for estimering af omkostninger til både etablering og drift for denne metode. Det vurderes, at pilotforsøget vil kunne gennemføres i løbet af 4 mdr.

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# Bilag A (BE6) Placering af DGU nr. 114.2567

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**Signaturer:**

- Anden boring
- Miljøboring
- Sløjfet boring
- Vandboring

| Boring | Filter (m u.t.) | Sum Grindstedstoffer (µg/l) | Vinylklorid (µg/l) | Benzen (µgl) |
|---|---|---|---|---|

## Regions Syddanmark
### Grindstedværket

**Situationsplan**

| | |
|---|---|
| ATR-nr. | A121940-002 |
| Tegn./Udarb. | PJN |
| Kontr. | AKRA |
| Godk. | AKRA |
| Mål | 1:2000 (A3) |
| Dato | 30. april 2019 |
| Dokument nr. | Bilag A |
| Rev. | 0 |

Bemærkninger

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# Bilag B Rapport fra Water IQ

**Pilot test of AOP-method for treatment of contaminated groundwater from the pollution plume at Grindstedværket.**

**Used method: $H_2O_2$ + fixed-bed catalyst**

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**Signature:**

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Annexes

1 Analysis results from Synlab, the Netherlands

2 Analysis results from ALS, Denmark

# 1 Introduction

## 1.1 Background

**The former Grindstedværket factory site in Grindsted, Denmark, has been contaminated by a number of pharmaceutical substances (referred to as Grindstedværket substances), hydrocarbons (particularly benzene), chlorinated solvents and degradation products of the solvents, especially vinyl chloride (VC) and cis- 1,2- dicholoroethene (Cis), due to past activities. The contaminated groundwater flows from the source site(s) to Grindsted Stream and much of the contamination flows into the creek at the former Renseanlæg Vest WWTP.**

**The Region of Southern Denmark (RSD) has decided to analyse the possibilities of reducing the impact on Grindsted Stream. The idea is to establish a temporary system by means of protective pumping combined with on-site treatment of groundwater (pump and treat) on the Renseanlæg Vest site.**

**On behalf of the region, COWI carried out a screening of relevant methods for onsite treatment of contaminated groundwater. It was assessed that advanced oxidation processes (AOP) could provide a suitable treatment of the groundwater before it is discharged. Four AOP processes have been selected for testing, either in the lab or in a mobile plant at the former Renseanlæg at Svinget 12, Grindsted.**

**The four AOP methods are:**

1. **Ozone**
2. **Ozone + $H_2O_2$**
3. **$H_2O_2$ + UV**
4. **$H_2O_2$ + fixed-bed catalyst.**

**Before carrying out AOP tests the groundwater must be pre-treated, and after the AOP tests, it will be post-treated with activated carbon.**

**Water IQ has performed AOP method 4: $H_2O_2$ + fixed-bed catalyst.**

## 1.2 Purpose

**The overall purpose of the AOP tests is to examine whether the methods are suited for treating the specific groundwater contamination mix found in Grindsted. The purpose of the AOP tests is:**

- **to test the suitability of the four selected AOP methods for treating groundwater.**
- **to study the treatment efficiency of all four AOP-processes regarding Grindstedværket substances, total hydrocarbons, BTEXN, chlorinated solvents and degradation products of the solvents, including in particular VC and Cis.**
- **to study pre-treatment of the polluted groundwater by removing iron and manganese prior to AOP treatment.**
- **to determine relevant design parameters per m³ water, including dosage and concentration of oxidants and UV-dose, reaction time/contact time for oxidation and for post-treatment with activated carbon as well as any need for further addition of other chemicals.**

**Furthermore, the eco-toxicity of both treated and untreated water will be tested to assess the possibilities of discharging the treated water into Grindsted Creek in case a full-scale system is established later on.**

## 1.3 Organization of report

**This report is structured as follows:**

| | |
|---|---|
| **Section 1** | **describes the background and structure of this report;** |
| **Section 2** | **describes the site location and the environmental situation;** |
| **Section 3** | **describes the technique used by Water IQ;** |
| **Section 4** | **describes the tests and all results;** |
| **Section 5** | **describes the results from ALS;** |
| **Section 6** | **describes the limitations and OPEX;** |
| **Section 7** | **summarizes the results and the key environmental issues and provides recommendations.** |

.

# 2 Site information

## 2.1 Location

The former Grindstedværket factory was located at the northern boundary of the village of Grindsted at Tarnvej 25. Nowadays this factory is part of DuPont (Nutrition Biosciences ApS).

The location where the samples for testing were obtained lies in the centre of Grindsted, directly north of the small stream, the Grindsted Å.

## 2.2 Contamination

The groundwater contamination originates from the former Grindstedværket factory and possibly some former wastewater disposal sites, and flows below the city of Grindsted in a south-westerly direction towards the Grindsted Å.

Tables 1 till 3 contain selected results from analyses of groundwater from the location of the Renseanlæg Vest site, given to Water IQ as part of the Tender information.

The analysis results are expected to provide a solid overview of the composition of the water that is tested, but significant variations are to be expected. Furthermore, COWI stressed that in excess of 1,100 chemical substances and products were used at Grindstedværket, so it is likely that samples will reveal low content of substances not previously analysed for in past studies.

Volatile organic components
Table 1 shows the presence of relatively high concentrations of volatile organic components, i.e. hydrocarbons and chlorinated components in samples taken from the well that would be used for providing the test samples. In particular high concentrations of benzene, VC and Cis were found.

The chlorinated solvents and hydrocarbons are volatile, thereby not contributing to NVOC. However, they form part of the analysis results when analysing for TOC, which is the sum of the volatile organic carbons (VOC) and non-volatile organic carbons (NVOC).

| | | DGU 114.2567 (BE6), filter 2 | |
|---|---|---|---|
| **Component** | **Unit** | **18-07-2019** | **10-10-2016** |
| **Organic parameters** | | | |
| Benzen | µg/l | 400 | 440 |
| Toluen | µg/l | 7.9 | 6.0 |
| Ethylbenzen | µg/l | 0.63 | 0.73 |
| m+p-Xylen | µg/l | 0.54 | 0.70 |
| o-Xylen | µg/l | 1.6 | 2.7 |
| Sum af xylener | µg/l | 2.8 | 4.1 |
| BTEX (sum) | µg/l | 410 | 450 |
| Naphthalen | µg/l | 0.02 | <0.02 |
| C6H6-C10 | µg/l | 420 | 460 |
| C10-C25 | µg/l | < 8 | 11 |
| C25-C35 | µg/l | < 9 | <0.02 |
| Sum (C6H6-C35) | µg/l | 420 | 480 |
| 1,2-dichlorethan | µg/l | < 2 | <2 |
| Trichlormethan (Chloroform) | µg/l | < 0.02 | <2 |
| 1,1,1-trichlorethan | µg/l | < 0.02 | <2 |
| Trichlorethen | µg/l | 2.1 | 4.6 |
| Tetrachlormethan | µg/l | < 0.02 | <2 |
| Tetrachlorethen | µg/l | 4.8 | 23 |
| Chlorethan | µg/l | < 2 | <2 |
| 1,1-dichlorethen | µg/l | < 2 | <2 |
| trans-1,2-dichlorethen | µg/l | 29 | 47 |
| cis-1,2-dichlorethen | µg/l | 350 | 1,200 |
| 1,1-dichlorethan | µg/l | < 2 | <2 |
| Vinyl chloride | µg/l | 2,700 | 4,700 |

***Table 1: Results of analysis of organic substances at the Renseanlæg Vest***

**Inorganic components**

**Table 2 shows that the inorganic parameters of the groundwater are typical for groundwater with a relatively low saline concentration. The content of heavy metals is not critical, and water hardness is relatively low. Nevertheless, the groundwater may contain a relatively substantial level of iron and manganese, which might make it necessary to remove iron and manganese before using the groundwater for AOP tests, depending on the characteristics of the test and the actual concentrations in the test samples.**

**Significant bromide concentrations (up to 1500 µg/l) were identified. Bromide concentrations over 35 µg/l are critical, since bromide and ozone may form the hazardous substance bromate, which causes cancer. As ozone plays no relevant role in the Water IQ process the presence of bromide requires no extra health and safety regulations.**

| Component | | DGU 114.2567 (BE6), filter 2 | |
|---|---|---|---|
| | Unit | 18-07-2019 | 10-10-2016 |
| pH | pH | 5.6 | 5.7 |
| Temperature at pH-measurement | °C | 21 | NA |
| Total dissolved solids | mg/l | 350 | 380 |
| Conductivity20°C | mS/m | 60 | 61 |
| Ammonia (NH4) | mg/l | 0.1 | 0.13 |
| Nitrite | mg/l | < 0.001 | 0.026 |
| Nitrate, $NO_3$ | mg/l | < 0.3 | <0.3 |
| Total Phosphor | mg/l | < 0.01 | 0.02 |
| Chloride | mg/l | 170 | 130 |
| Fluoride (F) | mg/l | < 0.05 | 0.065 |
| Sulfate (SO4) | mg/l | 29 | 56 |
| Aggressiv carbon dioxide | mg/l | 110 | 120 |
| Hydrogen carbonat | mg/l | 32.3 | 33.7 |
| Bromide (Br), filtered | mg/l | 0.9 | 1.5[1] |
| Lead (Pb) filtered in-situ | µg/l | 0.028 | 0.26 |
| Cadmium (Cd) filtered in-situ | µg/l | < 0.003 | 0.019 |
| Calcium (Ca) | mg/l | 3.4 | 5.3 |
| Chromiu (Cr) filtered in-situ | µg/l | < 0.03 | 0.81 |
| Iron (Fe) | mg/l | 1.1 | 2.4 |
| Iron (Fe) filtered in-situ | mg/l | 0.96 | NA |
| Potassium (K) | mg/l | 0.66 | 1.1 |
| Copper (Cu) filtered in-situ | µg/l | < 0.03 | NA |
| Magnesium (Mg) | mg/l | 1.6 | 2.1 |
| Manganese (Mn) | mg/l | 0.047 | NA |
| Manganese (Mn) filtered in-situ | mg/l | 0.045 | 0.18 |
| Sodium (Na) | mg/l | 110 | 120 |
| Nickel (Ni) | µg/l | 2.7 | 4.1 |
| Nickel (Ni) filtered in-situ | µg/l | 2 | NA |
| Zinc (Zn) filtered in-situ | µg/l | 3.7 | 10 |

***Table 2: Results of analysis of inorganic parameters at the Renseanlæg Vest***

**Organic components (non-volatile)**

**As is shown in table 3, the groundwater contains relatively large concentrations of Grindstedværket substances, especially sulpha substances and barbiturates. Apart from the results of the sampling well also the highest measured concentrations are mentioned.**

**On the basis of a limited amount of data from the location, it is estimated that the substances contributing to the NVOC content are mainly Grindstedværket substances. Assuming that 30 to 60 percent of the Grindstedværket substances are carbons (depending on the chemical formulas), the NVOC results are consistent with the sum of the Grindstedværket substances.**

| COMPONENT | CAS-NUMBER | UNIT | DGU 114.2567 (BE6) | | MAX.VALUE ON THE LOCALITY |
|---|---|---|---|---|---|
| | | | 18-07-2019 | 10-10-2016 | |
| **Grindstedværk subbstance** | | | | | |
| 3-Methoxypropionitril | 110-67-8 | µg/l | <0.1 | <0.1 | |
| 5-allyl-5-isobutyl-barbitur acid | 77-26-9 | µg/l | 17 | 14 | 17 |
| 5-Butylbarbiturat | 1953-33-9 | µg/l | 56 | <0.1 | 56 |
| Acetylsulfaguanidin | 19077-97-5 | µg/l | <0.1 | <0.1 | <0.1 |
| Acetylsulfanil acid | 121-62-0 | µg/l | <0.1 | 0.18 | 70 |
| Aethallymal | 2373-84-4 | µg/l | 2 | <0.1 | 2 |
| Allobarbital | 52-43-7 | µg/l | 100 | 100 | 270 |
| Allylamine (Dipropenylamin) | 107-11-9 | µg/l | <0.1 | <0.1 | 8.8 |
| Allyl-n-butylbarbiturat | 3146-66-5 | µg/l | 0.85 | 2.7 | 5.4 |
| Amobarbital | 57-43-2 | µg/l | 44 | 130 | 130 |
| Barbital | 57-44-3 | µg/l | 13 | 38 | 72 |
| Butabarbital | 125-40-6 | µg/l | 14 | 25 | 140 |
| Butobarbital | 77-28-1 | µg/l | 9.1 | 16 | 58 |
| Ethylcarbamat (Ethylurethan) | 51-79-6 | µg/l | <0.1 | 5,700 | 14,000 |
| Hexobarbital | 56-29-1 | µg/l | <0.1 | 0.25 | 0.25 |
| Isobutylbarbitur acid | 42846-91-3 | µg/l | 72 | <0.1 | 72 |
| Isopropylbarbitur acid | 7391-69-7 | µg/l | 55 | 0.19 | 55 |
| Meprobamat | 57-53-4 | µg/l | 170 | 720 | 720 |
| Metharbital | 50-11-3 | µg/l | <0.1 | 0.16 | 0.16 |
| Monoethylbarbitur acid | 2518-72-1 | µg/l | <0.1 | <0.1 | <0.1 |
| N-N-diethylnicotinamid | 59-26-7 | µg/l | 0.63 | 2.6 | 18 |
| Pentobarbital | 76-74-4 | µg/l | 22 | 160 | 160 |
| Phtalylsulfathiazol | 85-73-4 | µg/l | <0.1 | <0.1 | 21 |
| Secobarbital | 76-73-3 | µg/l | 11 | 26 | 26 |
| Sulfacetamide | 144-80-9 | µg/l | <0.1 | <0.1 | 3.8 |
| Sulfadiazin | 68-35-9 | µg/l | <0.05 | <0.05 | <0.05 |
| Sulfadimidin (Sulfamethazin) | 57-68-1 | µg/l | 43 | 85 | 460 |
| Sulfaguanidine | 57-67-0 | µg/l | 260 | 5.4 | 380 |
| Sulfamerazin | 127-79-7 | µg/l | 7.1 | 6.7 | 12 |
| Sulfamethizol | 144-82-1 | µg/l | <0.050 | 8.0 | 330 |
| Sulfanilamide | 63-74-1 | µg/l | 180 | 150 | 750 |
| Sulfanil acid | 121-57-3 | µg/l | 100 | <0.1 | 9.4 |
| Sulfanilyl urea | 547-44-4 | µg/l | 570 | 2.5 | 570 |
| Sulfapyridine | 144-83-2 | µg/l | <0.10 | <0.1 | 17 |
| Sulfathiazol | 72-14-0 | µg/l | 3.5 | 2.3 | 91 |
| Sum of Grindstedværk substances | - | µg/l | 1,750 | 7,196 | 14,926 |
| **NVOC** | | | | | |
| NVOC, non-volatile organic carbon | | µg/l | 1,100 | Not analysed | |

*Table 3: Results of analysis at the Renseanlæg Vest as well as highest level found at the location.*

## 2.3 Obtaining test samples

**On several occasions COWI has taken samples to determine the best location for the water sampling to be used for the AOP-tests. On the basis of the analysis results, it was decided**

**that the groundwater to be used for the tests had to be taken from filter 2 of well BE6 (DGU no. 114.2567).**

***Figure 1: The site of former Renseanlæg Vest WWTP, with the location of well 114.2567 (BE6), from which test water samples were taken.***

**Water IQ intended to use a mobile test installation for performing the tests on-site. The pilot installation is a downscaled manual controlled version of the full-scale OPTICLEAR DIAMOND® technology which has a fully automated oxidants mixing device, see chapter 3. During testing of the equipment before mobilisation Water IQ concluded that the installation might require last-minute adjustments.**

**As a result Water IQ decided to perform the tests in Eindhoven under direct supervision of Freddy Dekkers. COWI approved the change of pilot testing. On March 10th the required volume of water (2 $m^3$) was collected at the location of the former Renseanlæg Vest in Grindsted. COWI took care of the pumping of the contaminated water from the well to the containers.**

**A sample of the water has been taken to ALS laboratory for testing the "raw water" concentrations, see chapter 5.**

**After filling it was observed that there was still some head space due to the shape of the IBC's (the upper corners of the IBC's reach above the filling point). This is considered as a minor disturbance of the water quality.**

**At the location two cool boxes with all the packaging for the ALS testing were distributed.**

# 3 The installation

## 3.1 Background

**Water IQ International is the specialist for water (re)use in malting plants, food processing and horticulture. With the specific knowledge of water Water IQ provides sustainable solutions that enables clients to deal with water-related challenges.**

**One of the techniques Water IQ has developed treats the process water of horticulture. The system (Opticlear Diamond) removes up to 99 % of the pathogens resulting in an (almost) zero-emission system. This specific technique is based on the system asked for in AOP method 4: $H_2O_2$ + fixed-bed catalyst.**

**OPTICLEAR DIAMOND® technology, general information**
**The OPTICLEAR DIAMOND® is a system developed for process water treatment in two steps, molecular adsorption and efficient oxidation. In the first step, substances are adsorbed in a column filled with ceramic carrier material. This material has a specific coating. The coating is selected on the basis of the desired removal of substances and gives the material a load. This creates a "loaded sieve" which allows for an effective and selective filtration on a molecular level. Periodic reactivation of the carrier material secures the adsorption capacity.**

**After the adsorption, efficient oxidation takes place. Oxidants are injected via a mixing chamber into a column of ceramic carrier material, which is equipped with a catalyst. The catalyst increases the oxidation strength of the OPTICLEAR DIAMOND® and limits the energy consumption of the system.**

**Used technology**
**The pre-treated water (101, numbers referring to figures 2 and 3) is purified in a two-step process. The first step is a selective adsorption. In this step, substances are adsorbed in adsorption columns (103) filled with ceramic carrier material.**

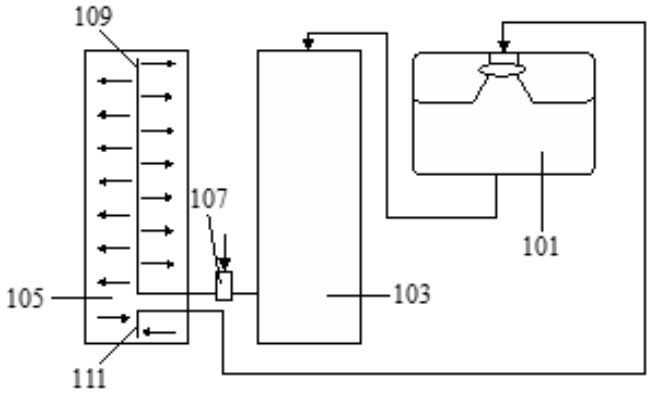


*Figure 2. High level flow diagram of the technology*

**The adsorption process enables selective purification of the water and uses a carrier material having a ceramic open structure to enable binding of polymeric organic molecules. The aim is to remove suspended solids and other organic pollution elements that would (undesirably) consume oxidants during the advanced oxidation (breakdown) of chemical components.**

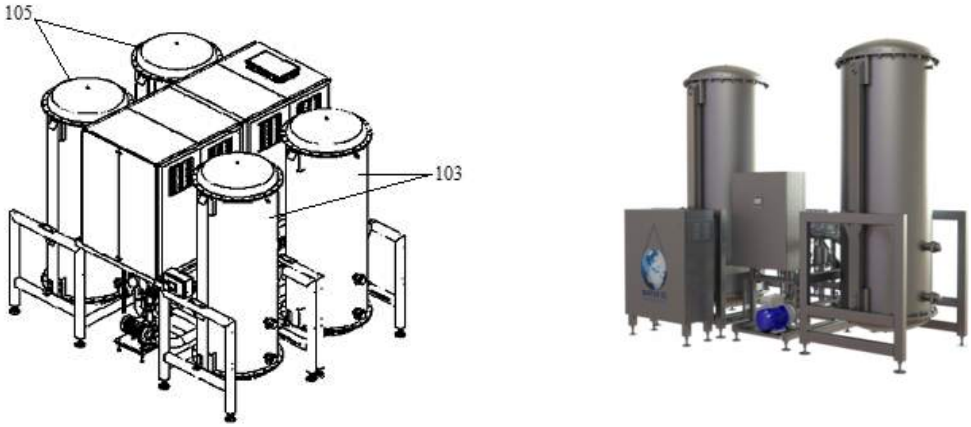


*Figure 3. Example of a full scale installation, able to treat 20 to 50 $m^3$/hour (left) or 10 $m^3$/hour (right) of chemically contaminated water.*

**After the adsorption process the water goes further into the second step which is a treatment based on advanced oxidation in oxidation columns (105). This step removes residues of chemicals, like crop protection agents or – in this case – pharmaceutical (by)products. Hydroxyl radicals are formed with a catalyst induced advanced oxidation. Oxidants hydrogen peroxide (liquid) and high concentrated (doubly ionized) oxygen (gas) is injected (107) in the water by means of a specially designed mixing chamber.**

**The catalyst is immobilized on the carrier material, a ceramic filter bed. The catalyst, which consists of a complex of metal ions, like copper, iron, cobalt, palladium, and oxidants produce the radicals (OH* and $O_2$-) that react with chemicals, micro-organisms and soluble organic contamination. These radicals ensure an energy efficient breakdown of chemicals in the water before discharging.**

**The water enters the oxidation columns via a perforated injection tube (109) extending vertically upwards in the columns and leaves the oxidation columns via a perforated drainage tube (111).**

**NB: The effluent will not be recycled in the tank (101) as depicted in fig.1 but will be directly discharged to the sewer.**

**The technology has been patented by Water IQ International B.V. (patent pending).**

## 3.2 Setup for testing

**Proposed test**

**As stated before, originally the tests would be performed on site with a pilot test unit specifically made for the Grindstedværket project. The unit had to be mobile thus requiring optimization of the total volume. One of the volume-reducing changes was the incorporation of the second step of the installation within the first step, resulting in a column within a column. The selective adsorption column has a total volume of 160 litres, corrected for the inner column. The (inner) advanced oxidation column has a total volume of just 20 litres.**

*Figure 4. Test installation with one column (column of the second step integrated in the first step)*

*Figure 5. Injection of catalyst and $H_2O_2$ (test setting) before the conventional mixing chamber*

**Another adjustment concerned the mixing chamber. Due to the limited flow the patented mixing chamber (with direct injections) could not be used as this chamber requires a flow of**

**at least 1.5 $m^3$/hour. Finally all automated systems were replaced by manual valves and buttons, because of sensitivity and possible damage due to transport. This resulted in a downscaled version of the Opticlear Diamond technology with an expected lower performance.**

**Additional post treatment**

**While pretesting Water IQ noticed that there was some flocculation of iron hydroxide in the water coming out of the test installation. This iron is not from the original Grindsted water but is supplemented as part of the catalyst that is injected. Due to the fact that a test installation is used and the settings have to be done manually Water IQ decided to use an overdose of catalyst, so that the availability of catalyst would not be the limiting factor for the reaction.**

***Figure 6. Post treatment for iron hydroxide due to catalyst***

**Water IQ decided to add a post treatment after the test installation to remove the iron hydroxide. Water IQ has installed the post treatment before the first final test. The post treatment is, more or less, a conventional small sand filter with the exception that no air or oxygen is submitted.**

# 4 The tests

**As mentioned before the IBC's were not filled completely due to their shape. This is considered as a minor disturbance of the water quality. During testing though the head space will gain in volume after each extraction of water (thus after each performed pre-test and (final) test run). During the sampling in Denmark the suggestion was made to transfer the content of one IBC to several drums (without head-space). This would make the situation at start identical for each test.**

**After internal discussion Water IQ suggested to correct for the changing concentration at start in a different way:**

> **The transfer of the water for sure would have a relevant effect on the concentration of volatile components due to the pumping. Furthermore the Safety and Health plan required minimization of the amount of activities in which contact with the contaminated water might occur.**
>
> **Water IQ therefore suggested to use the IBC's and take samples of the water before and after each of the 3 final test runs. The samples would be sent to a laboratory (Synlab[1], Hoogvliet (Rotterdam)) for an analysis on the most important volatile components being VAH (including benzene) and CAH (including VC and Cis).**
>
> **The results of each test would be available within 12-24 hours. The results would be sent to COWI as well. For each final test run Water IQ would have the accurate concentrations at start and after treatment. With these concentrations Water IQ could determine the efficiency of the treatment (on the volatile components). In this way the potential difference in the concentrations of the volatile contamination due to the gaining amount of head space would be nullified.**

**The proposed change was discussed with COWI and accorded.**

**At the end of the testing period all samples were sent to ALS under the required refrigerated conditions. For each sample applied that it has been stored under required (refrigerated) conditions before the final transport.**

**The samples for Suez (Water IQ filled a 25 litre jerry can per final test run) were sent after all test runs were performed. For each jerry can applied that it has been stored under required conditions before the final transport.**

| Origin | Packaging | Volume | Adress |
|---|---|---|---|
| Pre- (1) and AOP treated water (3) | ALS sampling containers | 4 ALS sets | ALS (DK) |
| AOP treated water | PPH 25L container | 3 x 25 litre | SUEZ (CH) |
| Raw water (4 IBC's) | Synlab sampling containers | 4 sets for volatile samples and metals | Synlab (NL) |
| Pre- and AOP treated water | Synlab sampling containers | 7 sets for volatile samples and metals | Synlab (NL) |

*Table 4. Summary of the samples (the samples of tests C and D are not included)*

[1] SYNLAB Analytics & Services B.V. in Rotterdam is accredited by the "Raad voor accreditatie" according to EN ISO/IEC 17025:2017 nr. L028. The analyses on volatile components were done according to AS3130-1.

## 4.1 Test results raw water

**The raw water (IBC 1 and 2) contained relatively high concentrations of benzene, VC and Cis and some low concentrations of trichloroethene and tetrachloroethene. The exact concentrations are mentioned in the following table 5 (NB: all original analysis results can be found in Annex 1):**

| Container | pH | COD (mg/l) | Concentrations (in µg/l) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Vinylchloride | Dichloroethene | Trichloroethene | Tetrachloroethene | Benzene |
| IBC 1 | 5.77 | 15 | 2,100 | 1,035 | 6.8 | 8.8 | 380 |
| IBC 2 | 5.73 | 37 | 2,900 | 1,344 | 6.7 | 9.0 | 440 |

*Table 5. Concentrations of the "raw water".*

## 4.2 Pre-treatment

**The water does not have to be pre-treated as the installation itself will take care of any iron. This was described in the Q&A session before tendering. The first step of the test installation works as follows (partly text from the tender document):**

> **The adsorption process enables selective purification of the water and uses a carrier material having a ceramic open structure to enable binding of non-charged polymeric organic molecules, comparable to the working principle of granular activated carbon.**
> **Besides this the first step removes (almost) all metals by binding it on the charged carrier material. In this way any iron or manganese will be removed before the injection of the $H_2O_2$ and catalyst and the start of the actual process in step two.**

**As the first step removes part of the organic contaminants, COWI has been consulted to make sure that the results of the testing would be interpreted in the right way. Water IQ decided to take samples before and after each step to ensure that the concentrations of volatile contaminants are known before, during and after treatment.**

**Sample A (sent to ALS) is taken after the first step of the installation, more or less resembling pre-treatment of the water. With the lab results (Synlab) Water IQ was able to conclude that the first step does influence the amount of volatile contaminants but only in a limited way (approx. 5-10 % loss in the first step).**

**Note: the volatile contaminants are not aerated, the installation is completely airtight and can not loose any volatile components.**

## 4.3 Pretesting

**During the test runs Water IQ tried several flows. At the end of the tests it was concluded that the optimal test settings would be with the minimum acceptable flow of approx. 160 litres per hour with a relatively high dose of $H_2O_2$. This is the lowest possible flow, due to the restrictions of the pump. For the reaction this is not the most favourable situation, as the**

**injection of $H_2O_2$ and the catalyst takes place once every second (instead of the preferred 3 times per second).**

**The resulting minimum flow is not optimal in the sense of residence time either. Experience with the treatment of pathogen containing process water has demonstrated that a (minimum) residence time of 15 minutes is required to get optimal results. With the minimum acceptable flow of 160 litres per hour and the inner volume of column 2 (the advanced oxidation) being 20 litres the residence time is approx. 7.5 minutes.**

## 4.4 Final tests

### 4.4.1 Test B (optimal test)

**Settings**
**The flow was 160 litres per hour. The amount of injected $H_2O_2$ (concentration 35 %) and catalyst was 0.33 litre per hour for both (1.0 stroke per second).**

**For the first final test (B) the water from IBC 1 has been used.**

**Results**
**In the first final run (run B) samples have been taken at several points in the installation (the number corresponds with the number on the lab results, see Annex 1):**

1. **Raw water, not processed**
2. **Water after the first step (pre treatment) of the installation (also sampled for ALS, run A, see 4.2)**
3. **Water after the second step**
4. **Final water after the post treatment (also sampled for ALS and Suez, run B)**

**The results after the post treatment have been influenced by the fact that the installation for post treatment had not been cleaned before use. The (higher) concentrations of metals (mainly copper, nickel and zinc) are the result of the manure purification that had been done earlier with this installation.**

**The results of the radical oxidation, the second step – sample 3 –, are very good (compared to the raw water of IBC 1):**

**Vinylchloride has completely disappeared;**
**Benzene has also completely disappeared;**
**Dichloroethene is found at a level of 1.5 µg/l, the efficiency being 99.8 %;**
**Trichloroethene has completely disappeared;**
**Tetrachloroethene is found at a level of 1.1 µg/l, the efficiency being 87.5 %.**

**The TOC results of final test B are (with 3 samples analysed, see *Note 3* paragraph 4.4.2):**

1. **4.6 mg/l**
2. **4.8 mg/l**
4. **5.8 mg/l**

**The amount of remaining $H_2O_2$ was approx. 50 ppm, which shows that the setting for $H_2O_2$ was in fact too high and did not correspond with the actual demand for the process.**

### 4.4.2 Test C (increased flow) and test D (simulated serial treatment)

**Settings**
**The settings for final runs C and D were supposed to introduce increased flow (shorter residence time) for run C and a simulated serial treatment with increased flow for run D. By storing the effluent of run C and run it through the complete installation a second time, the serial treatment was to be simulated (done especially for the effect on the Grindsted contaminations, believed to be more persistent).**

**The flow was set at 240 l/hour. During both tests the amount of injected $H_2O_2$ and catalyst was raised proportionally to 0.50 litre per hour for both (1.5 stroke per second).**

**For the second and third tests (C and D) the water from IBC 2 has been used.**

**Results**
**In runs C and D samples have been taken at several points in the installation (the number corresponds with the number on the lab results, see Annex 1):**

5. **Raw water, not processed (C)**
6. **Water after the first step (pre treatment) of the installation (C)**
7. **Water after the second step (C)**
8. **Final water after the post treatment (also sampled for ALS and Suez, run C)**
9. **Water after the first step (pre treatment) of the installation (D)**
10. **Water after the second step (D)**
11. **Final water after the post treatment (also sampled for ALS and Suez, run D)**

**The results of both runs C and D were disappointing and, more over, confusing. Especially the results of the Grindsted components (based on the lab results from ALS) were puzzling.**

**An explanation was not directly available.**

**Furthermore the addition of catalyst had dramatic results on both pH (very low) and amount of iron in the effluent (up to 34 mg/l). Especially the amount of iron made effective use of activated carbon (tests to be performed by Suez) without additional pre-treatment impossible.**

**The results were discussed with COWI and it was decided to ignore the results of tests C and D and perform additional – replacement – tests, see 4.5, on new containers with raw water from Grindsted.**

**Some suggestions were discussed with respect to the settings for the additional tests:**

- **The amount of $H_2O_2$ seemed to be too much, not corresponding with the actual need. It was decided to dramatically lower the concentration with a factor 10;**
- **As the addition of catalyst has a dramatic effect on the effluent it was decided to completely refrain from using additional catalyst. Just in case of a needed "spark" at the start of the process a small amount of catalyst would be used;**

***Note 1: Step one of the treatment seemed to release part of the earlier caught volatile contaminants (mainly vinylchloride, which reflects its mobility and the difficulty to capture it) with the concentration gaining more than 100-fold. This was discussed with COWI and it was decided to hold on to the idea of "simulated serial treatment" but to skip the first column in the second run, resulting in a better simulation of extended residence time.***

***Note 2: Refraining from additional catalyst makes post treatment unnecessary. Therefore for the additional final tests it was decided to skip the post treatment.***

***Note 3**: The fact that the TOC (see test B) is rising with decreasing concentrations of volatile components (and Grindsted components as well, as ALS results later on revealed) shows there is no direct relation between TOC and the degree of removal in the process of Water IQ. This was confirmed during the (failed) tests C and D. For the additional tests Water IQ decided to refrain from testing on TOC.*

***Note 4**: After running all initial tests the installation was cleaned completely. During this clean-up Water IQ discovered a very small leak between the columns 1 and 2, resulting in a cross contamination. Part of the water did not pass the injection and mixing chamber therefore missing the needed spark for the process. The leak was restored after discovery (and before the additional runs E and F).*

## 4.5 Additional tests

**For the additional tests "fresh" water had to be obtained from Grindsted. On April 7th the required volume of additional water (2 $m^3$) was acquired at the location of the former Renseanlæg Vest in Grindsted. COWI took care of the pumping of the contaminated water from the well to the containers. The water arrived in Eindhoven on April 10th.**

### 4.5.1 Results of the raw water

**The raw water (Containers 1 and 2 on the lab results, see Annex 1) again contained relatively high concentrations of benzene, VC and Cis and some low concentrations of trichloroethene and tetrachloroethene. The exact concentrations are mentioned in the following table 6:**

| Container | pH | Ec µS/cm | Concentrations (in µg/l) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Vinylchloride | Dichloroethene | Trichloroethene | Tetrachloroethene | Benzene |
| 1 | 5.94 | 629 | 1,700 | 1,242 | 5.5 | 9.6 | 390 |
| 2 | 5.82 | 632 | 1,800 | 1,138 | 5.1 | 9.5 | 350 |

*Table 6. Concentrations of the "raw water".*

### 4.5.2 Pretesting

**To be sure the settings for the final tests E and F would be correct Water IQ decided to perform two pre-tests. The following setting was used:**

- **$H_2O_2$ at approx. 100 mg/l;**
- **No additional catalyst, as the available catalyst within the column seemed to be sufficient;**
- **Approx. 125 l/min (using a new, smaller pump), which results in a residence time of approx. 10 minutes;**
- **First run through both columns (selective purification and advanced oxidation).**

**For the pretesting the water from Container 1 (table 6) has been used.**

**After the first run the remaining amount of $H_2O_2$ was measured: 6.5 ppm, showing that the amount of added $H_2O_2$ was sufficient. The pH was 10.87 and Ec 1,687 µS/cm.**

**For the second run the effluent of the first run was used and injected directly into the second column, the advanced oxidation. That way there would be no chance of disturbing effects of the first column. The following setting was used:**

- **Again $H_2O_2$ at approx. 100 mg/l. The same amount is used as in the first test to simulate an elongated residence time;**
- **Again no additional catalyst was injected as Water IQ succeeded in directly switching from the original product to the effluent of the first run. Therefore no restart was needed;**
- **Same flow.**

**After the second run the remaining amount of $H_2O_2$ was measured: 4.4 ppm, showing that the amount of added $H_2O_2$ was, again, sufficient. The pH was 10.60 and Ec 1,749 µS/cm.**

**During pre-testing just 2 samples have been taken at the end of the process (the number corresponds with the number on the lab results, see Annex 1):**

3. **Run 1**
4. **Run 2**

**Efficiency after run 1 (compared to the raw water of Container 1):**

**Vinylchloride is found at a level of 18 µg/l, the efficiency being 98.9 %;**
**Benzene is found at a level of 6.0 µg/l, the efficiency being 98.4 %;**
**Dichloroethene is found at a level of 42 µg/l, the efficiency being 96.5 %;**
**Trichloroethene is found at a level of 9.1 µg/l, which is higher than measured in the raw water, reflecting no efficiency;**
**Tetrachloroethene is found at a level of 1.8 µg/l, the efficiency being 81.2 %.**

**Iron was also measured (in the lab) after run 1. The concentration was 2.2 mg/l, which is below the threshold given by Suez for successful use of activated coal. It confirms the positive effect of using no additional catalyst.**

**Efficiency after run 2 (compared to the raw water of Container 1):**

**Vinylchloride is found at a level of 0.33 µg/l, the efficiency being 99.90 %;**
**Benzene has completely disappeared;**
**Dichloroethene is found at a level of 1.1 µg/l, the efficiency being 99.98 %;**
**Trichloroethene is found at a level of 7.0 µg/l, which is still higher than measured in the raw water, reflecting, again, no efficiency;**
**Tetrachloroethene is found at a level of 0.28 µg/l, the efficiency being 97.0 %.**

**The result of the remaining concentrations of trichloroethene is confusing. There is no direct explanation for the fact it does not break down (actually the concentration after the first and second run is a bit higher, but still comparable to the raw water).**

**All in all the results were convincing enough to use the corrected settings for the final tests E and F.**

### 4.5.3 Test E (lowered dose of $H_2O_2$)

**Settings**
**The following setting was used:**

- **$H_2O_2$ at approx. 100 mg/l. The amount of injected $H_2O_2$ (concentration 3.5 %, the original product was diluted tenfold) was 0.5 litre per hour (100 strokes per minute), more or less 100 mg/l;**
- **No additional catalyst, as the available catalyst within the column seemed to be sufficient;**

- **Approx. 125 l/min (using a new, smaller pump), which results in a residence time of approx. 10 minutes;**

**First run through both columns (selective purification and advanced oxidation).**

**For the final tests (E and F) the water from Container 2 (table 6) has been used.**

**Results**
**The effluent of the second column has been sampled (also sampled for ALS and Suez, run E)**

**The results of final test E (compared to the raw water of Container 2) are very good, just a bit less efficient than test B:**

**Vinylchloride is found at a level of 3.5 µg/l, the efficiency being 99.8 %;**
**Benzene has completely disappeared;**
**Dichloroethene is found at a level of 0.99 µg/l, the efficiency being 99.91 %;**
**Trichloroethene is found at a level of 1.4 µg/l, the efficiency being 72.5 %;**
**Tetrachloroethene is found at a level of 0.45 µg/l, the efficiency being 95,2 %.**

**After final test E the remaining amount of $H_2O_2$ was measured: between 3 and 10 ppm, showing that the amount of added $H_2O_2$ was sufficient. TOC has not been measured. The amount of TOC has no relation with the efficiency of the process.**

**On-site the pH and Ec were measured:**

- **pH = 10.32**
- **Ec = 1,032 µSiemens/cm**

### 4.5.4 Test F (lowered dose of $H_2O_2$, extended residence time)

**Settings**
**Final test F is supposed to simulate serial treatment by storing the effluent of test E and running it solely through the 2nd column (advanced oxidation). The following setting was used:**

- **$H_2O_2$ again at approx. 100 mg/l;**
- **No additional catalyst;**
- **Approx. 125 l/min (using a new, smaller pump), which results in a residence time of approx. 10 minutes;**

**Results**
**The effluent of the second column has been sampled (also sampled for ALS and Suez, run F)**

**The results of final test F (compared to the raw water of Container 2) are very good, more or less comparable with test B:**

**Vinylchloride has completely disappeared;**
**Benzene has also completely disappeared;**
**Dichloroethene has also completely disappeared;**
**Trichloroethene is found at a level of 0.95 µg/l, the efficiency being 81,3 %;**
**Tetrachloroethene has also completely disappeared.**

**After final test F the remaining amount of $H_2O_2$ was measured: approx. 3 ppm, showing, again, that the amount of added $H_2O_2$ was sufficient.**

**On-site the pH and Ec were measured:**

- **pH = 9.97**
- **Ec = 985 µSiemens/cm**

**Again the results of the remaining concentrations of trichloroethene in final tests E and F are not as expected. There is no direct explanation for the fact it shows the least efficiency in break-down. Other tests on heavily contaminated groundwater (concentrations trichloroethene above 50,000 µg/l) have shown efficiency rates for trichloroethene well above 99.9 %.**

## 4.6 Discussion about the measured pH in tests B, E and F

**The pH which at start was between 5.7 and 6.0 shows variations at the end of the final tests. The pH is actually influenced by a few settings:**

- **With an overdose of catalyst there will be a high concentration of Fe remaining in the effluent, like in the samples of the (failed) tests C and D. This automatically affects the acidity of the water, resulting in a low pH, even going down to pH 3.5;**
- **In case of the tests E and F no additional catalyst has been dosed and the amount of $H_2O_2$ dramatically decreased. The remaining concentration of $H_2O_2$ is low, measured between 3 and 10 ppm. The majority of the overdose (still !) is converted to $OH^-$ in the 2nd column (advanced oxidation) resulting in an elevated pH, approx. 10.**

**The acidity can be easily measured and corrected when an automated version of the purification technique is used, using in-situ monitoring techniques to control the pH and fine-tune the amount of catalyst or $H_2O_2$. The present test installation is manually operated which can only be improved when working on the actual scale needed.**

# 5 Final test results

## 5.1 Test results raw water

**The raw water (water sample taken on March 10th, at the first transport of contaminated water from Grindsted) has been analysed by ALS. The result is to be considered as the baseline water.**

**The samples (and results) in the previous paragraph were all analysed by Synlab, the Netherlands. They were used for acquiring direct information about the performance of the test installation.**

**In this report, for the comparison with the test results, not all components are presented. The most relevant results are presented in 3 separate tables in the same way as done in the tender documents (the original analysis results from ALS can be found in Annex 2).**

**Volatile organic components**

| Raw water | Concentrations (in µg/l) | | | | |
|---|---|---|---|---|---|
| | Vinylchloride | Dichloroethene | Trichloroethene | Tetrachloroethene | Benzene |
| Grindsted ALS | 7,100 | 1,441 | 22 | 48 | 520 |

*Table 7. Concentrations of volatile organic components, baseline.*

**Inorganic components**

| Raw water | Concentrations (in µg/l) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Mn | As | Cr | Cu | Ni | Zn | Fe |
| Grindsted ALS | 430 | 3.8 | 0.51 | 0.80 | 4.7 | 12 | 5,400 |

*Table 8. Concentrations of inorganic components, baseline.*

**Organic (non-volatile) components**

| Raw water | Concentrations (in µg/l) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Barbital | Allobarb. | Isobutylb. | Amobarb. | Sulfadim. | Sulfacet. | Sulfanilyl. |
| Grindsted ALS | 15 | 230 | 150 | 43 | 110 | 200 | 110 |

*Table 9. Concentrations of organic (non-volatile) components, baseline.*

## 5.2 Test results pre treatment (sample A)

**The test results of sample A – more or less – resemble the result of pre-treatment. In case of the Water IQ technique it is the result after the 1st column (selective adsorption).**

**In the following tables the ALS results are presented as well as the efficiency – presented as removal rate – of the pre-treatment.**

**Volatile organic components**

| Sample A | Vinylchloride | Dichloroethene | Trichloroethene | Tetrachloroethene | Benzene |
|---|---|---|---|---|---|
| Concentrations (in µg/l) | 4,700 | 1,143 | 8.4 | 15 | 300 |
| Removal rate (%) | 33.8 | 20.6 | 61.8 | 68.7 | 42.3 |

*Table 10. Concentrations of volatile organic components, sample A.*

**Inorganic components**

| Sample A | Mn | As | Cr | Cu | Ni | Zn | Fe |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | 12 | 1.2 | 1.1 | 1.5 | 4.6 | 11 | 330 |
| Removal rate (%) | 97.2 | 68.4 | - | - | 2.1 | 8.3 | 93.8 |

*Table 11. Concentrations of inorganic components, sample A.*

**Organic (non-volatile) components**

| Sample A | Barbital | Allobarb. | Isobutylb. | Amobarb. | Sulfadim. | Sulfacet. | Sulfanilyl. |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | 18 | 120 | 4.3 | 38 | 75 | 81 | 61 |
| Removal rate (%) | - | 47.8 | 97.1 | 11.6 | 31.8 | 59.5 | 44.5 |

*Table 12. Concentrations of organic (non-volatile) components, sample A.*

**The main purpose of the pre-treatment, removal of Mn and Fe, has been successful, both with a removal rate of > 90 %.**

**Furthermore it is interesting to see that several volatile and non-volatile organic components are being partially bound in the 1st column. The ability to bind to the ceramic carrier material differs enormously with the organic (non-volatile) components. Barbital for instance is not bound at all, while Isobutylbarbital is almost completely caught in the 1st column.**

**This effect will be temporary during continuous operation as (almost) all organic materials eventually will be flushed out of the first column.**

## 5.3 Test results final tests

### 5.3.1 Test B (optimal test)

**The samples of test B – the first final test – were taken after the additional post-treatment.**

**In the following tables the ALS results are presented as well as the efficiency – presented as removal rate – of test B.**

**Volatile organic components**

| Test B | Vinylchloride | Dichloroethene | Trichloroethene | Tetrachloroethene | Benzene |
|---|---|---|---|---|---|
| Concentrations (in µg/l) | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Removal rate (%) | 100 | 100 | 100 | 100 | 100 |

*Table 13. Concentrations of volatile organic components, test B.*

**Inorganic components**

| Test B | Mn | As | Cr | Cu | Ni | Zn | Fe |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | 1,400 | 1.4 | 60 | 25 | 9.1 | 8.4 | 42,000 |
| Removal rate (%) | - | - | - | - | - | - | - |

*Table 14. Concentrations of inorganic components, test B.*

**The result (for inorganic components) of final test B is strongly influenced by the use of the additional post-treatment. The (higher) concentrations of metals (mainly manganese, chromium and copper) are the result of the manure purification that had been done earlier with this installation. The high concentration of iron is probably due to the overdose of catalyst used in this first final test.**

**Organic (non-volatile) components**

| Test B | Barbital | Allobarb. | Isobutylb. | Amobarb. | Sulfadim. | Sulfacet. | Sulfanilyl. |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | < 0.10 | < 0.10 | 0.15 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Removal rate (%) | 100 | 100 | 99.9 | 100 | 100 | 100 | 100 |

*Table 15. Concentrations of organic (non-volatile) components, test B.*

**The result of final test B is optimal. All organic components, but a very small amount of Isobutylbarbital, have completely vanished.**

**Test B made clear that the injected concentration of $H_2O_2$ was clearly too high. Furthermore the concentration of Fe as well as the very low pH measured on-site led to the conclusion that for the coming additional tests E and F no or a very limited temporary amount of catalyst (as a spark) was to be injected. The process itself, despite the small volume of the 2nd column (advanced oxidation), seemed to work perfectly.**

### 5.3.2 Test E (lowered dose of $H_2O_2$)

**The samples of test E – the second final test – were taken after the second column, no additional post-treatment was used.**

**In the following tables the ALS results are presented as well as the efficiency – presented as removal rate – of test E.**

**Volatile organic components**

| Test E | Vinylchloride | Dichloroethene | Trichloroethene | Tetrachloroethene | Benzene |
|---|---|---|---|---|---|
| Concentrations (in µg/l) | 9.6 | 1.05 | 1.1 | 0.37 | 0.037 |
| Removal rate (%) | 99.8 | 99.92 | 95 | 99.2 | 99.99 |

*Table 16. Concentrations of volatile organic components, test E.*

**Inorganic components**

| Test E | Mn | As | Cr | Cu | Ni | Zn | Fe |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | 3 | 1.3 | n.a. | n.a. | 0.51 | n.a. | 600 |
| Removal rate (%) | 99.3 | 65 | - | - | 89 | - | 88.8 |

*Table 17. Concentrations of inorganic components, test E.*
*n.a. Not analysed*

**Organic (non-volatile) components**

| Test E | Barbital | Allobarb. | Isobutylb. | Amobarb. | Sulfadim. | Sulfacet. | Sulfanilyl. |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | 0.22 | < 0.10 | < 0.10 | 0.11 | < 0.10 | < 0.10 | < 0.10 |
| Removal rate (%) | 98.5 | 100 | 100 | 99.7 | 100 | 100 | 100 |

*Table 18. Concentrations of organic (non-volatile) components, test E.*

**The result of final test E is quite good compared to test B and considering the dramatically lowered amount of $H_2O_2$. The bulk of the organic components has been removed, all that remains are small amounts of the volatile organic components and some amount of the Grindsted components (of which Ethylurethan and Sulfanilsyre, both not mentioned in the table, have the lowest removal rate [97.9 and 96.3 % respectively]).**

**The resulting concentration of Meprobamat is a bit confusing with < 0.10 in the raw sample and 0.88 µg/l in sample E. This might be the effect of the radical oxidation or some differences in the interpretation of the lab results.**

### 5.3.3 Test F (lowered dose of $H_2O_2$, extended residence time)

**The samples of test F – the third final test – were taken after a second run through the advanced oxidation column (2nd column). Again, no additional post-treatment was used.**

**In the following tables the ALS results are presented as well as the efficiency – presented as removal rate – of test F.**

### Volatile organic components

| Test F | Vinylchloride | Dichloroethene | Trichloroethene | Tetrachloroethene | Benzene |
|---|---|---|---|---|---|
| Concentrations (in µg/l) | < 0.02 | < 0.02 | 0.59 | 0.022 | < 0.02 |
| Removal rate (%) | 100 | 100 | 97.3 | 99.95 | 100 |

*Table 19. Concentrations of volatile organic components, test F.*

### Inorganic components

| Test F | Mn | As | Cr | Cu | Ni | Zn | Fe |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | 8 | 1.2 | n.a. | n.a. | 0.20 | n.a. | 760 |
| Removal rate (%) | 98.1 | 68.4 | - | - | 95.7 | - | 85.5 |

*Table 20. Concentrations of inorganic components, test F.*
*n.a. Not analysed*

### Organic (non-volatile) components

| Test F | Barbital | Allobarb. | Isobutylb. | Amobarb. | Sulfadim. | Sulfacet. | Sulfanilyl. |
|---|---|---|---|---|---|---|---|
| Concentrations (in µg/l) | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Removal rate (%) | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

*Table 21. Concentrations of organic (non-volatile) components, test F.*

**The result of final test F is optimal, comparable to test B. Due to the elongated residence time part of the remaining contaminants after final test E have been removed. All that remains are very small amounts of tri- and tetrachloroethene. Of the Grindsted components only Ethylurethan and Sulfanilsyre, both not mentioned in the table, are detected with removal rates of 99.8 and 98.7 % respectively.**

**The elongated residence time in test F more or less replaces the effect of the surplus of $H_2O_2$ that was used in test B. Although the results are very good Water IQ is convinced the setting can still be optimised.**

# 6 Additional information

## 6.1 Limitations of the test installation

**The test installation has some limitations due to the fact that it was meant to be mobile. Furthermore the flow (on-site due to the limitations of the pumping well and in Eindhoven due to limitations to the amount of contaminated water to be transported across the borders) was designed to be no more than 250 l/hour.**

**Despite the limitations the installation did perform well. Still Water IQ likes to express that the process is not running in an optimal way. For example:**

- **Residence time.**
  **The residence time in the test installation is too low (with test B it was approx. 7.5 minutes, with test E it was 10 minutes). Experience with wastewater from greenhouses, contaminated with pesticides, shows that a minimum residence time of 15 minutes is required for optimal performance. In test F this has been simulated by running twice through the 2nd column (advanced oxidation). An upscale installation has no limitations with respect to the residence time;**
- **Flow**
  **The small minimal flow of the installation restricts the stability of the process. Both $H_2O_2$ and the catalyst (if necessary) are injected with 100 strokes/minute instead of the optimal 180 strokes/minute under normal conditions. The mixing and following process are not optimal;**
- **The mixing chamber**
  **One of the important components and specialty of Water IQ – the patented mixing chamber, see figure 7 – has not been installed.**

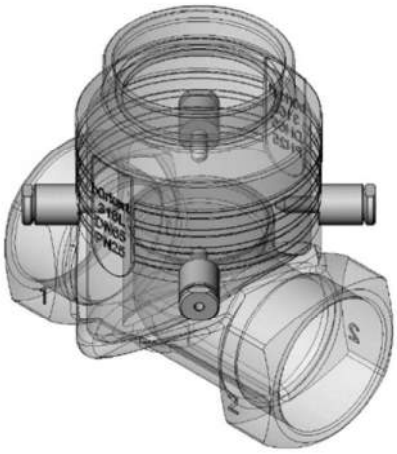

*Figure 7. Sketch of the patented mixing chamber*

**The chamber requires a minimum flow of approx. 1.0 $m^3$/hour to perform in a correct way. With the minimum flow of 125 litres per hour (due to limitations of the pump settings) it was not possible to use the patented mixing chamber. This resulted in (sub-)optimal conditions considering the mixing of the reactive fluids with the contaminated water;**

- **Manual settings**
  **The test installation is set and controlled by manual operation. The actual Opticlear Diamond system is completely automated and, for instance, uses in-situ measuring**

**techniques to control pH and fine-tune the amount of catalyst and/or $H_2O_2$. Furthermore the installation uses telemetry that allows remote control.**

**In short: the difficulty with lab testing normally is that a process works on a conditioned small scale but increasing it in volume to the actual size is not simple. With the proven Opticlear Diamond technique it just works the other way round. Water IQ has made a small scale test installation to make it (potentially) mobile and not requiring too much of a flow. The technique looses part of its operational success due to downscaling.**

## 6.2 Operational costs (OPEX)

**For estimating the Total Cost of Ownership Water IQ has long term OPEX experience from the installions operating on greenhouse effluent in the Netherlands. The OPEX of the Opticlear Diamond system mainly consist of electricity, hydrogen peroxide, catalyst and reactivation / cleaning. A breakdown based on full-scale experience is listed below.**

**Energy**
**The installation itself requires but a small amount of energy. The Opticlear Diamond consumes about 0,6 kWh per $m^3$.**

**Maintenance**
**As the complete installation is sturdy – mainly built in stainless steel 316L – it requires limited maintenance. In the greenhouses the frequency normally is once or twice a year. The installation has just a few moving parts which results in low maintenance costs.**

**Small adjustments in settings can be done via remote monitoring and control by smartphone or computer.**

**Catalyst and $H_2O_2$**
**The amount of catalyst and $H_2O_2$ needed for optimal removal of the contamination is very low for treatment of residues from greenhouses effluent. Based on a higher dosing required to remove the Grindsted contamination the costs will be around € 0,03 / $m^3$ (based on the testing concentrations).**

**Reactivation of the carrier material**
**The reactivation of the columns (both the selective adsorption and advanced oxidation column) is normally done while maintaining. In the greenhouses (with large amounts of organic material in the wastewater to be treated) it suffices to reactivate once or twice a year. The costs per $m^3$ are approx. € 0.03 – 0.05, transport excluded.**

# 7 Conclusions and recommendations

## 7.1 Conclusions

**The Region of Southern Denmark (RSD) has decided to analyse the possibilities of reducing the impact of various volatile and non-volatile contaminations originating from the former Grindstedværket factory site on Grindsted Stream. The idea is to establish a temporary system by means of protective pumping combined with onsite treatment of groundwater (pump and treat) on the Renseanlæg Vest site.**

**On behalf of the region, COWI carried out a screening of relevant methods for onsite treatment of contaminated groundwater. It was assessed that advanced oxidation processes (AOP) could provide a suitable treatment of the groundwater before it is discharged. Four AOP processes have been selected for testing, of which Water IQ has performed AOP method 4: $H_2O_2$ + fixed-bed catalyst.**

**Results per final test**
**Water IQ performed 5 final tests of which 2 were considered to be failures, most certainly due to a leak inside the installation, combined with the overdose of catalyst (and $H_2O_2$).**

**The results of the pre-treatment and the final tests are:**

**<u>Sample A (after pre-treatment)</u>**
**The result of sample A – more or less – resembles the result of pre-treatment. In case of the Water IQ technique it is the result after the 1st column (selective adsorption).**

**The main purpose of the pre-treatment, removal of Mn and Fe, has been successful, both with a removal rate of > 90 %.**

**Furthermore several volatile and non-volatile organic components were being partially bound in the 1st column. The ability to bind to the ceramic carrier material differs enormously with the organic (non-volatile) components.**

**<u>Final test B</u>**
**The result of final test B is optimal. All organic components, but a very small amount of Isobutylbarbital, have completely vanished.**

**However, test B made clear that the injected concentration of $H_2O_2$ was clearly too high. Furthermore the concentration of Fe as well as the very low pH measured on-site led to the conclusion that for the additional tests E and F no or a very limited temporary amount of catalyst (as a spark) was to be injected. The process itself, despite the small volume of the 2nd column (advanced oxidation), seemed to work perfectly.**

**<u>Final test E</u>**
**The result of final test E is quite good compared to test B and considering the dramatically lowered amount of $H_2O_2$. The bulk of the organic components has been removed, all that remains are small amounts of the volatile organic components and some amount of the Grindsted components (of which Ethylurethan and Sulfanilsyre have the lowest removal rate [97.9 and 96.3 % respectively]).**

**Final test F**

**The result of final test F is optimal, comparable to test B. Due to the elongated residence time part of the remaining contaminants after final test E have been removed. All that remains are very small amounts of tri- and tetrachloroethene. Of the Grindsted components only Ethylurethan and Sulfanilsyre are still present in very low concentrations with removal rates of 99.8 and 98.7 % respectively.**

**Comparing the results of the final tests with the original purpose of the 4 different pilots:**

- **Suitability of the technique.**
  **The technique of molecular adsorption and advanced oxidation (Opticlear Diamond) performs well and is adequate to purify the water contaminated with Grindsted substances;**
- **Treatment efficiency.**
  **The efficiency of the treatment is getting close to 100 % (for the test installation);**
- **Effect of pre-treatment.**
  **The 1st column of the installation more or less resembles or replaces a solitary pre-treatment. The first column (molecular adsorption) is effective in removing elevated concentrations of iron and manganese.**
  **Furthermore it seems to (partially) bind several organic components. This effect will be temporary as these components will be flushed out of the 1st column during continuous operation;**
- **Relevant design parameters.**
  **Before the tests Water IQ expected three parameters to be important:**
  - **Residence time**
  - **The concentration and total volume of $H_2O_2$ per $m^3$**
  - **The concentration and total volume of catalyst per $m^3$ to be dosed at the start of and during the process**

  **The results of the final tests show that the residence time is the most critical parameter. This corresponds to the experience Water IQ has in greenhouse operations. A minimal residence time of 15 minutes should be used to ensure optimal conditions. In case of more persistent contamination it might even be better to extend the residence time even more.**

  **The amount of $H_2O_2$ has an effect on the total efficiency as can be seen comparing the results of tests B and E. The difference in the applied concentrations is quite high (10-fold dilution) which seems to indicate that a choice for elongated residence time more cost efficient.**
  **The elongated residence time in test F more or less replaces the effect of the surplus of $H_2O_2$ that was used in test B. For operational use this means that a installation with a larger 2nd column or a sequential constellation (higher CAPEX) more or less equals the effect of a much higher dose of $H_2O_2$ (higher OPEX).**

  **The effect of additionally dosed catalyst can not be observed. It seems that adding catalyst in the process only inflicts the effluent in a negative way by adding considerable concentrations of iron (among other metals). Furthermore it pushes the pH to very low figures. The resulting effluent can not be "polished", if needed, by activated coal due to the high iron concentrations and low pH.**

  **Although the results are very good Water IQ is convinced the setting can be optimised using an automated and on-scale installation, see 7.2.**

## 7.2 Additional information

**Limitations of the test installation**
**The test installation has some limitations due to the fact that it was meant to be mobile. Water IQ likes to express that the process has not run in an optimal way. The following parts can easily be improved:**

- **Residence time is the key factor. In the test installation the residence time was too low. Experience with wastewater from greenhouses, contaminated with pesticides, shows that a minimum residence time of 15 minutes is required for optimal performance;**
- **The (minimum) flow of the installation should enable optimal injection frequency of the $H_2O_2$ and the catalyst (the latter only when needed). The small flow of the test installation has made some restrictions on the stability of the process;**
- **Implementation of the patented mixing chamber improves the stability of the process and decreases the amount of $H_2O_2$ needed. The flow of the test installation was too small to be able to use the patented mixing chamber;**
- **Finally the actual Opticlear Diamond system is completely automated using telemetry and allows remote control. The test installation was completely set and controlled by manual operation.**

**Operational costs (OPEX)**
**For a notion of the OPEX (as part of the TCO) the following reference amounts can be used, based on years of experience in treating wastewater from greenhouses:**

- **<u>Energy</u>. The installation consumes approx. 0.6 kWh/ $m^3$, partly depending on the scale of the installation;**
- **<u>Maintenance</u>. The installation is sturdy and requires very limited maintenance. Based on experience with greenhouses the frequency of maintenance is once or twice a year;**
- **<u>$H_2O_2$ and catalyst</u>. The costs per $m^3$ are approx. € 0.03 for the concentrations of the Grindsted contamination that have been tested;**
- **<u>Reactivation of the carrier material</u>. The reactivation of the columns (both the selective adsorption and advanced oxidation column) is done while maintaining. The costs per $m^3$ are approx. € 0.03 – 0.05, transport excluded.**

## 7.3 Recommendations

**Although the Opticlear Diamond system has already proven itself in greenhouses, it is still recommended to perform a pilot test in Grindsted. We advise to do it with an upscale installation, completely automated with telemetric monitoring and control and a flow of 0.5 – 2.5 $m^3$/hour.**

**This pilot test will give the opportunity to fine-tune the installation with respect to residence time and optimal amount of additional catalyst (if needed at all) and $H_2O_2$. Furthermore the need for an additional 2nd column (advanced oxidation) or activated coal as a polishing step can be determined. It will lead to the optimal constellation of the installation. Water IQ is working on an existing installation adjusting it with the newest equipment. This installation is due to be ready by the end of June.**

**Finally we would like to suggest to investigate the possibilities of using the Opticlear Diamond technique in more heavily contaminated areas of Grindsted. An additional remediation screen might be installed in a follow-up phase to remediate part of the Grindsted plume. This will require additional testing as, as we understood, the more heavily contaminated areas contain more, and more persistent, components.**

# Annex 1:

# Analysis results of on-site sampling (Synlab)

**SYNLAB Analytics & Services B.V.**
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Steenhouwerstraat 15 · 3194 AG Rotterdam
Tel.: +31 (0)10 231 47 00 · Fax: +31 (0)10 416 30 34
www.synlab.nl

# Analyserapport

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| | |
|---|---|
| Uw projectnaam | : Grindsted DK |
| Uw projectnummer | : 20200214 |
| SYNLAB rapportnummer | : 13219183, versienummer: 1. |
| Rapport-verificatienummer | : QAJKK6X8 |

Rotterdam, 18-03-2020

Geachte heer/mevrouw,

Hierbij ontvangt u de analyse resultaten van het laboratoriumonderzoek ten behoeve van uw project 20200214. Het onderzoek werd uitgevoerd conform uw opdracht. De gerapporteerde resultaten hebben uitsluitend betrekking op de geteste monsters. De door u aangegeven omschrijvingen voor de monsters, het project en de monsternamedatum (indien aangeleverd) zijn overgenomen in dit analyserapport. SYNLAB is niet verantwoordelijk voor de gegevens verstrekt door de opdrachtgever.

Het onderzoek is uitgevoerd door SYNLAB Analytics & Services B.V., gevestigd aan de Steenhouwerstraat 15 in Rotterdam (NL). Indien het onderzoek is uitgevoerd door derden of het SYNLAB laboratorium in Frankrijk (99-101 Avenue Louis Roche, Gennevilliers) is dit in het rapport aangegeven.

Dit analyserapport bestaat inclusief bijlagen uit 6 pagina's. In geval van een versienummer van '2' of hoger vervallen de voorgaande versies. Alle bijlagen maken onlosmakelijk onderdeel uit van het rapport. Alleen vermenigvuldiging van het hele rapport is toegestaan.

Mocht u vragen en/of opmerkingen hebben naar aanleiding van dit rapport, bijvoorbeeld als u nadere informatie nodig heeft over de meetonzekerheid van de analyseresultaten in dit rapport, dan verzoeken wij u vriendelijk contact op te nemen met de afdeling Customer Support.

Wij vertrouwen er op u met deze informatie van dienst te zijn.

Hoogachtend,

Jaap-Willem Hutter
Technical Director

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AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn



# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
| Projectnummer | 20200214 | Startdatum | 17-03-2020 |
| Rapportnummer | 13219183 - 1 | Rapportagedatum | 18-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Monster 1 |
| 002 | Grondwater (AS3000) | Monster 2 |
| 003 | Grondwater (AS3000) | Monster 3 |
| 004 | Grondwater (AS3000) | Monster 4 |

| Analyse | Eenheid | Q | 001 | 002 | 003 | 004 |
|---|---|---|---|---|---|---|
| METALEN | | | | | | |
| barium | µg/l | S | 110 [1)] | <15 [1)] | | 44 [1)] |
| cadmium | µg/l | S | <0.20 [1)] | <0.20 [1)] | | 0.37 [1)] |
| kobalt | µg/l | S | <2 [1)] | <2 [1)] | | 8.3 [1)] |
| koper | µg/l | S | <2.0 [1)] | 4.4 [1)] | | 230 [1)] |
| kwik | µg/l | S | <0.05 | <0.05 | | <0.05 |
| lood | µg/l | S | <2.0 [1)] | 4.0 [1)] | | 16 [1)] |
| molybdeen | µg/l | S | <2 [1)] | <2 [1)] | | 8.2 [1)] |
| nikkel | µg/l | S | 3.5 [1)] | 10 [1)] | | 51 [1)] |
| zink | µg/l | S | 11 [1)] | 26 [1)] | | 380 [1)] |
| VLUCHTIGE AROMATEN | | | | | | |
| benzeen | µg/l | S | 380 | 330 | <0.2 | 0.27 |
| tolueen | µg/l | S | 2.9 | 2.7 | <0.2 | <0.2 |
| ethylbenzeen | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.2 | <0.2 |
| o-xyleen | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.1 | <0.1 |
| p- en m-xyleen | µg/l | S | <2.0 [2)] | <2.0 [2)] | <0.2 | <0.2 |
| xylenen (0.7 factor) | µg/l | S | 2.1 [3)] | 2.1 [3)] | 0.21 [3)] | 0.21 [3)] |
| totaal BTEX (0.7 factor) | µg/l | | 385.7 [3)] | 335.5 [3)] | 0.63 [3)] | 0.76 [3)] |
| GEHALOGENEERDE KOOLWATERSTOFFEN | | | | | | |
| 1,1-dichloorethaan | µg/l | S | <2.0 [2)] | <2.0 [2)] | <0.2 | <0.2 |
| 1,2-dichloorethaan | µg/l | S | <2.0 [2)] | <2.0 [2)] | 0.97 | 0.74 |
| 1,1-dichlooretheen | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.1 | <0.1 |
| cis-1,2-dichlooretheen | µg/l | S | 1000 | 970 | 1.5 | 5.7 |
| trans-1,2-dichlooretheen | µg/l | S | 35 | 33 | <0.1 | <0.1 |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | µg/l | S | 1035 [3)] | 1003 [3)] | 1.57 [3)] | 5.77 [3)] |
| dichloormethaan | µg/l | S | <2.0 [2)] | <2.0 [2)] | <0.2 | <0.2 |
| 1,1-dichloorpropaan | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.2 | <0.2 |
| 1,2-dichloorpropaan | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.2 | <0.2 |
| 1,3-dichloorpropaan | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.2 | <0.2 |
| som dichloorpropanen (0.7 factor) | µg/l | S | 2.1 [3)] | 2.1 [3)] | 0.42 [3)] | 0.42 [3)] |
| tetrachlooretheen | µg/l | S | 8.8 | 9.4 | 1.1 | 1.4 |
| tetrachloormethaan | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.1 | <0.1 |
| 1,1,1-trichloorethaan | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.1 | <0.1 |
| 1,1,2-trichloorethaan | µg/l | S | <1.0 [2)] | <1.0 [2)] | <0.1 | <0.1 |
| trichlooretheen | µg/l | S | 6.8 | 6.6 | <0.2 | <0.2 |
| chloroform | µg/l | S | <2.0 [2)] | <2.0 [2)] | <0.2 | <0.2 |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

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GEOFOXX Tilburg BV
Dhr. M. Klijn



# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
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| Rapportnummer | 13219183 - 1 | Rapportagedatum | 18-03-2020 |

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| 002 | Grondwater (AS3000) | Monster 2 |
| 003 | Grondwater (AS3000) | Monster 3 |
| 004 | Grondwater (AS3000) | Monster 4 |

| Analyse | Eenheid | Q | 001 | 002 | 003 | 004 |
|---|---|---|---|---|---|---|
| vinylchloride | µg/l | S | 2100 | 1900 | <0.2 | <0.2 |
| tribroommethaan | µg/l | S | <2.0 [2)] | <2.0 [2)] | <0.2 | <0.2 |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
| Projectnummer | 20200214 | Startdatum | 17-03-2020 |
| Rapportnummer | 13219183 - 1 | Rapportagedatum | 18-03-2020 |

## Monster beschrijvingen

| | | |
|---|---|---|
| 001 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 002 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 003 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 004 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

## Voetnoten

| | |
|---|---|
| 1 | Geanalyseerd m.b.v.ICP-MS, conform NEN-EN-ISO 17294-2 i.p.v. ICP-AES |
| 2 | De rapportagegrens is verhoogd i.v.m. noodzakelijke verdunning. |
| 3 | De sommatie na verrekening van de 0.7 factor voor <-waarden volgens BoToVa. |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
| Projectnummer | 20200214 | Startdatum | 17-03-2020 |
| Rapportnummer | 13219183 - 1 | Rapportagedatum | 18-03-2020 |

| Analyse | Monstersoort | Relatie tot norm |
|---|---|---|
| barium | Grondwater (AS3000) | Conform AS3110-3 en conform NEN 6966 en conform NEN-EN-ISO 11885 |
| cadmium | Grondwater (AS3000) | Idem |
| kobalt | Grondwater (AS3000) | Idem |
| koper | Grondwater (AS3000) | Idem |
| kwik | Grondwater (AS3000) | Conform AS3110-3 en conform NEN-EN-ISO 17852 |
| lood | Grondwater (AS3000) | Conform AS3110-3 en conform NEN 6966 en conform NEN-EN-ISO 11885 |
| molybdeen | Grondwater (AS3000) | Idem |
| nikkel | Grondwater (AS3000) | Idem |
| zink | Grondwater (AS3000) | Idem |
| benzeen | Grondwater (AS3000) | Conform AS3130-1 |
| tolueen | Grondwater (AS3000) | Idem |
| ethylbenzeen | Grondwater (AS3000) | Idem |
| o-xyleen | Grondwater (AS3000) | Idem |
| p- en m-xyleen | Grondwater (AS3000) | Idem |
| xylenen (0.7 factor) | Grondwater (AS3000) | Idem |
| totaal BTEX (0.7 factor) | Grondwater (AS3000) | Eigen methode, headspace GCMS |
| 1,1-dichloorethaan | Grondwater (AS3000) | Conform AS3130-1 |
| 1,2-dichloorethaan | Grondwater (AS3000) | Idem |
| 1,1-dichlooretheen | Grondwater (AS3000) | Idem |
| cis-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| trans-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | Grondwater (AS3000) | Idem |
| dichloormethaan | Grondwater (AS3000) | Idem |
| 1,1-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,2-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,3-dichloorpropaan | Grondwater (AS3000) | Idem |
| som dichloorpropanen (0.7 factor) | Grondwater (AS3000) | Idem |
| tetrachlooretheen | Grondwater (AS3000) | Idem |
| tetrachloormethaan | Grondwater (AS3000) | Idem |
| 1,1,1-trichloorethaan | Grondwater (AS3000) | Idem |
| 1,1,2-trichloorethaan | Grondwater (AS3000) | Idem |
| trichlooretheen | Grondwater (AS3000) | Idem |
| chloroform | Grondwater (AS3000) | Idem |
| vinylchloride | Grondwater (AS3000) | Idem |
| tribroommethaan | Grondwater (AS3000) | Idem |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 001 | G6762644 | 17-03-2020 | 17-03-2020 | ALC236 |
| 001 | G6762632 | 17-03-2020 | 17-03-2020 | ALC236 |
| 001 | B1909930 | 17-03-2020 | 17-03-2020 | ALC204 |
| 002 | G6762614 | 17-03-2020 | 17-03-2020 | ALC236 |
| 002 | G6762626 | 17-03-2020 | 17-03-2020 | ALC236 |
| 002 | B1909936 | 17-03-2020 | 17-03-2020 | ALC204 |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
| Projectnummer | 20200214 | Startdatum | 17-03-2020 |
| Rapportnummer | 13219183 - 1 | Rapportagedatum | 18-03-2020 |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 003 | G6762625 | 17-03-2020 | 17-03-2020 | ALC236 |
| 003 | G6762619 | 17-03-2020 | 17-03-2020 | ALC236 |
| 004 | B1909942 | 17-03-2020 | 17-03-2020 | ALC204 |
| 004 | G6762650 | 17-03-2020 | 17-03-2020 | ALC236 |
| 004 | G6762656 | 17-03-2020 | 17-03-2020 | ALC236 |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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**SYNLAB Analytics & Services B.V.**
Correspondentieadres
Steenhouwerstraat 15 · 3194 AG Rotterdam
Tel.: +31 (0)10 231 47 00 · Fax: +31 (0)10 416 30 34
www.synlab.nl

# Analyserapport

GEOFOXX Tilburg BV
Dhr. M. Klijn
Postbus 2205
5001 CE  TILBURG



| | |
|---|---|
| Uw projectnaam | : Grindsted DK |
| Uw projectnummer | : 20200214 |
| SYNLAB rapportnummer | : 13219191, versienummer: 1. |
| Rapport-verificatienummer | : HP5T8MCN |

Rotterdam, 18-03-2020

Geachte heer/mevrouw,

Hierbij ontvangt u de analyse resultaten van het laboratoriumonderzoek ten behoeve van uw project 20200214. Het onderzoek werd uitgevoerd conform uw opdracht. De gerapporteerde resultaten hebben uitsluitend betrekking op de geteste monsters. De door u aangegeven omschrijvingen voor de monsters, het project en de monsternamedatum (indien aangeleverd) zijn overgenomen in dit analyserapport. SYNLAB is niet verantwoordelijk voor de gegevens verstrekt door de opdrachtgever.

Het onderzoek is uitgevoerd door SYNLAB Analytics & Services B.V., gevestigd aan de Steenhouwerstraat 15 in Rotterdam (NL). Indien het onderzoek is uitgevoerd door derden of het SYNLAB laboratorium in Frankrijk (99-101 Avenue Louis Roche, Gennevilliers) is dit in het rapport aangegeven.

Dit analyserapport bestaat inclusief bijlagen uit 4 pagina's. In geval van een versienummer van '2' of hoger vervallen de voorgaande versies. Alle bijlagen maken onlosmakelijk onderdeel uit van het rapport. Alleen vermenigvuldiging van het hele rapport is toegestaan.

Mocht u vragen en/of opmerkingen hebben naar aanleiding van dit rapport, bijvoorbeeld als u nadere informatie nodig heeft over de meetonzekerheid van de analyseresultaten in dit rapport, dan verzoeken wij u vriendelijk contact op te nemen met de afdeling Customer Support.

Wij vertrouwen er op u met deze informatie van dienst te zijn.

Hoogachtend,

Jaap-Willem Hutter
Technical Director

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
| Projectnummer | 20200214 | Startdatum | 17-03-2020 |
| Rapportnummer | 13219191 - 1 | Rapportagedatum | 18-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Monster 1 |
| 002 | Grondwater (AS3000) | Monster 2 |
| 003 | Grondwater (AS3000) | Monster 4 |

| Analyse | Eenheid | Q | 001 | 002 | 003 |
|---|---|---|---|---|---|
| TOC | mg/l | Q | 4.6 | 4.8 | 5.8 |

De met Q gemerkte analyses zijn geaccrediteerd door de RvA.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
| Projectnummer | 20200214 | Startdatum | 17-03-2020 |
| Rapportnummer | 13219191 - 1 | Rapportagedatum | 18-03-2020 |

**Monster beschrijvingen**

| | | |
|---|---|---|
| 001 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 002 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 003 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 17-03-2020 |
| Projectnummer | 20200214 | Startdatum | 17-03-2020 |
| Rapportnummer | 13219191 - 1 | Rapportagedatum | 18-03-2020 |

| Analyse | Monstersoort | Relatie tot norm |
|---|---|---|
| TOC | Grondwater (AS3000) | Conform NEN-EN 1484 |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 001 | G6762638 | 17-03-2020 | 17-03-2020 | ALC236 |
| 002 | G6762620 | 17-03-2020 | 17-03-2020 | ALC236 |
| 003 | G6762631 | 17-03-2020 | 17-03-2020 | ALC236 |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

**SYNLAB Analytics & Services B.V.**
Correspondentieadres
Steenhouwerstraat 15 · 3194 AG Rotterdam
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www.synlab.nl

# Analyserapport

GEOFOXX Tilburg BV
Dhr. M. Klijn
Postbus 2205
5001 CE  TILBURG



| | |
|---|---|
| Uw projectnaam | : Grindsted DK |
| Uw projectnummer | : 20200214 |
| SYNLAB rapportnummer | : 13220750, versienummer: 2. Gewijzigd rapport |
| Rapport-verificatienummer | : D13DWZPV |

Rotterdam, 20-03-2020

Geachte heer/mevrouw,

Hierbij ontvangt u de analyse resultaten van het laboratoriumonderzoek ten behoeve van uw project 20200214. Het onderzoek werd uitgevoerd conform uw opdracht. De gerapporteerde resultaten hebben uitsluitend betrekking op de geteste monsters. De door u aangegeven omschrijvingen voor de monsters, het project en de monsternamedatum (indien aangeleverd) zijn overgenomen in dit analyserapport. SYNLAB is niet verantwoordelijk voor de gegevens verstrekt door de opdrachtgever.

Het onderzoek is uitgevoerd door SYNLAB Analytics & Services B.V., gevestigd aan de Steenhouwerstraat 15 in Rotterdam (NL). Indien het onderzoek is uitgevoerd door derden of het SYNLAB laboratorium in Frankrijk (99-101 Avenue Louis Roche, Gennevilliers) is dit in het rapport aangegeven.

Dit analyserapport bestaat inclusief bijlagen uit 9 pagina's. In geval van een versienummer van '2' of hoger vervallen de voorgaande versies. Alle bijlagen maken onlosmakelijk onderdeel uit van het rapport. Alleen vermenigvuldiging van het hele rapport is toegestaan.

Mocht u vragen en/of opmerkingen hebben naar aanleiding van dit rapport, bijvoorbeeld als u nadere informatie nodig heeft over de meetonzekerheid van de analyseresultaten in dit rapport, dan verzoeken wij u vriendelijk contact op te nemen met de afdeling Customer Support.

Wij vertrouwen er op u met deze informatie van dienst te zijn.

Hoogachtend,

Jaap-Willem Hutter
Technical Director

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn



# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Monster 5 |
| 002 | Grondwater (AS3000) | Monster 6 |
| 003 | Grondwater (AS3000) | Monster 7 |
| 004 | Grondwater (AS3000) | Monster 8 |
| 005 | Grondwater (AS3000) | Monster 9 |

| Analyse | Eenheid | Q | 001 | 002 | 003 | 004 | 005 |
|---|---|---|---|---|---|---|---|
| METALEN | | | | | | | |
| barium | µg/l | S | 93 | <15 | 20 | 97 [3] | 32 |
| cadmium | µg/l | S | <0.20 | <0.20 | 0.34 | <0.20 | <0.20 |
| kobalt | µg/l | S | <2 | <2 | <2 | <2 | 2.0 |
| koper | µg/l | S | <2.0 | <2.0 | 57 | <2.0 | 3.6 |
| kwik | µg/l | S | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| lood | µg/l | S | <2.0 | 3.1 | 8.3 | 2.2 [3] | <2.0 |
| molybdeen | µg/l | S | <2 | <2 | <2 | 2.2 [3] | 3.5 |
| nikkel | µg/l | S | <3 | <3 | 20 | <3 | 4.1 |
| zink | µg/l | S | <10 | <10 | 41 | <10 | <10 |
| VLUCHTIGE AROMATEN | | | | | | | |
| benzeen | µg/l | S | 440 | 480 | 5.8 | 14 | 47 |
| tolueen | µg/l | S | <5.0 [1] | <5.0 [1] | <0.2 | <0.2 | <1.0 [1] |
| ethylbenzeen | µg/l | S | <5.0 [1] | <5.0 [1] | <0.2 | <0.2 | <1.0 [1] |
| o-xyleen | µg/l | S | <5.0 [1] | <5.0 [1] | <0.1 | <0.1 | <1.0 [1] |
| p- en m-xyleen | µg/l | S | <10 [1] | <10 [1] | <0.2 | <0.2 | <2.0 [1] |
| xylenen (0.7 factor) | µg/l | S | 10.5 [2] | 10.5 [2] | 0.21 [2] | 0.21 [2] | 2.1 [2] |
| totaal BTEX (0.7 factor) | µg/l | | 457.5 [2] | 497.5 [2] | 6.29 [2] | 14.49 [2] | 50.5 [2] |
| POLYCYCLISCHE AROMATISCHE KOOLWATERSTOFFEN | | | | | | | |
| naftaleen | µg/l | S | 0.15 | 0.13 | <0.02 | <0.02 | <0.02 |
| GEHALOGENEERDE KOOLWATERSTOFFEN | | | | | | | |
| 1,1-dichloorethaan | µg/l | S | <10 [1] | <10 [1] | <0.2 | <0.2 | <2.0 [1] |
| 1,2-dichloorethaan | µg/l | S | <10 [1] | <10 [1] | 0.86 | 0.78 | <2.0 [1] |
| 1,1-dichlooretheen | µg/l | S | <5.0 [1] | <5.0 [1] | <0.1 | <0.1 | <1.0 [1] |
| cis-1,2-dichlooretheen | µg/l | S | 1300 | 1400 | 58 | 99 | 190 |
| trans-1,2-dichlooretheen | µg/l | S | 44 | 49 | 0.18 | 0.27 | 2.8 |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | µg/l | S | 1344 [2] | 1449 [2] | 58.18 [2] | 99.27 [2] | 192.8 [2] |
| dichloormethaan | µg/l | S | <10 [1] | <10 [1] | <0.2 | <0.2 | <2.0 [1] |
| 1,1-dichloorpropaan | µg/l | S | <5.0 [1] | <5.0 [1] | <0.2 | <0.2 | <1.0 [1] |
| 1,2-dichloorpropaan | µg/l | S | <5.0 [1] | <5.0 [1] | <0.2 | <0.2 | <1.0 [1] |
| 1,3-dichloorpropaan | µg/l | S | <5.0 [1] | <5.0 [1] | <0.2 | <0.2 | <1.0 [1] |
| som dichloorpropanen (0.7 factor) | µg/l | S | 10.5 [2] | 10.5 [2] | 0.42 [2] | 0.42 [2] | 2.1 [2] |
| tetrachlooretheen | µg/l | S | 9.0 | 9.9 | 2.9 | 3.6 | 2.6 |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn



# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Monster 5 |
| 002 | Grondwater (AS3000) | Monster 6 |
| 003 | Grondwater (AS3000) | Monster 7 |
| 004 | Grondwater (AS3000) | Monster 8 |
| 005 | Grondwater (AS3000) | Monster 9 |

| Analyse | Eenheid | Q | 001 | 002 | 003 | 004 | 005 |
|---|---|---|---|---|---|---|---|
| tetrachloormethaan | µg/l | S | <5.0 [1)] | <5.0 [1)] | <0.1 | <0.1 | <1.0 [1)] |
| 1,1,1-trichloorethaan | µg/l | S | <5.0 [1)] | <5.0 [1)] | <0.1 | <0.1 | <1.0 [1)] |
| 1,1,2-trichloorethaan | µg/l | S | <5.0 [1)] | <5.0 [1)] | <0.1 | <0.1 | <1.0 [1)] |
| trichlooretheen | µg/l | S | 6.7 | 7.7 | 0.74 | 1.1 | 1.2 |
| chloroform | µg/l | S | <10 [1)] | <10 [1)] | <0.2 | <0.2 | <2.0 [1)] |
| vinylchloride | µg/l | S | 2900 | 3100 | 0.44 | 1.3 | 160 |
| tribroommethaan | µg/l | S | <10 [1)] | <10 [1)] | <0.2 | <0.2 | <2.0 [1)] |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

## Monster beschrijvingen

| | | |
|---|---|---|
| 001 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 002 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 003 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 004 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 005 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

## Voetnoten

| | |
|---|---|
| 1 | De rapportagegrens is verhoogd i.v.m. noodzakelijke verdunning. |
| 2 | De sommatie na verrekening van de 0.7 factor voor <-waarden volgens BoToVa. |
| 3 | Het resultaat is gewijzigd naar aanleiding van nader laboratoriumonderzoek. |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn



# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 006 | Grondwater (AS3000) | Monster 10 |
| 007 | Grondwater (AS3000) | Monster 11 |

| Analyse | Eenheid | Q | 006 | 007 |
|---|---|---|---|---|
| METALEN | | | | |
| barium | µg/l | S | 35 | 120 [3] |
| cadmium | µg/l | S | 0.29 | <0.20 |
| kobalt | µg/l | S | 3.7 | <2 |
| koper | µg/l | S | 27 | <2.0 |
| kwik | µg/l | S | <0.05 | <0.05 |
| lood | µg/l | S | 4.1 | <2.0 |
| molybdeen | µg/l | S | 4.8 | 4.6 [3] |
| nikkel | µg/l | S | 18 | 4 [3] |
| zink | µg/l | S | 38 | <10 |
| VLUCHTIGE AROMATEN | | | | |
| benzeen | µg/l | S | <0.2 | 0.56 |
| tolueen | µg/l | S | <0.2 | <0.2 |
| ethylbenzeen | µg/l | S | <0.2 | <0.2 |
| o-xyleen | µg/l | S | <0.1 | <0.1 |
| p- en m-xyleen | µg/l | S | <0.2 | <0.2 |
| xylenen (0.7 factor) | µg/l | S | 0.21 [2] | 0.21 [2] |
| totaal BTEX (0.7 factor) | µg/l | | 0.63 [2] | 1.05 [2] |
| POLYCYCLISCHE AROMATISCHE KOOLWATERSTOFFEN | | | | |
| naftaleen | µg/l | S | <0.02 | <0.02 |
| GEHALOGENEERDE KOOLWATERSTOFFEN | | | | |
| 1,1-dichloorethaan | µg/l | S | <0.2 | <0.2 |
| 1,2-dichloorethaan | µg/l | S | 0.60 | 0.77 |
| 1,1-dichlooretheen | µg/l | S | <0.1 | <0.1 |
| cis-1,2-dichlooretheen | µg/l | S | 4.5 | 9.7 |
| trans-1,2-dichlooretheen | µg/l | S | <0.1 | 0.11 |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | µg/l | S | 4.57 [2] | 9.81 [2] |
| dichloormethaan | µg/l | S | <0.2 | <0.2 |
| 1,1-dichloorpropaan | µg/l | S | <0.2 | <0.2 |
| 1,2-dichloorpropaan | µg/l | S | <0.2 | <0.2 |
| 1,3-dichloorpropaan | µg/l | S | <0.2 | <0.2 |
| som dichloorpropanen (0.7 factor) | µg/l | S | 0.42 [2] | 0.42 [2] |
| tetrachlooretheen | µg/l | S | 0.79 | 0.98 |
| tetrachloormethaan | µg/l | S | <0.1 | <0.1 |
| 1,1,1-trichloorethaan | µg/l | S | <0.1 | <0.1 |
| 1,1,2-trichloorethaan | µg/l | S | <0.1 | <0.1 |
| trichlooretheen | µg/l | S | <0.2 | <0.2 |
| chloroform | µg/l | S | <0.2 | <0.2 |
| vinylchloride | µg/l | S | 0.30 | 0.84 |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 006 | Grondwater (AS3000) | Monster 10 |
| 007 | Grondwater (AS3000) | Monster 11 |

| Analyse | Eenheid | Q | 006 | 007 |
|---|---|---|---|---|
| tribroommethaan | µg/l | S | <0.2 | <0.2 |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

## Monster beschrijvingen

| | | |
|---|---|---|
| 006 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 007 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

## Voetnoten

| | |
|---|---|
| 2 | De sommatie na verrekening van de 0.7 factor voor <-waarden volgens BoToVa. |
| 3 | Het resultaat is gewijzigd naar aanleiding van nader laboratoriumonderzoek. |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

| Analyse | Monstersoort | Relatie tot norm |
|---|---|---|
| barium | Grondwater (AS3000) | Conform AS3110-3 en conform NEN 6966 en conform NEN-EN-ISO 11885 |
| cadmium | Grondwater (AS3000) | Idem |
| kobalt | Grondwater (AS3000) | Idem |
| koper | Grondwater (AS3000) | Idem |
| kwik | Grondwater (AS3000) | Conform AS3110-3 en conform NEN-EN-ISO 17852 |
| lood | Grondwater (AS3000) | Conform AS3110-3 en conform NEN 6966 en conform NEN-EN-ISO 11885 |
| molybdeen | Grondwater (AS3000) | Idem |
| nikkel | Grondwater (AS3000) | Idem |
| zink | Grondwater (AS3000) | Idem |
| benzeen | Grondwater (AS3000) | Conform AS3130-1 |
| tolueen | Grondwater (AS3000) | Idem |
| ethylbenzeen | Grondwater (AS3000) | Idem |
| o-xyleen | Grondwater (AS3000) | Idem |
| p- en m-xyleen | Grondwater (AS3000) | Idem |
| xylenen (0.7 factor) | Grondwater (AS3000) | Idem |
| totaal BTEX (0.7 factor) | Grondwater (AS3000) | Eigen methode, headspace GCMS |
| naftaleen | Grondwater (AS3000) | Conform AS3110-4 |
| 1,1-dichloorethaan | Grondwater (AS3000) | Conform AS3130-1 |
| 1,2-dichloorethaan | Grondwater (AS3000) | Idem |
| 1,1-dichlooretheen | Grondwater (AS3000) | Idem |
| cis-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| trans-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | Grondwater (AS3000) | Idem |
| dichloormethaan | Grondwater (AS3000) | Idem |
| 1,1-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,2-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,3-dichloorpropaan | Grondwater (AS3000) | Idem |
| som dichloorpropanen (0.7 factor) | Grondwater (AS3000) | Idem |
| tetrachlooretheen | Grondwater (AS3000) | Idem |
| tetrachloormethaan | Grondwater (AS3000) | Idem |
| 1,1,1-trichloorethaan | Grondwater (AS3000) | Idem |
| 1,1,2-trichloorethaan | Grondwater (AS3000) | Idem |
| trichlooretheen | Grondwater (AS3000) | Idem |
| chloroform | Grondwater (AS3000) | Idem |
| vinylchloride | Grondwater (AS3000) | Idem |
| tribroommethaan | Grondwater (AS3000) | Idem |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 001 | B1909935 | 19-03-2020 | 19-03-2020 | ALC204 |
| 001 | G6762637 | 19-03-2020 | 19-03-2020 | ALC236 |
| 001 | G6762643 | 19-03-2020 | 19-03-2020 | ALC236 |
| 002 | G6762649 | 19-03-2020 | 19-03-2020 | ALC236 |
| 002 | B1909941 | 19-03-2020 | 19-03-2020 | ALC204 |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220750 - 2 | Rapportagedatum | 20-03-2020 |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 002 | G6762648 | 19-03-2020 | 19-03-2020 | ALC236 |
| 003 | B1909932 | 19-03-2020 | 19-03-2020 | ALC204 |
| 003 | G6762618 | 19-03-2020 | 19-03-2020 | ALC236 |
| 003 | G6762612 | 19-03-2020 | 19-03-2020 | ALC236 |
| 004 | G6762642 | 19-03-2020 | 19-03-2020 | ALC236 |
| 004 | G6762630 | 19-03-2020 | 19-03-2020 | ALC236 |
| 004 | B1909938 | 19-03-2020 | 19-03-2020 | ALC204 |
| 005 | G6762641 | 19-03-2020 | 19-03-2020 | ALC236 |
| 005 | B1909971 | 19-03-2020 | 19-03-2020 | ALC204 |
| 005 | G6762647 | 19-03-2020 | 19-03-2020 | ALC236 |
| 006 | G6762623 | 19-03-2020 | 19-03-2020 | ALC236 |
| 006 | B1909948 | 19-03-2020 | 19-03-2020 | ALC204 |
| 006 | G6762629 | 19-03-2020 | 19-03-2020 | ALC236 |
| 007 | G6762652 | 19-03-2020 | 19-03-2020 | ALC236 |
| 007 | G6762646 | 19-03-2020 | 19-03-2020 | ALC236 |
| 007 | B1909954 | 19-03-2020 | 19-03-2020 | ALC204 |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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**SYNLAB Analytics & Services B.V.**
Correspondentieadres
Steenhouwerstraat 15 · 3194 AG Rotterdam
Tel.: +31 (0)10 231 47 00 · Fax: +31 (0)10 416 30 34
www.synlab.nl

# Analyserapport

GEOFOXX Tilburg BV
Dhr. M. Klijn
Postbus 2205
5001 CE  TILBURG



| | |
|---|---|
| Uw projectnaam | : Grindsted DK |
| Uw projectnummer | : 20200214 |
| SYNLAB rapportnummer | : 13220756, versienummer: 1. |
| Rapport-verificatienummer | : JZPURR9D |

Rotterdam, 22-03-2020

Geachte heer/mevrouw,

Hierbij ontvangt u de analyse resultaten van het laboratoriumonderzoek ten behoeve van uw project 20200214. Het onderzoek werd uitgevoerd conform uw opdracht. De gerapporteerde resultaten hebben uitsluitend betrekking op de geteste monsters. De door u aangegeven omschrijvingen voor de monsters, het project en de monsternamedatum (indien aangeleverd) zijn overgenomen in dit analyserapport. SYNLAB is niet verantwoordelijk voor de gegevens verstrekt door de opdrachtgever.

Het onderzoek is uitgevoerd door SYNLAB Analytics & Services B.V., gevestigd aan de Steenhouwerstraat 15 in Rotterdam (NL). Indien het onderzoek is uitgevoerd door derden of het SYNLAB laboratorium in Frankrijk (99-101 Avenue Louis Roche, Gennevilliers) is dit in het rapport aangegeven.

Dit analyserapport bestaat inclusief bijlagen uit 6 pagina's. In geval van een versienummer van '2' of hoger vervallen de voorgaande versies. Alle bijlagen maken onlosmakelijk onderdeel uit van het rapport. Alleen vermenigvuldiging van het hele rapport is toegestaan.

Mocht u vragen en/of opmerkingen hebben naar aanleiding van dit rapport, bijvoorbeeld als u nadere informatie nodig heeft over de meetonzekerheid van de analyseresultaten in dit rapport, dan verzoeken wij u vriendelijk contact op te nemen met de afdeling Customer Support.

Wij vertrouwen er op u met deze informatie van dienst te zijn.

Hoogachtend,

Jaap-Willem Hutter
Technical Director

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220756 - 1 | Rapportagedatum | 22-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Monster 5 |
| 002 | Grondwater (AS3000) | Monster 6 |
| 003 | Grondwater (AS3000) | Monster 7 |
| 004 | Grondwater (AS3000) | Monster 8 |
| 005 | Grondwater (AS3000) | Monster 9 |

| Analyse | Eenheid | Q | 001 | 002 | 003 | 004 | 005 |
|---|---|---|---|---|---|---|---|
| TOC | mg/l | Q | 4.8 | 4.5 | 6.4 | 5.6 | 5.8 |
| METALEN | | | | | | | |
| ijzer totaal | µg/l | | 190 | 590 | 53000 | 13000 | 1100 |

De met Q gemerkte analyses zijn geaccrediteerd door de RvA.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220756 - 1 | Rapportagedatum | 22-03-2020 |

**Monster beschrijvingen**

| | | |
|---|---|---|
| 001 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 002 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 003 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 004 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 005 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220756 - 1 | Rapportagedatum | 22-03-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 006 | Grondwater (AS3000) | Monster 10 |
| 007 | Grondwater (AS3000) | Monster 11 |

| Analyse | Eenheid | Q | 006 | 007 |
|---|---|---|---|---|
| TOC | mg/l | Q | 5.9 | 7.7 |
| METALEN | | | | |
| ijzer totaal | µg/l | | 32000 | 34000 |

De met Q gemerkte analyses zijn geaccrediteerd door de RvA.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220756 - 1 | Rapportagedatum | 22-03-2020 |

**Monster beschrijvingen**

| | | |
|---|---|---|
| 006 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 007 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 19-03-2020 |
| Projectnummer | 20200214 | Startdatum | 19-03-2020 |
| Rapportnummer | 13220756 - 1 | Rapportagedatum | 22-03-2020 |

| Analyse | Monstersoort | Relatie tot norm |
|---|---|---|
| TOC | Grondwater (AS3000) | Conform NEN-EN 1484 |
| ijzer totaal | Grondwater (AS3000) | Ontsluiting conform NEN-EN-ISO 15587-1, meting conform NEN 6966 en NEN-EN-ISO 11885 |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 001 | G6762636 | 19-03-2020 | 19-03-2020 | ALC236 |
| 001 | U3171572 | 19-03-2020 | 19-03-2020 | ALC247 |
| 002 | G6762655 | 19-03-2020 | 19-03-2020 | ALC236 |
| 002 | U3171569 | 19-03-2020 | 19-03-2020 | ALC247 |
| 003 | G6762624 | 19-03-2020 | 19-03-2020 | ALC236 |
| 003 | U3171570 | 19-03-2020 | 19-03-2020 | ALC247 |
| 004 | U3171571 | 19-03-2020 | 19-03-2020 | ALC247 |
| 004 | G6762654 | 19-03-2020 | 19-03-2020 | ALC236 |
| 005 | G6762653 | 19-03-2020 | 19-03-2020 | ALC236 |
| 005 | U3171575 | 19-03-2020 | 19-03-2020 | ALC247 |
| 006 | U3171578 | 19-03-2020 | 19-03-2020 | ALC247 |
| 006 | G6762635 | 19-03-2020 | 19-03-2020 | ALC236 |
| 007 | U3171577 | 19-03-2020 | 19-03-2020 | ALC247 |
| 007 | G6762640 | 19-03-2020 | 19-03-2020 | ALC236 |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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**SYNLAB Analytics & Services B.V.**
Correspondentieadres
Steenhouwerstraat 15 · 3194 AG Rotterdam
Tel.: +31 (0)10 231 47 00 · Fax: +31 (0)10 416 30 34
www.synlab.nl

# Analyserapport

GEOFOXX Tilburg BV
Dhr. M. Klijn
Postbus 2205
5001 CE  TILBURG



| | |
|---|---|
| Uw projectnaam | : Grindsted DK |
| Uw projectnummer | : 20200214 |
| SYNLAB rapportnummer | : 13231621, versienummer: 1. |
| Rapport-verificatienummer | : PVNNK9GE |

Rotterdam, 14-04-2020

Geachte heer/mevrouw,

Hierbij ontvangt u de analyse resultaten van het laboratoriumonderzoek ten behoeve van uw project 20200214. Het onderzoek werd uitgevoerd conform uw opdracht. De gerapporteerde resultaten hebben uitsluitend betrekking op de geteste monsters. De door u aangegeven omschrijvingen voor de monsters, het project en de monsternamedatum (indien aangeleverd) zijn overgenomen in dit analyserapport. SYNLAB is niet verantwoordelijk voor de gegevens verstrekt door de opdrachtgever.

Het onderzoek is uitgevoerd door SYNLAB Analytics & Services B.V., gevestigd aan de Steenhouwerstraat 15 in Rotterdam (NL). Indien het onderzoek is uitgevoerd door derden of het SYNLAB laboratorium in Frankrijk (99-101 Avenue Louis Roche, Gennevilliers) is dit in het rapport aangegeven.

Dit analyserapport bestaat inclusief bijlagen uit 4 pagina's. In geval van een versienummer van '2' of hoger vervallen de voorgaande versies. Alle bijlagen maken onlosmakelijk onderdeel uit van het rapport. Alleen vermenigvuldiging van het hele rapport is toegestaan.

Mocht u vragen en/of opmerkingen hebben naar aanleiding van dit rapport, bijvoorbeeld als u nadere informatie nodig heeft over de meetonzekerheid van de analyseresultaten in dit rapport, dan verzoeken wij u vriendelijk contact op te nemen met de afdeling Customer Support.

Wij vertrouwen er op u met deze informatie van dienst te zijn.

Hoogachtend,

Jaap-Willem Hutter
Technical Director

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 10-04-2020 |
| Projectnummer | 20200214 | Startdatum | 10-04-2020 |
| Rapportnummer | 13231621 - 1 | Rapportagedatum | 14-04-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Container 1 Ruw |
| 002 | Grondwater (AS3000) | Container 2 Ruw |
| 003 | Grondwater (AS3000) | Run 1 |
| 004 | Grondwater (AS3000) | Run 2 |

| Analyse | Eenheid | Q | 001 | 002 | 003 | 004 |
|---|---|---|---|---|---|---|
| VLUCHTIGE AROMATEN | | | | | | |
| benzeen | µg/l | S | 390 | 350 | 6.0 | <0.2 |
| tolueen | µg/l | S | 3.8 | 3.3 | <0.2 | <0.2 |
| ethylbenzeen | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.2 | <0.2 |
| o-xyleen | µg/l | S | 1.1 | <1.0 [1)] | <0.1 | <0.1 |
| p- en m-xyleen | µg/l | S | <2.0 [1)] | <2.0 [1)] | <0.2 | <0.2 |
| xylenen (0.7 factor) | µg/l | S | 2.5 [2)] | 2.1 [2)] | 0.21 [2)] | 0.21 [2)] |
| totaal BTEX (0.7 factor) | µg/l | | 397 [2)] | 356.1 [2)] | 6.49 [2)] | 0.63 [2)] |
| POLYCYCLISCHE AROMATISCHE KOOLWATERSTOFFEN | | | | | | |
| naftaleen | µg/l | S | 0.15 | 0.13 | <0.02 | <0.02 |
| GEHALOGENEERDE KOOLWATERSTOFFEN | | | | | | |
| 1,1-dichloorethaan | µg/l | S | <2.0 [1)] | <2.0 [1)] | <0.2 | <0.2 |
| 1,2-dichloorethaan | µg/l | S | <2.0 [1)] | <2.0 [1)] | <0.2 | <0.2 |
| 1,1-dichlooretheen | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.1 | <0.1 |
| cis-1,2-dichlooretheen | µg/l | S | 1200 | 1100 | 42 | 1.1 |
| trans-1,2-dichlooretheen | µg/l | S | 42 | 38 | 4.4 | 0.12 |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | µg/l | S | 1242 [2)] | 1138 [2)] | 46.4 [2)] | 1.22 [2)] |
| dichloormethaan | µg/l | S | <2.0 [1)] | <2.0 [1)] | <0.2 | <0.2 |
| 1,1-dichloorpropaan | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.2 | <0.2 |
| 1,2-dichloorpropaan | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.2 | <0.2 |
| 1,3-dichloorpropaan | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.2 | <0.2 |
| som dichloorpropanen (0.7 factor) | µg/l | S | 2.1 [2)] | 2.1 [2)] | 0.42 [2)] | 0.42 [2)] |
| tetrachlooretheen | µg/l | S | 9.6 | 9.5 | 1.8 | 0.28 |
| tetrachloormethaan | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.1 | <0.1 |
| 1,1,1-trichloorethaan | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.1 | <0.1 |
| 1,1,2-trichloorethaan | µg/l | S | <1.0 [1)] | <1.0 [1)] | <0.1 | <0.1 |
| trichlooretheen | µg/l | S | 5.5 | 5.1 | 9.1 | 7.0 |
| chloroform | µg/l | S | <2.0 [1)] | <2.0 [1)] | <0.2 | <0.2 |
| vinylchloride | µg/l | S | 1700 | 1800 | 18 | 0.33 |
| tribroommethaan | µg/l | S | <2.0 [1)] | <2.0 [1)] | <0.2 | <0.2 |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 10-04-2020 |
| Projectnummer | 20200214 | Startdatum | 10-04-2020 |
| Rapportnummer | 13231621 - 1 | Rapportagedatum | 14-04-2020 |

## Monster beschrijvingen

| | | |
|---|---|---|
| 001 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 002 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 003 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 004 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

## Voetnoten

| | |
|---|---|
| 1 | De rapportagegrens is verhoogd i.v.m. noodzakelijke verdunning. |
| 2 | De sommatie na verrekening van de 0.7 factor voor <-waarden volgens BoToVa. |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 10-04-2020 |
| Projectnummer | 20200214 | Startdatum | 10-04-2020 |
| Rapportnummer | 13231621 - 1 | Rapportagedatum | 14-04-2020 |

| Analyse | Monstersoort | Relatie tot norm |
|---|---|---|
| benzeen | Grondwater (AS3000) | Conform AS3130-1 |
| tolueen | Grondwater (AS3000) | Idem |
| ethylbenzeen | Grondwater (AS3000) | Idem |
| o-xyleen | Grondwater (AS3000) | Idem |
| p- en m-xyleen | Grondwater (AS3000) | Idem |
| xylenen (0.7 factor) | Grondwater (AS3000) | Idem |
| totaal BTEX (0.7 factor) | Grondwater (AS3000) | Eigen methode, headspace GCMS |
| naftaleen | Grondwater (AS3000) | Conform AS3110-4 |
| 1,1-dichloorethaan | Grondwater (AS3000) | Conform AS3130-1 |
| 1,2-dichloorethaan | Grondwater (AS3000) | Idem |
| 1,1-dichlooretheen | Grondwater (AS3000) | Idem |
| cis-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| trans-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | Grondwater (AS3000) | Idem |
| dichloormethaan | Grondwater (AS3000) | Idem |
| 1,1-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,2-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,3-dichloorpropaan | Grondwater (AS3000) | Idem |
| som dichloorpropanen (0.7 factor) | Grondwater (AS3000) | Idem |
| tetrachlooretheen | Grondwater (AS3000) | Idem |
| tetrachloormethaan | Grondwater (AS3000) | Idem |
| 1,1,1-trichloorethaan | Grondwater (AS3000) | Idem |
| 1,1,2-trichloorethaan | Grondwater (AS3000) | Idem |
| trichlooretheen | Grondwater (AS3000) | Idem |
| chloroform | Grondwater (AS3000) | Idem |
| vinylchloride | Grondwater (AS3000) | Idem |
| tribroommethaan | Grondwater (AS3000) | Idem |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 001 | G6762616 | 10-04-2020 | 10-04-2020 | ALC236 |
| 002 | G6762615 | 10-04-2020 | 10-04-2020 | ALC236 |
| 003 | G6762613 | 10-04-2020 | 10-04-2020 | ALC236 |
| 004 | G6762621 | 10-04-2020 | 10-04-2020 | ALC236 |

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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**SYNLAB Analytics & Services B.V.**
Correspondentieadres
Steenhouwerstraat 15 · 3194 AG Rotterdam
Tel.: +31 (0)10 231 47 00 · Fax: +31 (0)10 416 30 34
www.synlab.nl

# Analyserapport

GEOFOXX Tilburg BV
Dhr. M. Klijn
Postbus 2205
5001 CE TILBURG



| | |
|---|---|
| Uw projectnaam | : Grindsted DK |
| Uw projectnummer | : 20200214 |
| SYNLAB rapportnummer | : 13231632, versienummer: 1. |
| Rapport-verificatienummer | : PH62TWUY |

Rotterdam, 14-04-2020

Geachte heer/mevrouw,

Hierbij ontvangt u de analyse resultaten van het laboratoriumonderzoek ten behoeve van uw project 20200214. Het onderzoek werd uitgevoerd conform uw opdracht. De gerapporteerde resultaten hebben uitsluitend betrekking op de geteste monsters. De door u aangegeven omschrijvingen voor de monsters, het project en de monsternamedatum (indien aangeleverd) zijn overgenomen in dit analyserapport. SYNLAB is niet verantwoordelijk voor de gegevens verstrekt door de opdrachtgever.

Het onderzoek is uitgevoerd door SYNLAB Analytics & Services B.V., gevestigd aan de Steenhouwerstraat 15 in Rotterdam (NL). Indien het onderzoek is uitgevoerd door derden of het SYNLAB laboratorium in Frankrijk (99-101 Avenue Louis Roche, Gennevilliers) is dit in het rapport aangegeven.

Dit analyserapport bestaat inclusief bijlagen uit 4 pagina's. In geval van een versienummer van '2' of hoger vervallen de voorgaande versies. Alle bijlagen maken onlosmakelijk onderdeel uit van het rapport. Alleen vermenigvuldiging van het hele rapport is toegestaan.

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Wij vertrouwen er op u met deze informatie van dienst te zijn.

Hoogachtend,

Jaap-Willem Hutter
Technical Director

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 10-04-2020 |
| Projectnummer | 20200214 | Startdatum | 10-04-2020 |
| Rapportnummer | 13231632 - 1 | Rapportagedatum | 14-04-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Run 1 |

| Analyse | Eenheid | Q | 001 |
|---|---|---|---|
| METALEN | | | |
| ijzer totaal | µg/l | | 2200 |

Paraaf :

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 10-04-2020 |
| Projectnummer | 20200214 | Startdatum | 10-04-2020 |
| Rapportnummer | 13231632 - 1 | Rapportagedatum | 14-04-2020 |

**Monster beschrijvingen**

001 * De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk.

Paraaf :

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 10-04-2020 |
| Projectnummer | 20200214 | Startdatum | 10-04-2020 |
| Rapportnummer | 13231632 - 1 | Rapportagedatum | 14-04-2020 |

| Analyse | Monstersoort | Relatie tot norm |
|---|---|---|
| ijzer totaal | Grondwater (AS3000) | Ontsluiting conform NEN-EN-ISO 15587-1, meting conform NEN 6966 en NEN-EN-ISO 11885 |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 001 | U3171579 | 10-04-2020 | 10-04-2020 | ALC247 |

Paraaf :

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

**SYNLAB Analytics & Services B.V.**
Correspondentieadres
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Tel.: +31 (0)10 231 47 00 · Fax: +31 (0)10 416 30 34
www.synlab.nl

# Analyserapport

GEOFOXX Tilburg BV
Dhr. M. Klijn
Postbus 2205
5001 CE TILBURG



| | |
|---|---|
| Uw projectnaam | : Grindsted DK |
| Uw projectnummer | : 20200214 |
| SYNLAB rapportnummer | : 13235153, versienummer: 1. |
| Rapport-verificatienummer | : 5XEEDWSZ |

Rotterdam, 21-04-2020

Geachte heer/mevrouw,

Hierbij ontvangt u de analyse resultaten van het laboratoriumonderzoek ten behoeve van uw project 20200214. Het onderzoek werd uitgevoerd conform uw opdracht. De gerapporteerde resultaten hebben uitsluitend betrekking op de geteste monsters. De door u aangegeven omschrijvingen voor de monsters, het project en de monsternamedatum (indien aangeleverd) zijn overgenomen in dit analyserapport. SYNLAB is niet verantwoordelijk voor de gegevens verstrekt door de opdrachtgever.

Het onderzoek is uitgevoerd door SYNLAB Analytics & Services B.V., gevestigd aan de Steenhouwerstraat 15 in Rotterdam (NL). Indien het onderzoek is uitgevoerd door derden of het SYNLAB laboratorium in Frankrijk (99-101 Avenue Louis Roche, Gennevilliers) is dit in het rapport aangegeven.

Dit analyserapport bestaat inclusief bijlagen uit 4 pagina's. In geval van een versienummer van '2' of hoger vervallen de voorgaande versies. Alle bijlagen maken onlosmakelijk onderdeel uit van het rapport. Alleen vermenigvuldiging van het hele rapport is toegestaan.

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Wij vertrouwen er op u met deze informatie van dienst te zijn.

Hoogachtend,

Jaap-Willem Hutter
Technical Director

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

GEOFOXX Tilburg BV
Dhr. M. Klijn



# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 20-04-2020 |
| Projectnummer | 20200214 | Startdatum | 20-04-2020 |
| Rapportnummer | 13235153 - 1 | Rapportagedatum | 21-04-2020 |

| Nummer | Monstersoort | Monsterspecificatie |
|---|---|---|
| 001 | Grondwater (AS3000) | Run E |
| 002 | Grondwater (AS3000) | Run F |

| Analyse | Eenheid | Q | 001 | 002 |
|---|---|---|---|---|
| METALEN | | | | |
| ijzer totaal | µg/l | | 2100 | |
| VLUCHTIGE AROMATEN | | | | |
| benzeen | µg/l | S | <0.2 | <0.2 |
| tolueen | µg/l | S | <0.2 | <0.2 |
| ethylbenzeen | µg/l | S | <0.2 | <0.2 |
| o-xyleen | µg/l | S | <0.1 | <0.1 |
| p- en m-xyleen | µg/l | S | <0.2 | <0.2 |
| xylenen (0.7 factor) | µg/l | S | 0.21 [1)] | 0.21 [1)] |
| totaal BTEX (0.7 factor) | µg/l | | 0.63 [1)] | 0.63 [1)] |
| POLYCYCLISCHE AROMATISCHE KOOLWATERSTOFFEN | | | | |
| naftaleen | µg/l | S | <0.02 | <0.02 |
| GEHALOGENEERDE KOOLWATERSTOFFEN | | | | |
| 1,1-dichloorethaan | µg/l | S | <0.2 | <0.2 |
| 1,2-dichloorethaan | µg/l | S | 0.20 | <0.2 |
| 1,1-dichlooretheen | µg/l | S | <0.1 | <0.1 |
| cis-1,2-dichlooretheen | µg/l | S | 0.88 | <0.1 |
| trans-1,2-dichlooretheen | µg/l | S | 0.11 | <0.1 |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | µg/l | S | 0.99 [1)] | 0.14 [1)] |
| dichloormethaan | µg/l | S | <0.2 | <0.2 |
| 1,1-dichloorpropaan | µg/l | S | <0.2 | <0.2 |
| 1,2-dichloorpropaan | µg/l | S | <0.2 | <0.2 |
| 1,3-dichloorpropaan | µg/l | S | <0.2 | <0.2 |
| som dichloorpropanen (0.7 factor) | µg/l | S | 0.42 [1)] | 0.42 [1)] |
| tetrachlooretheen | µg/l | S | 0.45 | <0.1 |
| tetrachloormethaan | µg/l | S | <0.1 | <0.1 |
| 1,1,1-trichloorethaan | µg/l | S | <0.1 | <0.1 |
| 1,1,2-trichloorethaan | µg/l | S | <0.1 | <0.1 |
| trichlooretheen | µg/l | S | 1.4 | 0.95 |
| chloroform | µg/l | S | <0.2 | <0.2 |
| vinylchloride | µg/l | S | 3.5 | <0.2 |
| tribroommethaan | µg/l | S | <0.2 | <0.2 |

De met S gemerkte analyses zijn geaccrediteerd en vallen onder de AS3000-erkenning.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

# Analyserapport

| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 20-04-2020 |
| Projectnummer | 20200214 | Startdatum | 20-04-2020 |
| Rapportnummer | 13235153 - 1 | Rapportagedatum | 21-04-2020 |

## Monster beschrijvingen

| | | |
|---|---|---|
| 001 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |
| 002 | * | De monstervoorbehandeling en analyses zijn uitgevoerd conform Accreditatieschema AS3000, dit geldt alleen voor de analyses die worden gerapporteerd met het "S" kenmerk. |

## Voetnoten

1 De sommatie na verrekening van de 0.7 factor voor <-waarden volgens BoToVa.

Paraaf :

SYNLAB Analytics & Services B.V. IS GEACCREDITEERD VOLGENS DE DOOR DE RAAD VOOR ACCREDITATIE GESTELDE CRITERIA VOOR TESTLABORATORIA CONFORM EN ISO/IEC 17025:2017 ONDER NR. L 028

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GEOFOXX Tilburg BV
Dhr. M. Klijn

# Analyserapport



| | | | |
|---|---|---|---|
| Projectnaam | Grindsted DK | Orderdatum | 20-04-2020 |
| Projectnummer | 20200214 | Startdatum | 20-04-2020 |
| Rapportnummer | 13235153 - 1 | Rapportagedatum | 21-04-2020 |

| Analyse | Monstersoort | Relatie tot norm |
|---|---|---|
| ijzer totaal | Grondwater (AS3000) | Ontsluiting conform NEN-EN-ISO 15587-1, meting conform NEN 6966 en NEN-EN-ISO 11885 |
| benzeen | Grondwater (AS3000) | Conform AS3130-1 |
| tolueen | Grondwater (AS3000) | Idem |
| ethylbenzeen | Grondwater (AS3000) | Idem |
| o-xyleen | Grondwater (AS3000) | Idem |
| p- en m-xyleen | Grondwater (AS3000) | Idem |
| xylenen (0.7 factor) | Grondwater (AS3000) | Idem |
| totaal BTEX (0.7 factor) | Grondwater (AS3000) | Eigen methode, headspace GCMS |
| naftaleen | Grondwater (AS3000) | Conform AS3110-4 |
| 1,1-dichloorethaan | Grondwater (AS3000) | Conform AS3130-1 |
| 1,2-dichloorethaan | Grondwater (AS3000) | Idem |
| 1,1-dichlooretheen | Grondwater (AS3000) | Idem |
| cis-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| trans-1,2-dichlooretheen | Grondwater (AS3000) | Idem |
| som (cis,trans) 1,2-dichloorethenen (0.7 factor) | Grondwater (AS3000) | Idem |
| dichloormethaan | Grondwater (AS3000) | Idem |
| 1,1-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,2-dichloorpropaan | Grondwater (AS3000) | Idem |
| 1,3-dichloorpropaan | Grondwater (AS3000) | Idem |
| som dichloorpropanen (0.7 factor) | Grondwater (AS3000) | Idem |
| tetrachlooretheen | Grondwater (AS3000) | Idem |
| tetrachloormethaan | Grondwater (AS3000) | Idem |
| 1,1,1-trichloorethaan | Grondwater (AS3000) | Idem |
| 1,1,2-trichloorethaan | Grondwater (AS3000) | Idem |
| trichlooretheen | Grondwater (AS3000) | Idem |
| chloroform | Grondwater (AS3000) | Idem |
| vinylchloride | Grondwater (AS3000) | Idem |
| tribroommethaan | Grondwater (AS3000) | Idem |

| Monster | Barcode | Aanlevering | Monstername | Verpakking |
|---|---|---|---|---|
| 001 | G6762610 | 20-04-2020 | 20-04-2020 | ALC236 |
| 001 | U3171573 | 20-04-2020 | 20-04-2020 | ALC247 |
| 002 | G6762611 | 20-04-2020 | 20-04-2020 | ALC236 |
| 002 | U3171580 | 20-04-2020 | 20-04-2020 | ALC247 |

Paraaf :

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AL ONZE WERKZAAMHEDEN WORDEN UITGEVOERD ONDER DE ALGEMENE VOORWAARDEN GEDEPONEERD BIJ DE KAMER VAN KOOPHANDEL EN FABRIEKEN TE ROTTERDAM INSCHRIJVING HANDELSREGISTER: KVK ROTTERDAM 24265286

# Annex 2:

# Analysis results of ALS

# Bilag C Rapport fra SUEZ

# Grinsted- Advanced Oxidation Process (AOP) and PAC tests on polluted Ground Water

## Laboratory Test report

### Project-No.: 008824

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# 1 Introduction

## 1.1 Context

The activities at the former Grindstedværket have caused pollution of the factory ground and groundwater below. The groundwater contamination consists mainly **of multiple pharmaceutical substances**, **hydrocarbons** (especially Benzene), **chlorinated solvents**, especially vinyl chloride and cis 1,2-DCE (Dichloroethylene).
The Region of Southern Denmark has decided to initiate a study of the possibilities of reducing the impact of Grindsted pollutants. The idea is to establish a temporary facility to groundwater pumping for on-site groundwater remediation at the Sewage Treatment Plant West.
COWI as consultant has for the region conducted a screening of relevant purification methods for pumped groundwater, and in this connection, it has been assessed that advanced oxidation processes (AOP) may be suitable for groundwater purification before discharge. **Four AOP processes** have been identified.
Ozone (O3) (herein called Experiment A)
Ozone + peroxide ($H_2O_2$) (herein called Experiment B)
UV + peroxide (herein called Experiment C)
Catalyst + peroxide (herein called Experiment D)

Suez has been chosen by the region to perform AOP test of experiments A, B and C. Experiment D was conducted by Water IQ in Holland
For all 4 methods, a **post-treatment** has been carried out with Powder Activated Carbon (PAC) after the AOP tests.

Suez realized the post treatment of the oxidized effluents of all experiments (Including experiment D).

The purpose of the AOP trials (sub-agreements 1 and 2, tender documents client) is:

- to investigate the suitability of the 4 selected AOP methods for groundwater purification
- to investigate the cleaning efficiency of Grindstedværket Substances at the 4 selected AOP processes
- to examine pre-treatment / purification of the samples by removing iron and manganese prior to AOP purification,
- to determine relevant design parameters per m³ of water, including dosage and concentration of oxidizing agents and UV dose, reaction times / contact times for oxidation and for cleaning with activated carbon and possible needs for further addition of other chemicals.

Through advance treatment, combination of ozone & BAF (biological activated carbon) is part of the picture solutions for REUSE purpose. In the same way, AOP in combination with activated carbon is a trend-forward solution for the treatment of more difficult water matrices such as Grindsted contaminated groundwater.
In addition, the ecotoxicity of both treated and untreated water were investigated (sub-agreement 3, tender documents client) to assess the possibilities of diverting the purified water to Grindsted stream in a possible future full-scale plant.
Suez was in charge of producing enough post treated effluent for the ecotoxicity investigation.

In order to answer the tender requirement regarding Sub-agreement 1, Suez Dégremont Technologies involves the following other Suez entities:
Suez - Denmark – Water A/S
Suez – CIRSEE – International Suez research and Expertise center
To give the best chance of success to the AOP technologies assessment in such a water matrix, all parts involved will brings specific competencies such as: ozone & AOP expertise, scientific knowledge and process expertise in water, local expertise and context knowledge (non-exhaustive).

This present study is composed of 2 parts. The first part is a preliminary study (PART 1). Blind tests were done for AOP equipment assessment. Screening test results, required to define 3 doses (optimal, overdosed, underdosed) of the processes $O_3$, $O_3$ /$H_2O_2$ and UV/ $H_2O_2$ are as well presented.
The 4 technologies treatment performances assessment based on the ALS analysis results of inorganic, organics and Grinsted package compounds is presented in the 2nd part of this study.

## 1.2 Reference documents

The technical paper and the contract were based on the reference documents presented in the following Table:

Table 1: List of the reference documents

| Title | Reference |
|---|---|
| Contract under the thresholds with a clear cross-border interest – Lab tests of AOP-methods for treatment of contaminated groundwater from the pollution plume at Grindstedvaerket | A121940, COWI, November 2019 |
| Cleaning of polluted ground water from the pollution Plume at Grindstedvaerket | Appendix A (special work description) |
| Contract in between Region of Southern Denmark and Suez | Contract signed 04.02.2020 and 20.02.2020 |

# 2 Overview, milestones and Scope of the lab work

The total test process has been performed in two different locations: Denmark (sampling and pre-treatment) & Switzerland (AOP and-post treatment).
As water matrix conservation is essential in the test process, water samples were kept in fully filled containers, without the presence of air to avoid, as much as possible, out-gassing of the volatile compounds. Along the same lines, pre-treatment of the water should be done avoiding as much as possible strong agitation which could create out-gassing. Anyway, since the concentration of iron was <10 mg/L it was decided to skip the pre-treatment to remove iron and manganese.

Regarding the treatment goals, PNEC (Predicted no Effect Concentration) were considered as treatment goal. It is taken into account that the treated water will be discharged in a water body.
Doses (ozone, UV, carbon…), defined in Appendix A, will be adapted in consequences.

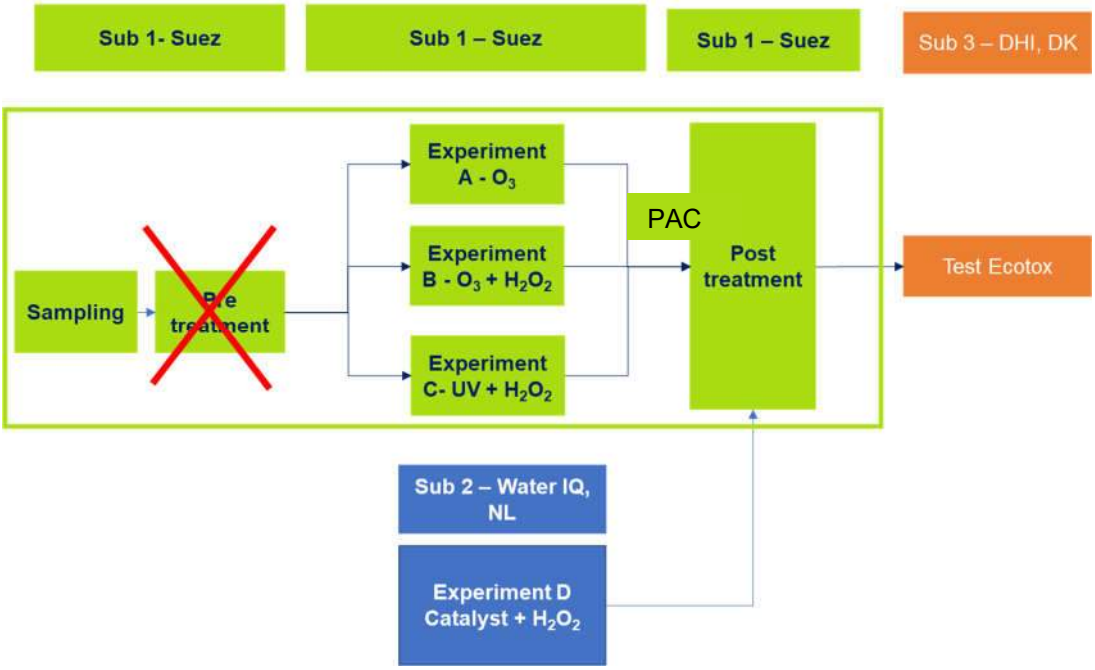



Figure 1: Sketch of the milestones and scope of the study

Suez - Denmark – Water A/S managed onsite sampling.

Suez Dégremont Technologies performed AOP laboratory testing and PAC tests and treatment.

Suez – CIRSEE – International Suez research and Expertise Center supported Suez Dégremont Technologies for process treatment expertise and PAC laboratory testing.

# 3 Organization and test plan

## 3.1 Test treatment process line and test plan

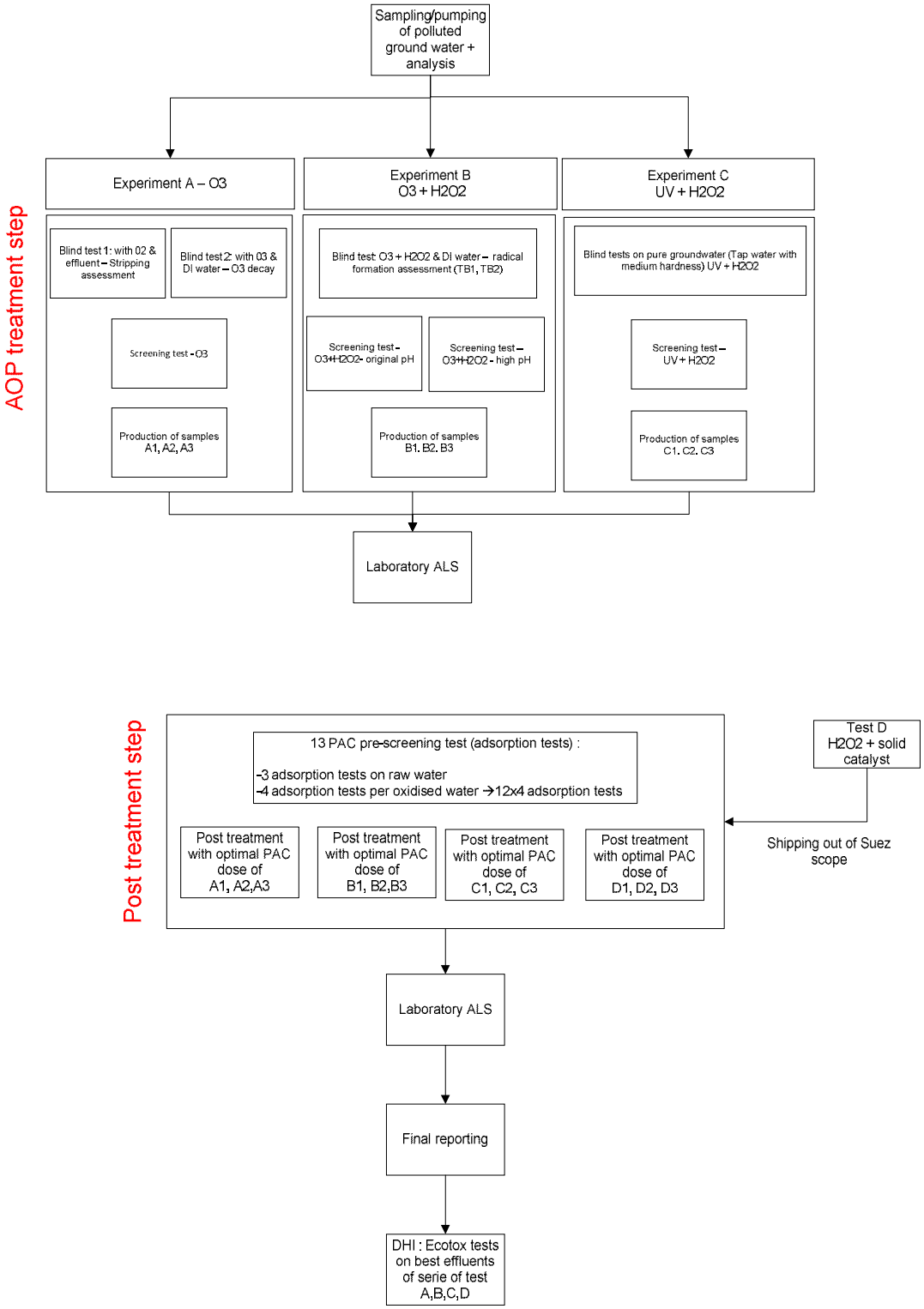



Figure 2: Final SUEZ test plan (Sub 1)

## 3.2 Planning

The collection of the 1m$^3$ sample was done the 10$^{th}$ of March and the end of the lab testing period was achieved before the 25$^{th}$ of May. The planning was approved despite constraints due to COVID 19 situation.
Lab testing performed by Suez were achieved within the defined time-schedule.
Detailed planning is available in appendix 7.1.

## 3.3 Sampling Grinsted site and sample handling Suez laboratory

### 3.3.1 General measures to avoid stripping

In general, agitation, aeration (bubbling, frequent opening, high flow…) or decompression was avoided to limit as much as possible degassing of the effluent and therefore loss of volatiles compounds and modification of the water matrix.

### 3.3.2 Onsite sampling

Figure 3: Picture of the onsite sampling (25.02.2020)

The 25$^{th}$ of February 2020, a sample was collected for iron, DOC and COD analysis. This water was sampled to determine if pre-treatment of water was required.

The baseline sample sent to ALS and the 1m$^3$ sample for laboratory testing were taken from the same well on the 10$^{th}$ of March 2020.

### 3.3.3 Shipping conditions (Temperature time)

Figure 4: Picture of the sample storage before shipping

1 $m^3$ sample collected and shipped through 1 x IBC pallet tank the 10/03/2020 (see Figure 4).
1 $m^3$ sample received in Dubendorf the 16/03/2020 at outside temperature (max 14°C).

### 3.3.4 Storage in SUEZ lab facilities and Splitting of the 1 m3 into 30 drums of 30 L

Figure 5: Picture of splitting installation

To make possible the handling and the storage in the fridge between 2-5°C of 1 $m^3$ effluent, the splitting of all the amount of volume into smaller 30 L drums have been done on March 17th. To minimize as much as possible the degassing of volatiles compounds during the transfers, a special procedure has been implemented.
All containers and parts were decontaminated prior to the operation.
The drums were all overfilled in a way that the liquid meniscus presents a concave shape to avoid as much as possible outgassing due to possible agitation.

A hose with appropriate diameter was connected to the outlet of the 1 $m^3$ container.
The height of the 1 $m^3$ container with the receiver drum of 30 L was adjusted to create a flow by gravity.

1 additional valve (valve 2) was implemented to control the flowrate.
When possible, the outlet of the hose was maintained close to the corner of the 25 L drum to reduce the flowrate and avoid stripping.
The drums were immediately closed after overfilling them.

### 3.3.5 Impact of the splitting on the tested effluent water quality

Samples at different stage of the shipping and splitting stage have been collected and analysed on DOC, PUT, COD, UV254, $Br^-$, $BrO_3$.

T0S0: Received raw water tested, before splitting. Parameters analysed by external lab (Bachema, ISO17025 accreditation)
T0S1: Received raw water tested, at the end of splitting. Parameters analysed by external lab (Bachema, ISO17025 accreditation)

Table 2: Comparison table of detected parameters before and after splitting of the tested effluent

| Parameter | Unit | T0S0* | T0S1* | T0S0 & T0S1 relative uncertainty (%) |
|---|---|---|---|---|
| COD | mg/L | 19.3 | 20.2 | 0.07 |
| UV absorption at 254 nm | $cm^{-1}$ | 0.221 | 0.223 | < 2% |
| Bromide | µg/l | 1400 | N.M | 6-12 % |
| Bromate | µg/l | <5 | N.M | 6-12 % |
| Benzene | µg/l | 318 | 355 | 12-24% |
| Trichlorethylen | µg/l | 9 | 11 | 12-24% |
| Tetrachlorethylen | µg/l | 14 | 18 | 12-24% |
| Chlorethan | µg/l | 9 | 10 | 12-24% |
| Vinyl chloride | µg/l | 2110 | 1910 | 12-24% |
| trans-1.2-dichlorethylen | µg/l | 27 | 31 | 12-24% |
| cis-1.2-dichlorethylen | µg/l | 924 | 995 | 12-24% |

T0S0 and T0S1 measurements are similar considering measurement uncertainty.

All 20 Litre drums filled with the raw water can be considered as one and the same sample without significant variation of water quality from one to the other.

### 3.3.6 Impact of the shipping on the effluent

According to the document "Annexe A", delivered by COWI. The water matrix is variable from one day to another, from one well to another. Therefore, test results and conclusions of this present study are only valid for the received and tested effluent.

As the measurements T0S0 (sample of the 1m$^3$ effluent shipped before splitting) and T0S1 (sample of the 1m$^3$ effluent shipped after splitting) are similar, the averages values of each parameter were calculated.

Bachema laboratory analysed T0S0 and T0S1. ALS laboratory analysed the baseline sample.
Below, Table 3 presents the detected and comparable analysed parameters of the two laboratories.

Table 3: Detected and comparable parameters on Grinsted water before treatment

| Parameter | Unit | Baseline | Average T0S0 & T0S1 | Baseline(±%) | T0S0 & T0S1 (±%) |
|---|---|---|---|---|---|
| Iron | mg/L | 5.4 | N.M | 10% | - |
| DOC | mg/L | **4.9** | **5.3** | 15% | 6-12 % |
| Bromide | µg/l | 1460 | 1400 | 20% | 6-12 % |
| Bromate | µg/l | <5 | <5 | 30% | 6-12 % |
| Benzene | µg/l | **520** | **337** | 20% | 12-24% |
| Trichlorethylene | µg/l | **22** | **10** | 20% | 12-24% |
| Tetrachloroethylene | µg/l | **48** | **16** | 20% | 12-24% |
| Chloroethane | µg/l | **35** | **10** | 20% | 12-24% |
| Vinyl chloride | µg/l | **7100** | **2010** | 20% | 12-24% |
| trans-1.2-dichlorethylen | µg/l | **41** | **29** | 20% | 12-24% |
| cis-1.2-dichlorethylen | µg/l | **1400** | **960** | 20% | 12-24% |

N.M: Not measured

T0S0: sample tested after shipping / before splitting (sampling 10/03/2020 – Received 16/03/2020)

T0S1: sample tested after shipping/ after splitting (sampling 10/03/2020 – Received 16/03/2020)

Baseline: Raw water sampled on site, reference as baseline for the study and comparison of all tested technologies. Parameter analysed by ALS (sampling date 10/03/2020)

Total iron in the effluent being < 10 mg/L of TSS limit for our AOP plant was considered enough low to skip pre-treatment initially foreseen. Therefore, no treatment prior to AOP have been conducted.

Assessing the difference in the results, it can be noted that some differences are far more than the specified measurement uncertainties. It is probably due to the volatility of some compounds. This is quite significant regarding Vinyl chloride. The deviations can also be partially due to a difference in water quality in between the 2 samples (baseline sample and shipped sample)

Due to the fact that both involved laboratories are iso 17025 accredited, it can be assumed that the presented results are within the manifested measurement uncertainties and the applied analytical methods are validated.

## 3.4 Water sample representativity

The representativity assessment of the sample is delicate since only 2 additional series of analysis have been done on the well BE6, (18.07.2019 and 10.10.2016).
Nevertheless, among the 73 analysed compounds (inorganic, organic and Grinsted compounds), for 74 % of them, the measured baseline concentrations were in the same range of concentrations considering the 20 - 30 % analytical uncertainty.

## 3.5 Analytical methods

Table 4: Analytical methods

| Parameter | Standard/method | Analyzer | LQ / LD | Uncertainty | Laboratory |
|---|---|---|---|---|---|
| COD | DIN EN 38409-41 | Hach Lange DR6000 | 5 mg/L – 60 mg/L | ±7% | Internal |
| UV adsorption | Spectro method at absorption 254 nm | Hach Lange DR6000 | 0.002 $cm^{-1}$ | 2% | Internal |
| Peroxide | | | 0.2 mg/L-6 mg/L | 6% | Internal |
| DOC | DIN EN 1484 | Shimadzu VWP | 0.05 mg/L | 6-12% | External |
| Bromide | DIN EN ISO 10304-1; SLMB Kp. 27A 4.10 | | 0.01 mg/L | 6-12% | External |
| Bromate | DIN EN ISO 10304-1; SLMB Kp. 27A 4.10 | | 0.005 mg/L | 6-12% | External |
| PUT | EPA 524.2 | GC MS in water | 0.05 µg/l | 12 %- 24 % | External |

Memo:

During each sampling step, degassing was avoided.
Therefore, vials were carefully handled (shaking avoided).
Samples vials were tagged before testing and sample always overfilled, and immediately capped to avoid volume for gas, especially for PUT analysis.

# 4 PART 1: Preliminary study: Definition of Oxidant and PAC doses

## 4.1 AOP tests

### 4.1.1 AOP test plan and test installation:

#### 4.1.1.1 Test plant common for experiment A, B, C

Following the demand referred in the tender document Appendix A, 3 advanced oxidation methods were conducted on the received effluent (17/03/2020) for:

- Ozone ($O_3$) (Experiment A)
- Ozone + peroxide ($H_2O_2$) (Experiment B)
- UV + peroxide (Experiment C)

For each method, blind tests, screening tests and production of oxidized effluents at 3 different UV, $H_2O_2$, $O_3$ doses (optimal dosage, Over-dosage and/or long reaction time, Under-dosage and/or short reaction time) were realized in the same Suez AOP plant.
all AOP lab test were performed in a 25L AOP plant. The AOP test plant is designed to conduct semi-batch tests and continuous tests applying ozone and combinations of ozone, UV (low pressure lamps) and peroxide under certain pH conditions. The reactor is equipped with a double wall connected to a chiller/heater circulation system, to maintain defined temperature conditions.

Figure 6: Picture of Suez Ozonation / AOP semi batch plant

During all AOP tests, following parameters were measured online:

- pH and temperature
- Ozone concentration feed gas and off gas
- Gas flow feed gas
- Dissolved ozone

Grab samples for chemical analysis were taken when necessary.

#### 4.1.1.2 Particularity for experiment B

During experiment B, peroxide was introduced continuously at a known and controlled concentration into the AOP plant with a peristaltic pump to simulate real conditions. Flowrate of the peristaltic pump was controlled before testing and considered for the calculation of peroxide dose. Excess of peroxide in the grab samples was quenched with an equivalent amount of sulphite.

#### 4.1.1.3 Adaptation for experiment C

The AOP lab plant is usually meant to test AOP based with ozone. The mixing is done by a gas inertia. During experiment C, no gas was introduced to avoid stripping. The AOP lab plant was consequently adapted to insure good mixing conditions.
Instead of introducing the gas/liquid mix through a venturi injector and a radial diffusor on the bottom of the reactor, the recycling loop was only used for a good mixing, bringing the water from the bottom of the reactor back to the surface water level without creating bubbles.
The mixing efficiency was tested by adding fluorescein into the loop prior to start testing work and considered as effective, see Figure 7
Figure 7

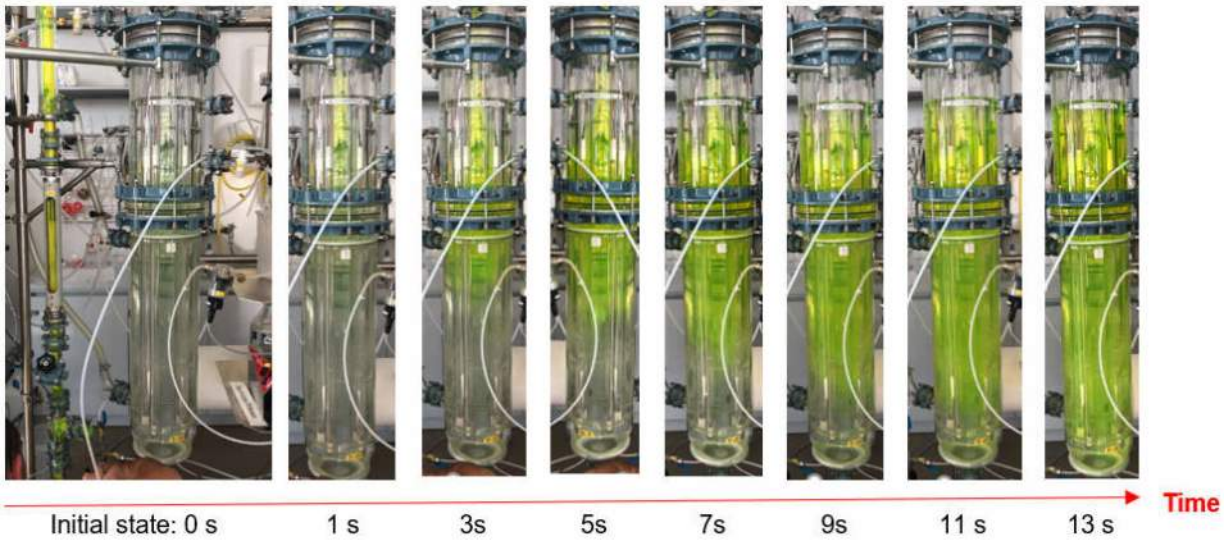



Figure 7: Screen shoot of the reactor during mixing fluorescein with adaption

### 4.1.2 AOP test principles

#### 4.1.2.1 Experiment A

##### 4.1.2.1.1 Blind tests

As required in the tender Appendix A 4.2.1, 2 blind tests were conducted:

- Blind test 1 (TA1): stripping of volatile components assessment

The stripping of volatile components occurring in the AOP lab plant was assessed.
Untreated polluted ground water (raw water) was treated with pure oxygen in the AOP test plant. Chosen setup (gas flow, pH, temperature and contact time) were the same as the one chosen for the ozone screening tests (TA3, TA4, TA5). The only difference is that the test was running with oxygen instead of a mixture of ozone and oxygen. (see paragraph 4.2.1.1.1)
In total, 6 samples (including raw water) of 300 ml each were taken during the test time, meaning 1 sample/ 4 min test.
On the 6 samples, DOC and UV adsorption at 254 nm were performed. PUT analysis were performed on 4 samples of the 6 samples (initial, final and 2 intermediates).

- Blind test 2 (TA2): Ozone decay

The Ozone decay of the effluent was assessed during this test.
DI water was treated with ozone in the AOP test plant at 20°C ±2°C. Chosen setup (gas flow, ozone concentration, pH, temperature and contact time) was the same as the one chosen for the ozone screening tests (TA3, TA4, TA5). The only difference was that DI water was treated with ozone instead of the polluted ground water (see paragraph 4.2.1.1.1)
Dissolved ozone in the water (ozone residual) was measured online.
Once the contact time was elapsed, the ozonation was immediately stopped, recirculation was maintained, and online dissolved ozone measurement was logged every 5 min during 1h.

No sample was taken during this experiment.
Online dissolved ozone measurement accuracy was tested and assessed with indigo method prior blind test TA2. Only 3 % difference of measurements were measured between the Indigo methods measurements results and the online device measurements results.

##### 4.1.2.1.2 Screening tests

As suggested in Appendix A, optimal ozone dose is defined with a series of screening tests following DOC, COD, UV adsorption at 254, PUT and $BrO_3$ results. During each screening test, ozone is applied continuously following the setup (see paragraph 4.2.1.1.1). 6 samples of 300 ml each (including sample before ozonation) are taken every 4 min. Samples with residual dissolved ozone was quenched with an equivalent of a stock solution containing 100 g $Na_2SO_3$ /L.

In total, 3 screening tests were performed with different setups:

- TA3: Ozone test, original pH. Ozone dose applied max: approx. 100 mg/L
- TA4: Ozone test, original pH. Ozone dose applied max: approx. 35 mg/L
- TA5: Repetition of TA3.

Remark:
PUT vials contained already an excess of $Na_2SO_3$ for conservation. PUT vials were directly overfilled from the AOP plant and immediately closed after sampling without any quenching step.

Based on the screening test results, the 3 ozone doses (optimal, low and high dose) were determined.

#### 4.1.2.2 Experiment B

##### 4.1.2.2.1 Blind tests

2 blind tests were conducted in the SUEZ AOP test plant with ozone and peroxide on DI water to follow the OH radical formation by measuring the peroxide concentration decreasing.
DI water was oxidized with ozone and peroxide in the SUEZ AOP plant.
The setups (gas flow, pH, temperature and contact time) were the same as the ones chosen for the screening tests (TB3, TB4, TB5). (see paragraph 3.1)
In total, 6 samples (including sample before testing) of 300 ml each were taken during the test time to analyse residual hydrogen peroxide concentration.

During the test TB1, peroxide was added continuously at stoichiometric dose.

For test TB2, the total amount of peroxide corresponding to the final peroxide/ozone stoichiometric concentration at the end of the test was introduced at the beginning of the test. The peroxide concentration decreased during the test. We considered that the amount of peroxide reduced was consumed for the OH radical formation.

##### 4.1.2.2.2 Screening tests

The screening tests of experiment B were similar to the ones of experiment A described paragraph 3.2.1.2.
Peroxide and ozone were applied continuously during the tests to simulate full scale treatment.
In total 3 screening tests were performed with different setups:

- TB3: Continuous **stoichiometric** (hydrogen peroxide/ozone) addition of hydrogen peroxide during test, **original pH**. Ozone dose max: approx. 40 mg/L

- TB4: Continuous **50 % stoichiometric** (hydrogen peroxide/ozone) addition of hydrogen peroxide during test, **original pH**. Ozone dose max: approx. 40 mg/L

- TB5 Continuous **stoichiometric** (hydrogen peroxide/ozone) addition of hydrogen peroxide during test, **pH regulated at 7.5**. Ozone dose max: approx. 40 mg/L

In addition, peroxide was measured:

- After the ozone quenching when dissolved ozone was measured / or immediately after sampling if no dissolved ozone was measured.

- After hydrogen peroxide quenching if it was required to ensure that no oxidant was remaining in the samples before analysis.

COD, DOC, UV absorption and bromate were measured during the screening tests.

#### 4.1.2.3 Experiment C

##### 4.1.2.3.1 Blind tests

As asked for in the tender document Appendix A, blind tests were conducted in SUEZ AOP test plant with UV and peroxide on simulated “pure ground water” to follow the radical formation by measuring the peroxide concentration decreasing.

In agreement with Cowi, the “pure ground water” was a synthetic effluent containing similar concentrations in terms of main inorganic compounds, see Table 5.

Table 5: Comparison water composition of Grinsted effluent and synthetic effluent for blind tests.

| Ion | Grinsted reference -Annexe A (mg/L) | Synthetic concentration (mg/L) |
|---|---|---|
| Cl- | 130-170 | 150 |
| Na+ | 110-120 | 110 |
| Fe 2+ | 1.1-2.4 | 5 |
| HCO3- | 32.3-33.7 | 33 |
| SO42- | 29-56 | 28 |
| Ca2+ | 3.4-5.3 | 4.5 |
| Mg2+ | 1.6-2.1 | 2 |
| Mn2+ | 0.047 | 0.1 |
| Br- | 0.9-1.5 | 1.4 |
| K+ | 0.66-1.1 | 0.7 |

3 blind tests (TC1, TC2, TC3) were performed with a defined amount of hydrogen peroxide (TC1 & TC3: 20 mg/L, TC2:10 mg/L) and defined UV dose (TC1 & TC2 : 2 UV lamps, TC3: only 1 UV lamp), see test conditions Table 8. The all amount of hydrogen peroxide was introduced at the beginning of the test.
The UV dose was applied continuously and increasing with contact time.
In total 5 grab samples (including sample before testing) were taken during each blind test for hydrogen peroxide analysis. We considered that all the peroxide loss was converted into OH radicals.

##### 4.1.2.3.2 Screening tests

Screening test are conducted to determine the 3 oxidants doses (optimal, high, low).

In total 2 screening no 3 tests were performed:

- 1 test with low hydrogen peroxide and low UV dose (TC4: 10 mg $H_2O_2$/L, UV max: 2998 mJ/cm$^2$)
- 1 test with high hydrogen peroxide and high UV doses (TC5: 20 mg $H_2O_2$/L; UV max: 9311 mJ/cm$^2$)

In total 5 grab samples (including sample before testing) were taken during each screening test for COD, DOC, UV absorption and UV transmission at 254 nm, and hydrogen peroxide analysis.

Residual hydrogen peroxide was quenched with an equivalent of a solution containing 100 g $Na_2SO_3$ /L in each grab samples before analysis.

## 4.2 AOP blind tests results and AOP Screening tests results: Definition of the 3 oxidants doses (optimal, overdose, underdose)

### 4.2.1.1 Experiment A

#### 4.2.1.1.1 Ozone conditions

Table 6: Summary of test conditions - Experiment A (Blind and screening tests)

| Parameter | Comment | |
|---|---|---|
| Sample volume: | 25 L | |
| Reactor settings / contact system: | Pump recycling loop, 15 L/min | Venturi injector /radial diffusor |
| Analytical samples: | 300 ml each for TA1<br>200 ml each for TA3, TA4, TA5 | Interval grab samples |
| Contact time | 20 min | |
| pH control: | no | Online |
| Dissolved ozone | Polarographic probe Q46H, ATI | Online |
| Ozone gas concentration measuring | Feed gas and off gas, BMT | Online |
| Ozone feed gas concentration | TA1 : 0 g/Nm$^3$<br>TA2 : Approx. 125 g/Nm$^3$<br>TA3 : Approx. 125 g/Nm$^3$<br>TA4 : Approx. 45 g/Nm$^3$<br>TA5 : Approx. 125 g/Nm$^3$ | Online |
| Gas flow | 60 NL/h for all tests experiment A | Online |
| AOP | TA1: Oxygen<br>TA2: Ozone only<br>TA3: Ozone only<br>TA4: Ozone only<br>TA5: Ozone only | |

#### 4.2.1.1.2 Blind test results

##### *1.2.1.1.1.1 Blind test: stripping assessment (TA1)*

COD, UV absorption at 254 nm and major volatiles compounds where measured and followed during stripping test.

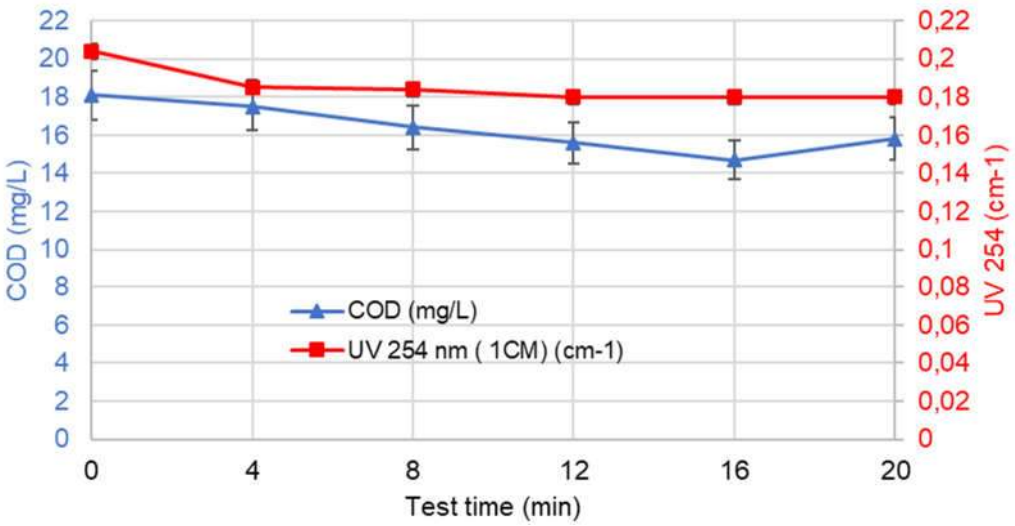



Figure 8: COD and UV absorption evolution during stripping in SUEZ AOP plant

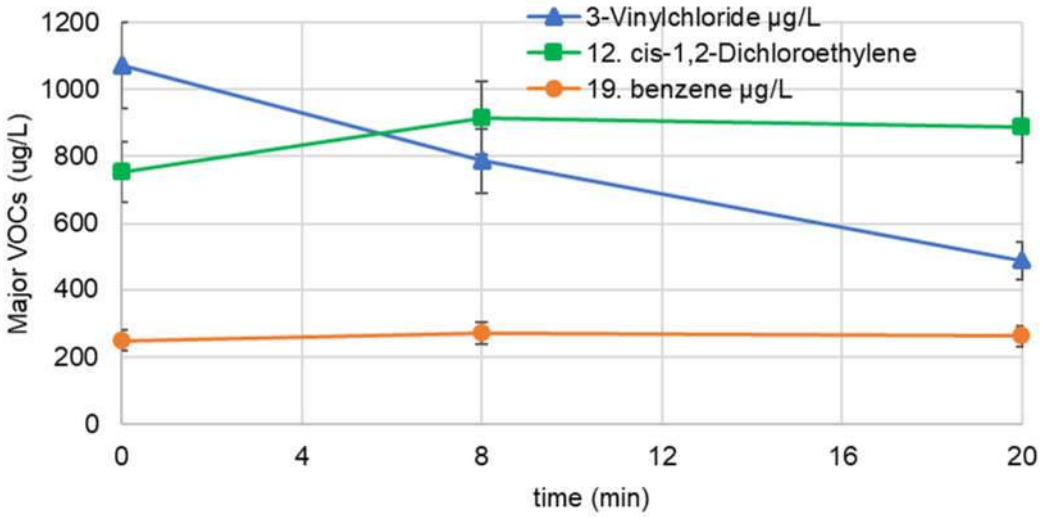


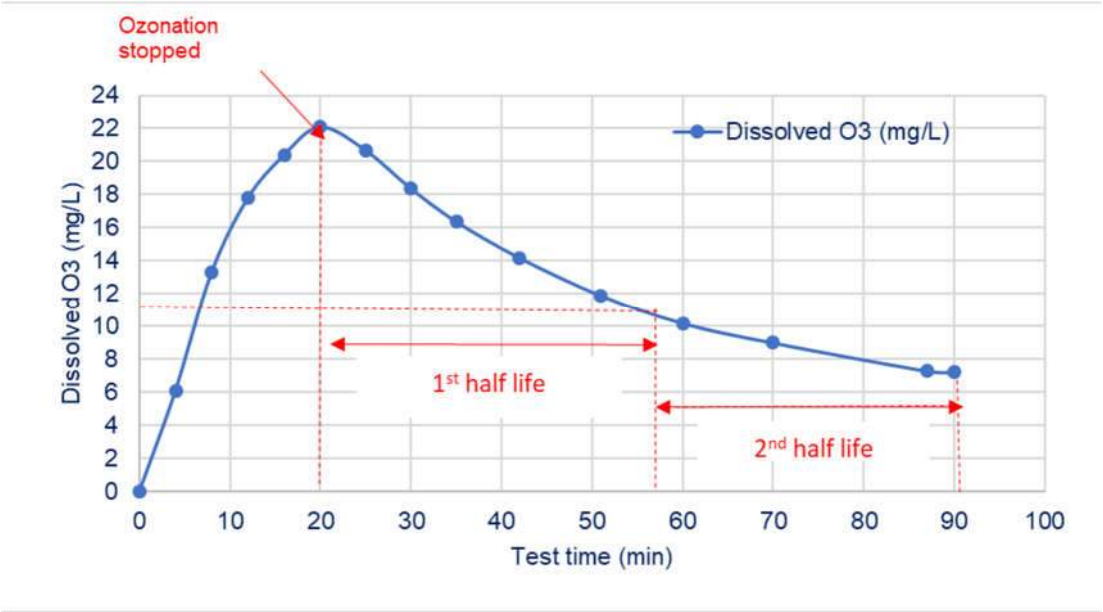

Figure 9: Major VOCs compounds in Grinsted effluent evolution during stripping of SUEZ AOP plant

Stripping in SUEZ AOP plant does not significantly affect COD, UV, Benzene, and 1,2-cis-Dichloroethylene. Only Vinyl chloride is reduced by approx. 50 % (see Figure 8 and Figure 9)

*1.2.1.1.1.2 Blind test: Ozone decay assessment*

In this blind test the ozone uptake and the decay (half lifetime) was determined for the respective test installation. Therefore, ozone at a concentration of approx. 125 g/Nm3 was added into deionized water for 20 minutes. After 20 minutes the ozonation was stopped and the ozone decay was measured by continuously measuring the dissolved ozone concentration during the entire test.

A half lifetime of 35 – 40 minutes was determined which is realistic at the respective pH and temperature




ozone uptake and decay in TA2, pH 5.44, temp 19+- 0.5 °C

#### 4.2.1.1.3 Screening tests:

3 ozone screening tests have been performed:

- 2 ozone screening tests (TA3 & TA5) with ozone dose max of approx. 100 mg/L each with grab samples collected homogeneously. Gasflow was 60 NL/h
- 1 ozone screening test (TA4) with lower ozone dose (approx. 35 mg/L) with grab sample more frequent at lower ozone concentrations. Gasflow was 60NL/h

##### *1.2.1.1.2.1 Ozone transfer*

The goal in ozonation is to have the complete amount of introduced ozone into the water having reacted with the water matrix. In this case, the transfer efficiency would be > 99.9 %.

Having ozone in the off-gas system meaning, not having reacted with the water matrix, decreases the transfer efficiency accordingly:

$$Transfer\ efficiency\ (\%) = \frac{Ozone\ applied\ (^{g}/_{L}) - Absorbed\ ozone\ (^{g}/_{L})}{Ozone\ applied\ (^{g}/_{L})} x\ 100 \text{ (Eq. 1)}$$

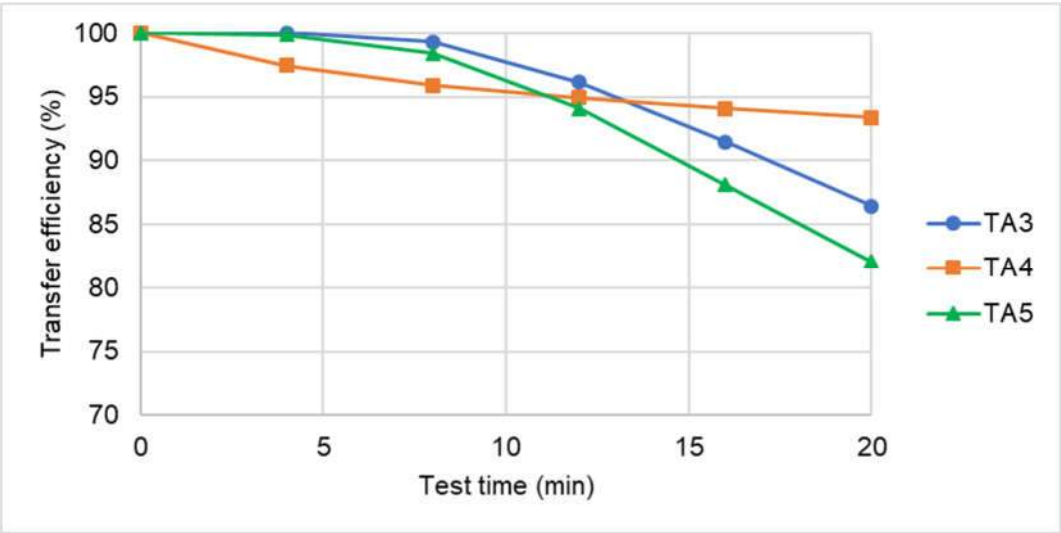



Figure 10: Experiment A - Screening test - Transfer efficiency vs test time

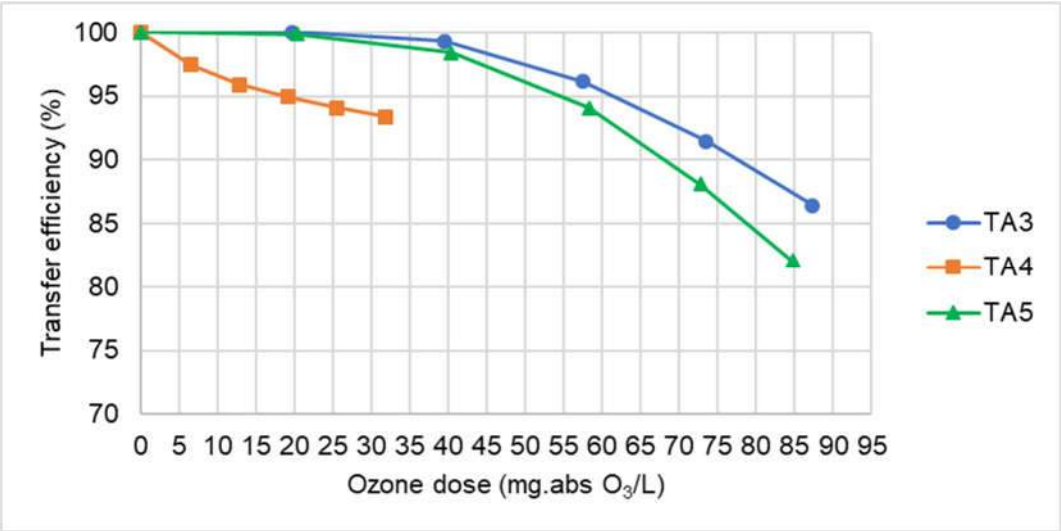



Figure 11: Experiment A - Screening test - Transfer efficiency vs ozone dose

Comment: In the tests 3 and 5, higher doses were applied with an identical gas flow, meaning the ozone concentration was approx. 125 g/Nm3 whereas in test 4 the concentration was only approx. 40 g/Nm3. Therefore, the absorption efficiency decreased to below 90 % for the higher doses.

*1.2.1.1.2.2 pH evolution*

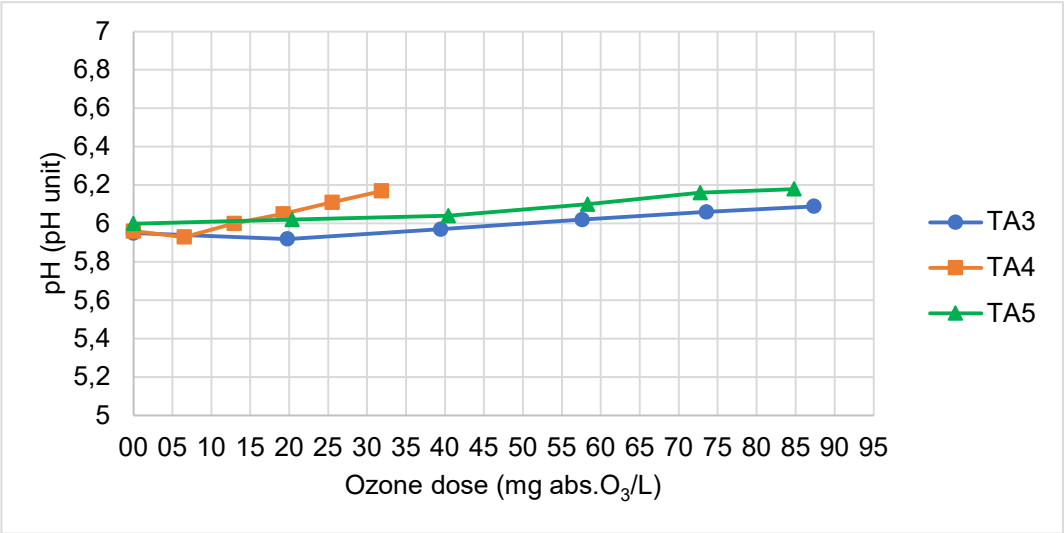



Figure 12: Experiment A - pH vs ozone dose

pH does increases slightly from approx. 6 to max 6.2 during ozonation.
pH is globally quite stable.

*1.2.1.1.2.3 COD and DOC evolution*

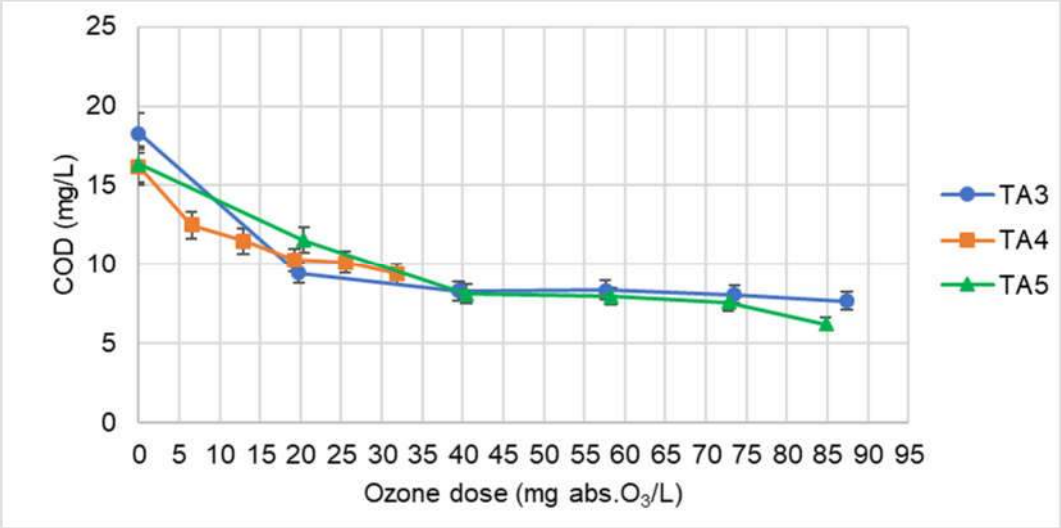



Figure 13: Experiment A - COD vs ozone dose

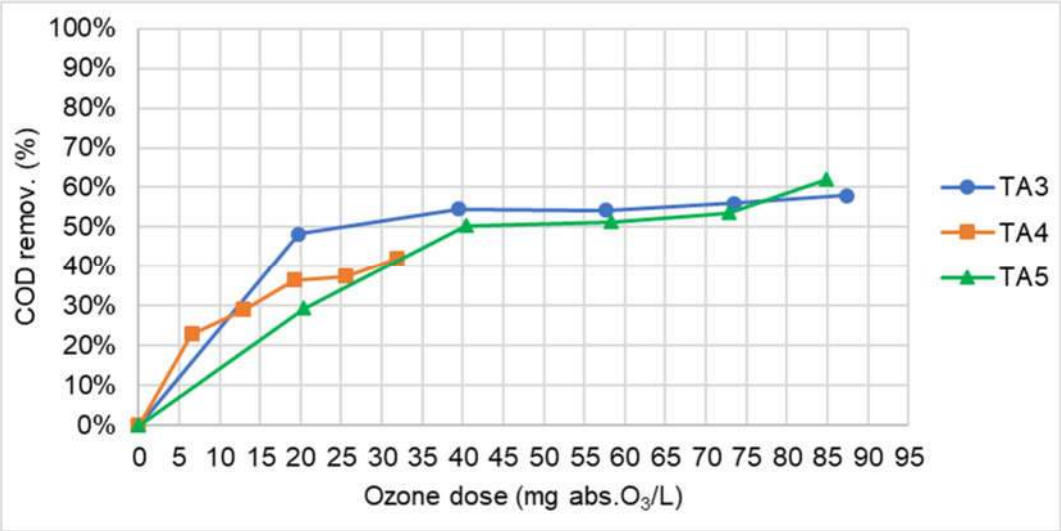



Figure 14: Experiment A - COD removal vs ozone dose

COD decreases during ozonation and reaches a plateau phase with approx. 20 to 40 mg abs. $O_3$/L. COD removal reaches approx. 55 % removal. Figure 14 shows that COD is a suitable assessment parameter and it indicates that there is no need to treat the water with more than 25 mg abs. $O_3$/L.

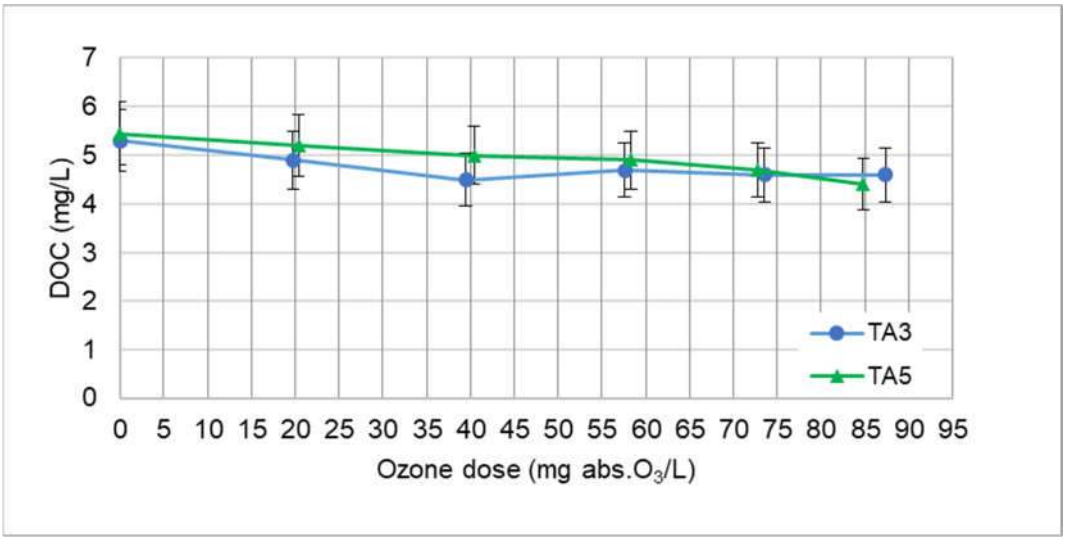



Figure 15: Experiment A - DOC vs ozone dose

Comment: At significantly low ozone dose, and low DOC concentrations, mineralisation of organic compounds does not significantly occur. Since, DOC is not evolving, DOC is not a suitable assessment parameter. DOC oxidation means mineralizing down to CO2 and water. The ozone doses for a complete mineralizing are high and therefore the effect on the DOC at this low ozone dose is not very significant and in combination with the quite high measurement uncertainty at this level it is not suitable to use the DOC as an assessment parameter.

*1.2.1.1.2.4 UV absorption at 254 nm evolution*

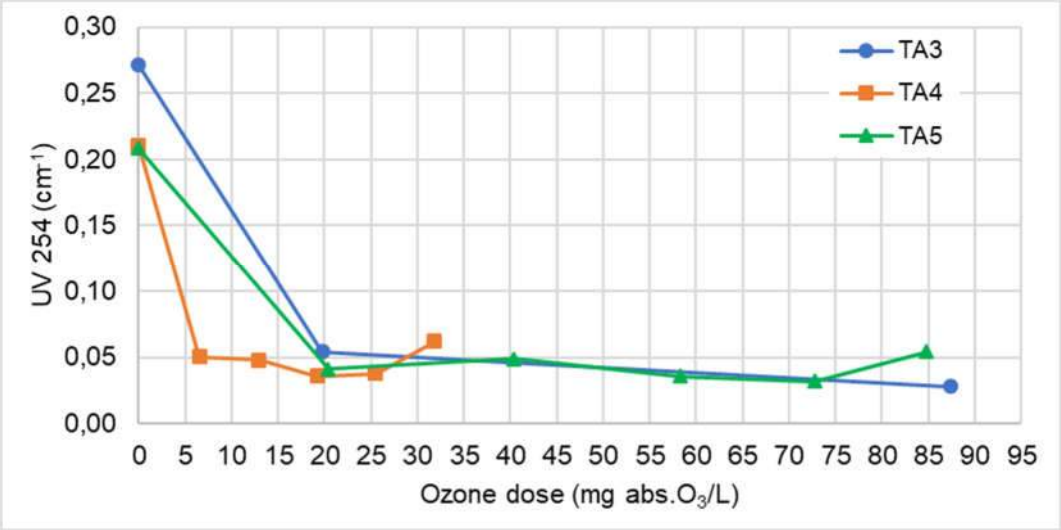



Figure 16: Experiment A – UV absorption at 254 nm vs ozone dose

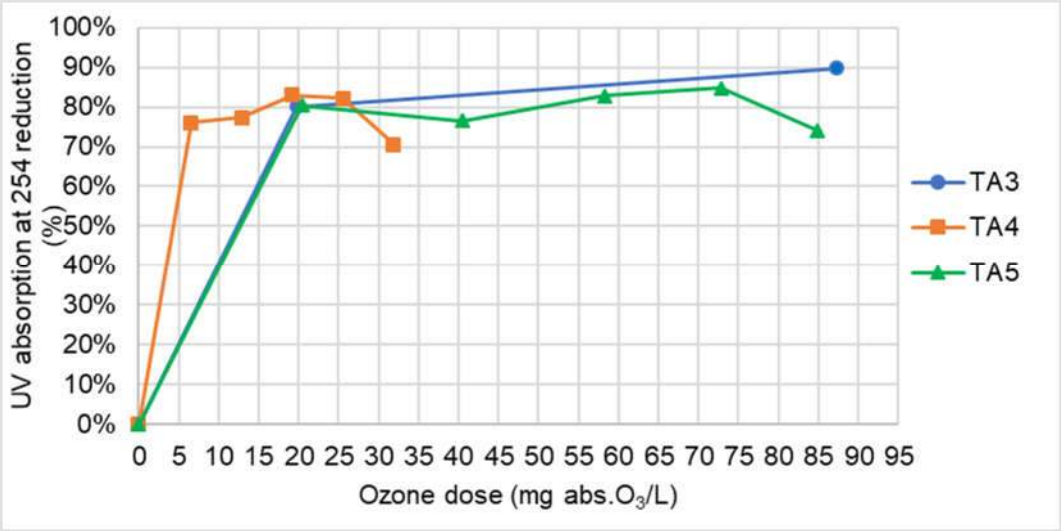



Figure 17: Experiment A – UV absorption reduction vs ozone dose

UV absorption at 254 nm decreases fast and significantly during ozonation and reaches a plateau phase with approx. 7 to 20 mg abs. $O_3$/L. (see Figure 16). UV absorption at 254 nm can be considered as a suitable assessment parameter. UV is reduced up to 80 - 90 % in this range of ozone doses.

*1.2.1.1.2.5 Bromate formation and Dissolved ozone*

Bromate is an undesirable ozone by-product. Its formation is multifactorial: it involves mainly temperature, pH, bromide concentration inlet, dissolved ozone.
Bromide initial concentration being approx. 1400 ug/L, bromate might be formed.
Avoiding it, is one of the main concerns.
That is why bromate was measured on grab samples at different ozone dose (20 °C, pH approx. 6)

Figure 18 shows a compilation of bromate results during the ozone screening test (TA3, TA4, TA5).

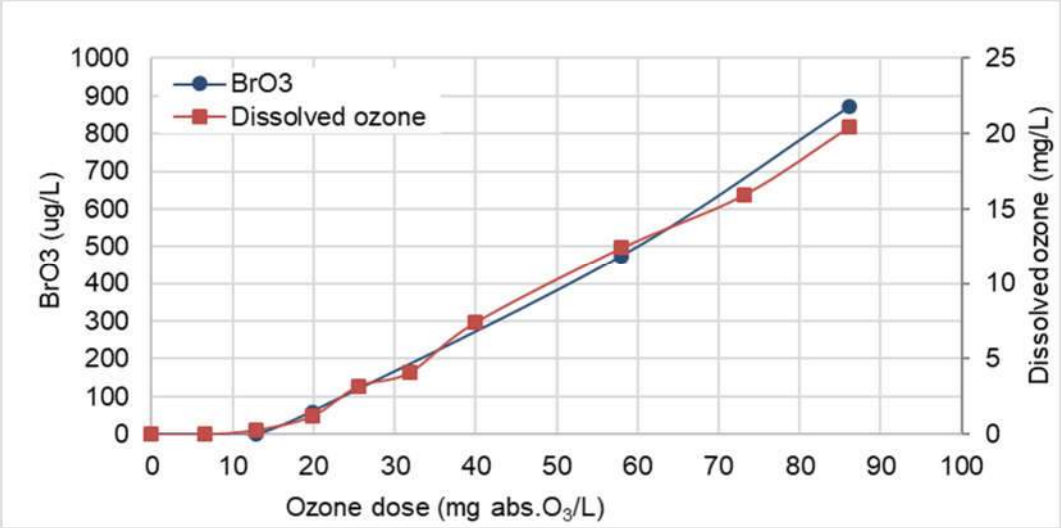



Figure 18: Experiment A – Compilation of bromate and dissolved ozone results of TA3, TA4, TA5 vs ozone dose

Bromate is formed during ozonation up to approx.900 ug/L with high ozone dose (90 mg abs. $O_3$/L).

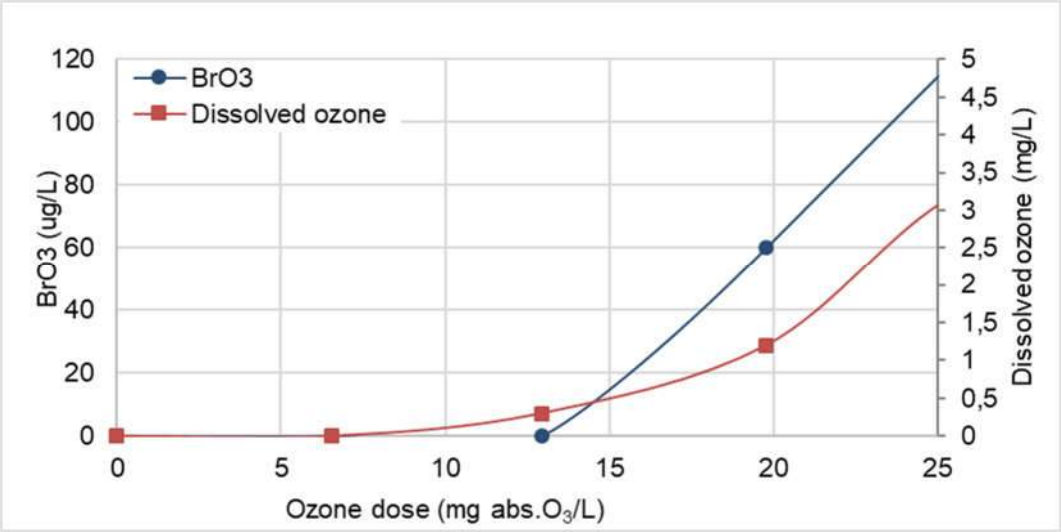



Figure 19: Zoom of Figure 18 on ozone dose below 25 mg/L

Figure 19 is a zoom of Figure 18 at low ozone doses.
Bromate is formed with apparition of dissolved ozone.
Before approx. 13 mg abs. $O_3$/L, no bromate is detected.

### 4.2.1.2 Experiment B

#### 4.2.1.2.1 Test conditions

Table 7: Summary of test conditions - Experiment B (Blind and screening tests)

| **Sample volume:** | **25 L** | |
|---|---|---|
| Reactor settings / contact system: | Pump recycling loop, 15 L/min | Venturi injector /radial diffusor |
| Analytical samples: | 100 ml each sample for TB1, TB2 (Blind tests)<br>200 ml each sample for TB3, TB4, TB5 (Screening tests) | Interval grab samples |
| Contact time | 20 min for all blind and screening tests | |
| Dissolved ozone | Polarographic probe Q46H, ATI | Online |
| Ozone gas concentration measuring | Feed gas and off gas, BMT | Online |
| Ozone feed gas concentration and peroxide dose | TB1: Approx. 50 g/Nm$^3$<br>TB2: Approx. 50 g/Nm$^3$<br>TB3: Approx. 55 g/Nm$^3$<br>TB4: Approx. 55 g/Nm$^3$<br>TB5: Approx. 55 g/Nm$^3$ | Online |
| Gas flow | 60 NL/h for all tests experiment B | Online |
| AOP | TB1, TB2: $O_3/H_2O_2$ stochiometric dose, original pH<br><br>TB3: $O_3/H_2O_2$ stochiometric dose, original pH<br><br>TB4: $O_3/H_2O_2$ 50 % stochiometric dose, original pH<br><br>TB5: $O_3/H_2O_2$ stochiometric dose, pH controlled at 7.5 | |

#### 4.2.1.2.2 Blind test: Radical formation assessment

TB1 and TB2 are two blind tests to assess the OH radical formation consequent of hydrogen peroxide additions. In TB1, hydrogen peroxide is introduced continuously during the blind test ($H_2O_2$ applied 14.5 mg/L – end test) whereas in test TB2, 16 mg/L hydrogen peroxide is introduced at the beginning of the blind test.

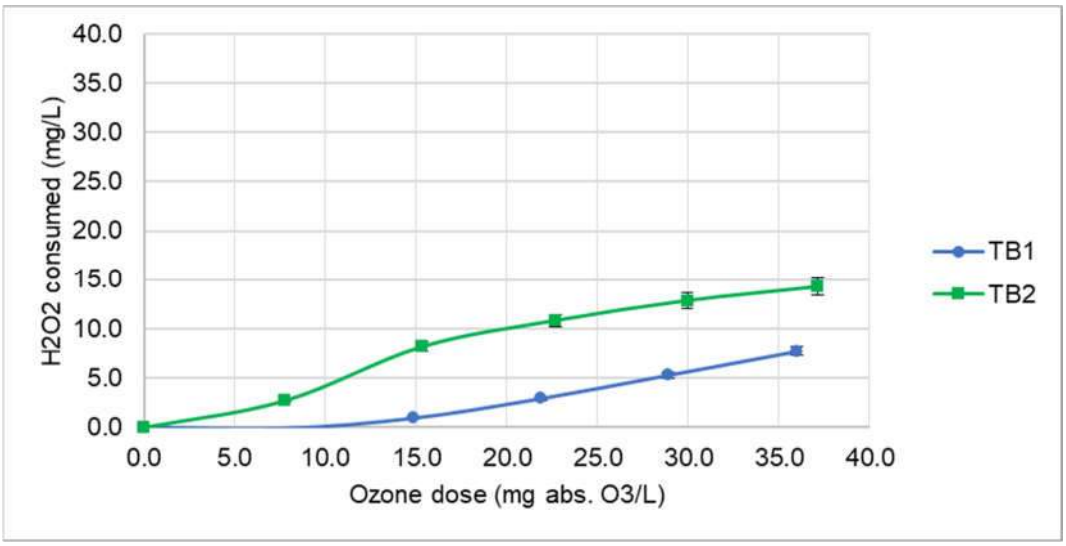



Figure 20: Experiment B: Peroxide consumption for OH radical formation during $O_3/H_2O_2$ test

$H_2O_2$ consumption is higher in TB2 than in TB1 for approximately the same amount of applied ozone dose. The hydrogen peroxide conversion (reaction rate) is better when applied at the beginning of the test.

Nevertheless, for screening tests, it has been decided to apply hydrogen peroxide continuously to simulate full-scale process conditions.

4.2.1.2.3 Screening tests:

In order to improve simulation, the peroxide dosing pump was started 30 seconds prior to ozonation.

*4.2.1.2.3.1 Ozone transfer*

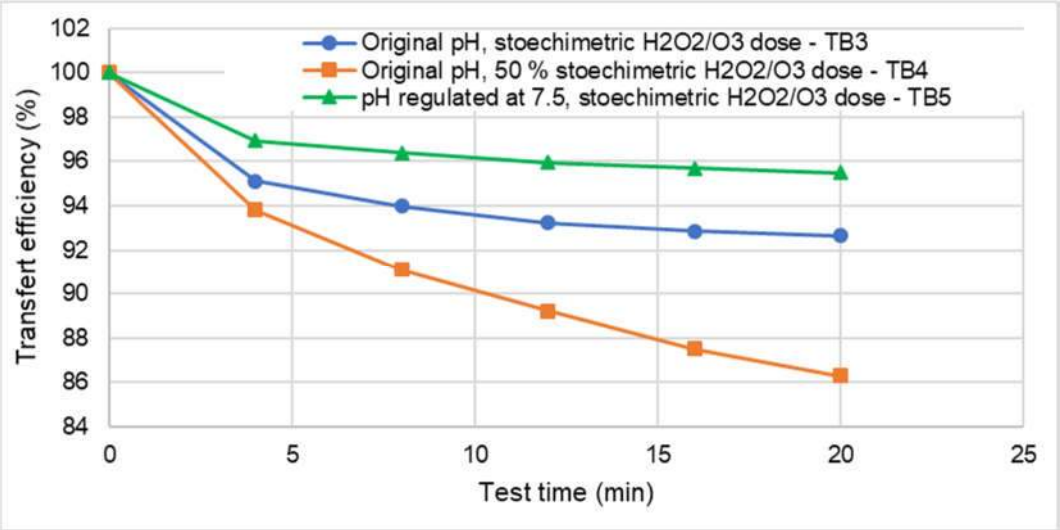



Figure 21: Experiment B - Screening test - Transfer efficiency vs test time

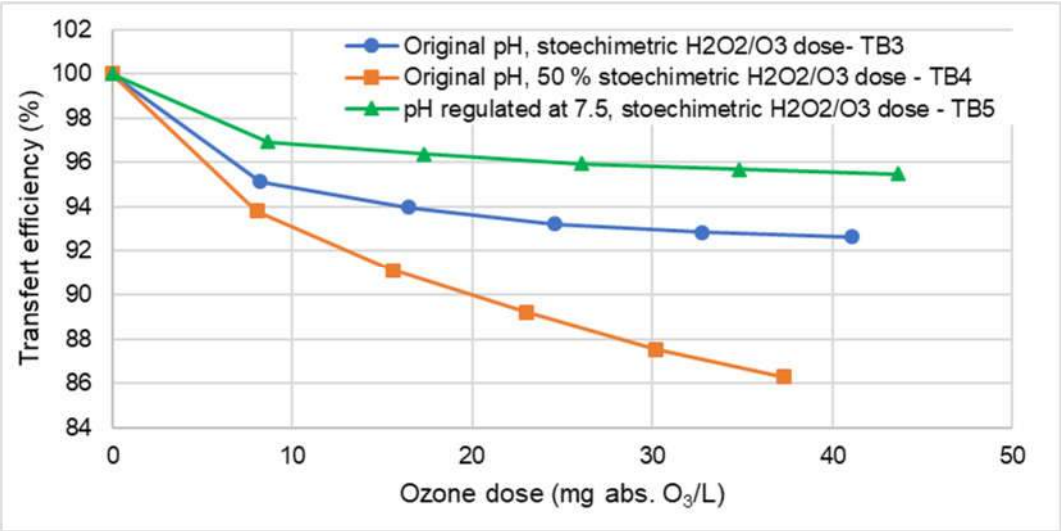



Figure 22: Experiment B- Screening test - Transfer efficiency vs ozone dose

As expected, the ozone transfer efficiency was the highest at controlled, elevated pH 7.5 and with a stoichiometric peroxide dose.
With a lower peroxide dose (50%) and a pH value of approx. 6, the transfer efficiency decreases to 86%.

#### *4.2.1.2.3.2 pH evolution*

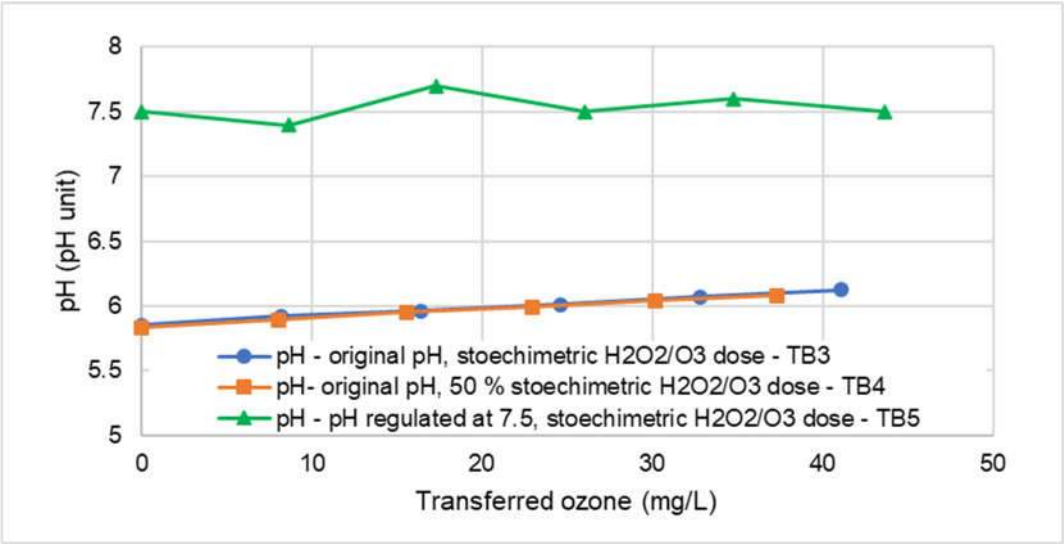



Figure 23: Experiment B - pH vs ozone dose

TB5 test pH was regulated and TB3 and TB4 remained quite stable during test

*4.2.1.2.3.3 COD and DOC evolution*

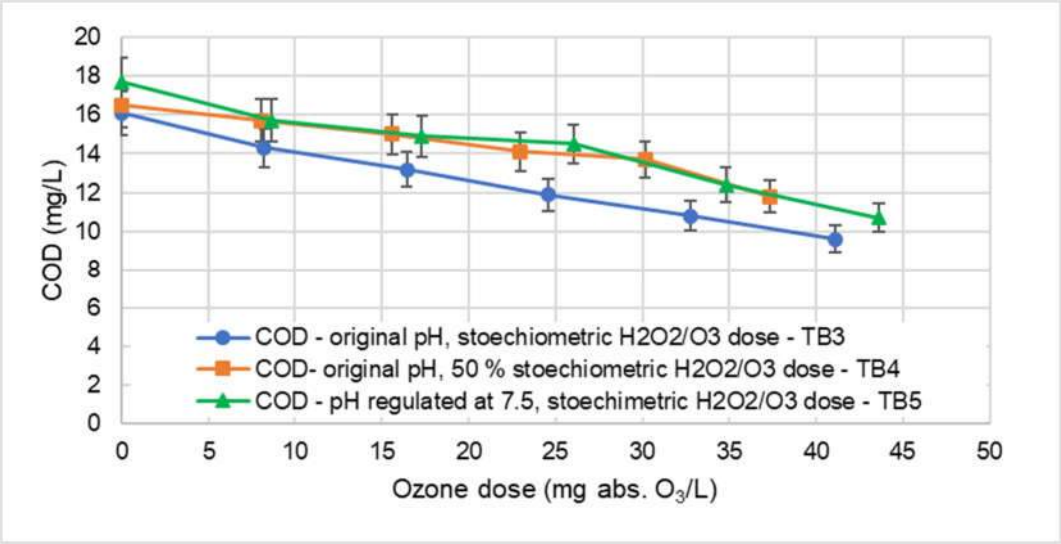



Figure 24: Experiment B - COD removal vs ozone dose

As expected, COD deceases with ozone transferred.

The 7 % uncertainty internally determined and used for data evaluation has to be considered as higher in this case due to additional uncertainty of peroxide quenching and iron oxidation (particles). Therefore, COD was only used as a secondary indicator in addition of UV measurement.

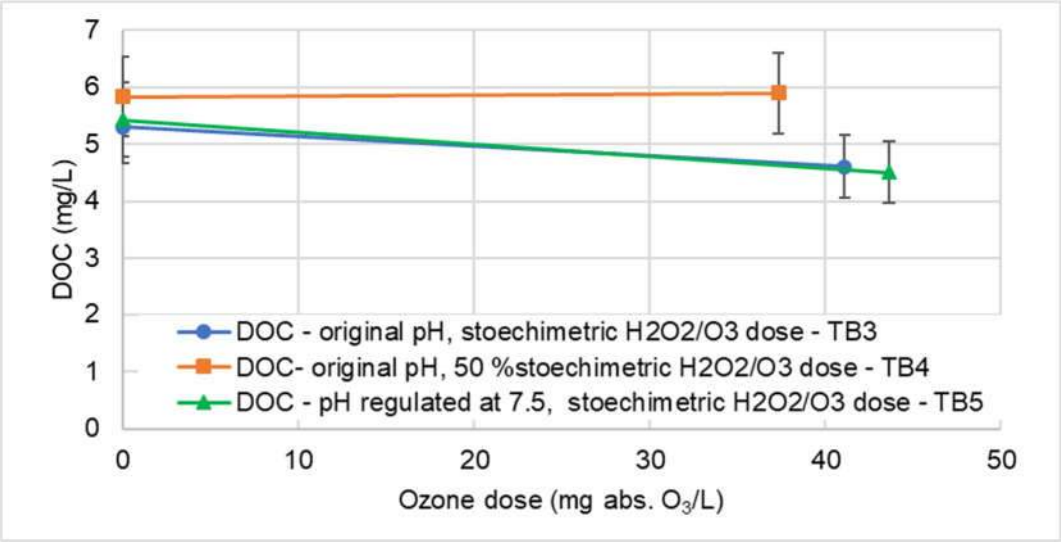



Figure 25: Experiment B - DOC removal vs ozone dose

Sample before and After AOP tests have been taken. With this high uncertainty of measurement (12%), DOC cannot be considered as a suitable assessment parameter.

#### *4.2.1.2.3.4 UV absorption at 254 nm evolution*

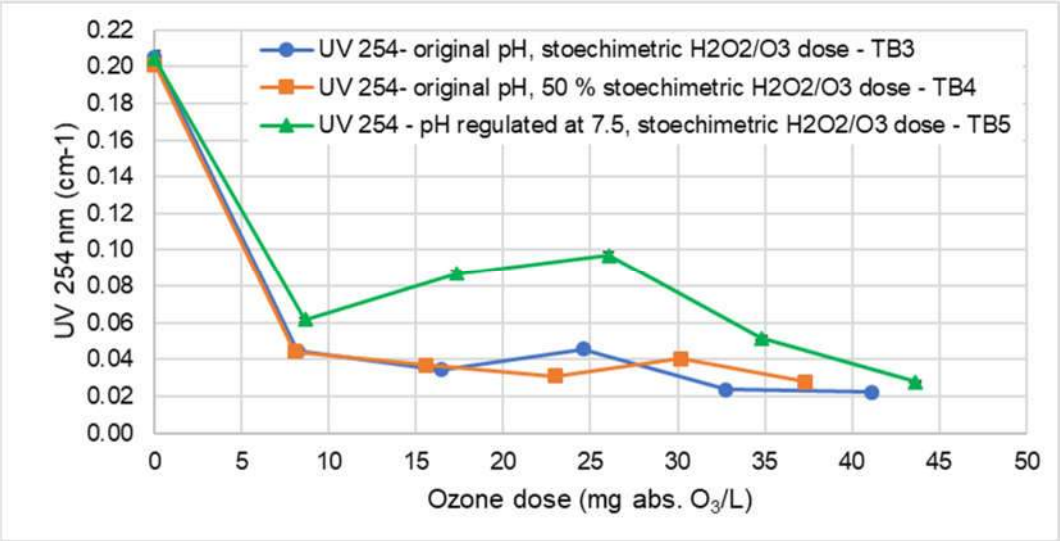



Figure 26: Experiment B - UV absorption at 254 nm vs ozone dose

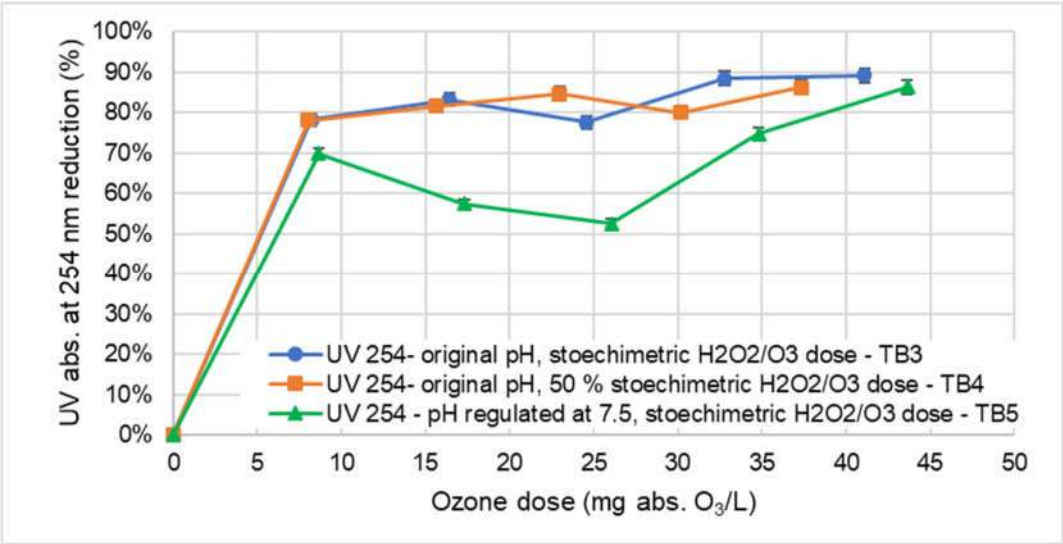



Figure 27: Experiment B - UV reduction vs ozone dose

UV absorption reaches a plateau phase after approx. 5 mg abs. $O_3$/L. UV evolution at 50 % stoichiometric $H_2O_2/O_3$ dose and stoichiometric dose are similar. Working at pH 7.5, the UV absorption reduction is lower, certainly due to changes in electrophilic groups in the organic molecules (e.g deprotonation). Since UV absorption show the same trend for stoichiometric and 50% stoichiometric peroxide dose and the fact that considerable amount of excess peroxide was measured, the 50% dose was chosen as base for the high, low and optimal dose tests.

*4.2.1.2.3.5 Peroxide residuals*

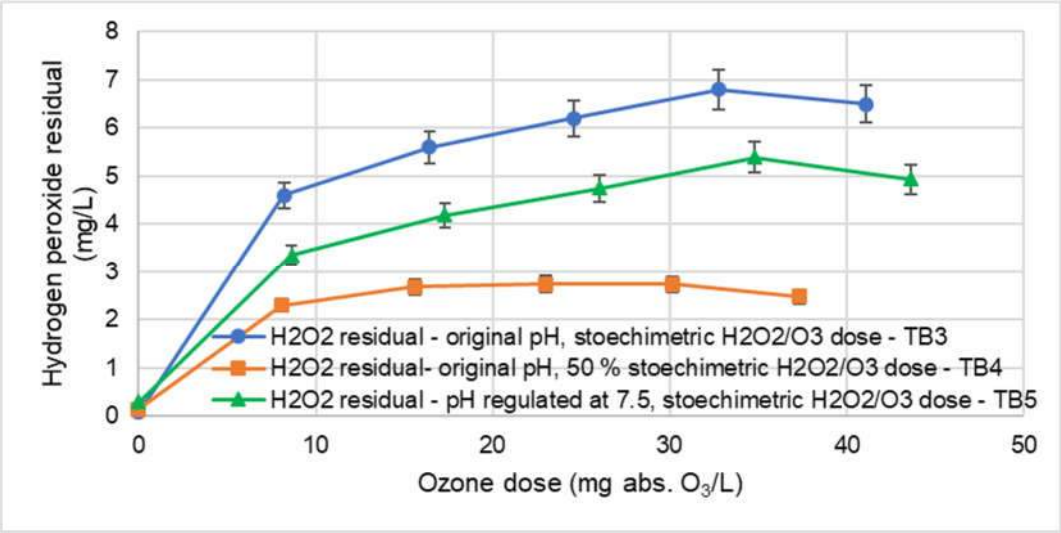



Figure 28: Experiment B - Residual hydrogen peroxide after ozone quenching, and before hydrogen peroxide quenching

Residual of hydrogen peroxide is reaching a plateau phase after approx. 7 mg abs. $O_3$/L with 50 % $H_2O_2/O_3$ stoichiometric hydrogen peroxide dose, whereas, it continues increasing at stoichiometric dose. We can therefore assume that working at stoichiometric $H_2O_2/O_3$ does not bring more benefit than working at 50 % $H_2O_2/O_3$ hydrogen peroxide dose. It confirms conclusion about UV absorption results.

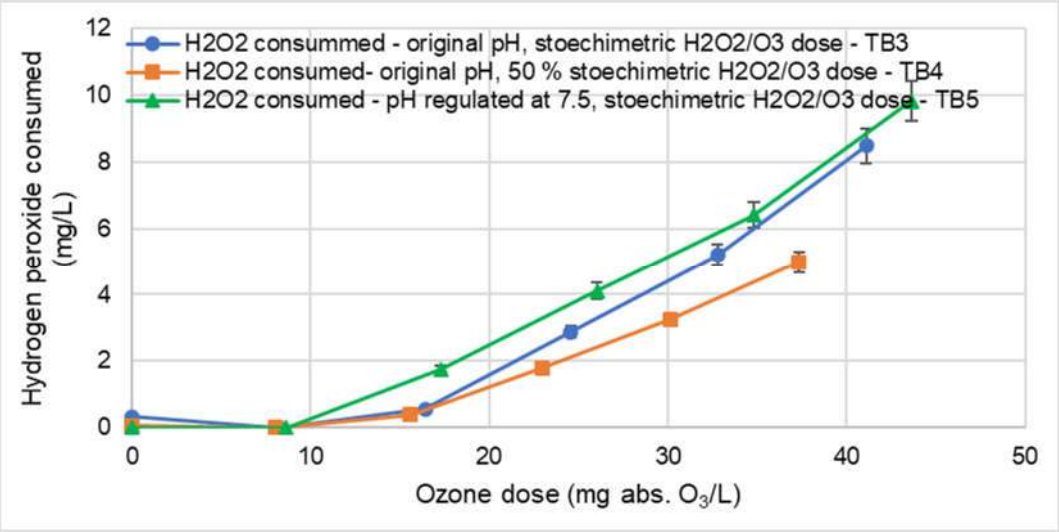



Figure 29: Experiment B - Hydrogen peroxide consumption during test

Due to the elevated pH, controlled at 7.5, the peroxide conversion rate was the highest as expected in TB5 due to the faster reaction rate of the dissociated peroxide molecule HO2- at higher pH. The conversion in TB4 was lower due to only 50% stoichiometric dose. Bromate formation and Dissolved ozone measurement during test

Bromate formation during ozonation is an issue. Bromate was followed during ozone /peroxide screening tests (Experiment B).

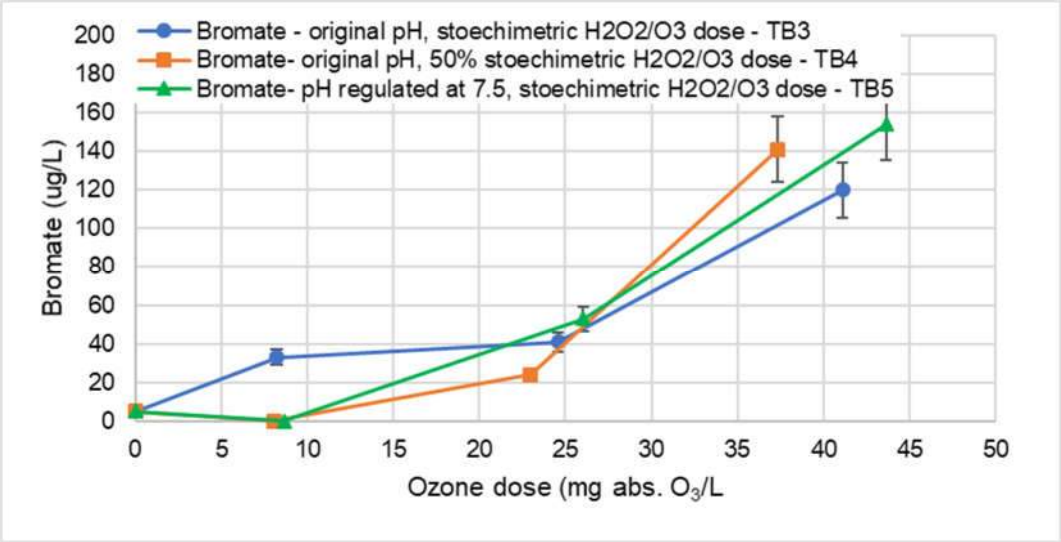



Figure 30: Experiment B -Bromate vs ozone dose

As we know, when bromide is present in the concentrations > 50 µg/L, bromate formation can be expected when having dissolved ozone. Bromate formation can be minimized by increasing peroxide concentrations (due to avoiding dissolved ozone).

In test TB3, bromate was measured without having dissolved ozone and with a stoichiometric peroxide concentration (in TB4 only 50% stoichiometric peroxide dose).

Therefore, we consider the low dose TB3 (1st point of blue curve) as an outlier. So, we can say that bromate formation is not occurring below approx. 10 mg abs. $O_3$/L.

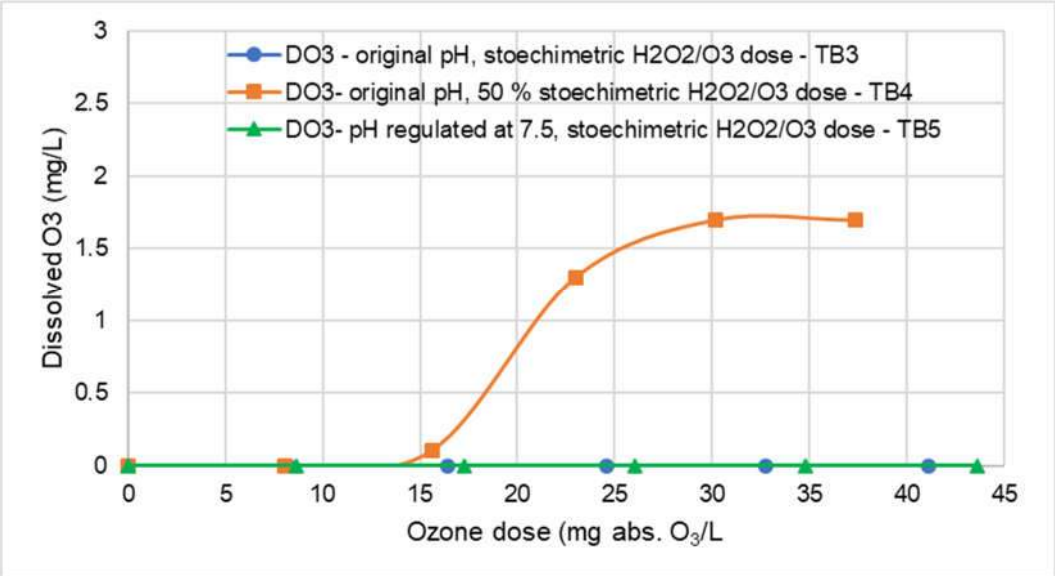



Figure 31: Experiment B – Dissolved ozone evolution during test

As expected, dissolved ozone appears when lower hydrogen peroxide doses are applied as it was in TB4 due to only 50% stoichiometric peroxide dose.

### 4.2.1.3 Experiment C

#### 4.2.1.3.1 Test conditions

Table 8: Summary of test conditions - Experiment C (Blind and screening tests)

| **Sample volume:** | **25 L** | |
|---|---|---|
| Reactor settings / contact system: | Pump recycling loop, 15 L/min, no gas flow | - |
| Analytical samples: | 150 ml each sample for TC1, TC2, TC3 (blind tests)<br>250 ml each sample for TC4, TC5 (Screening tests) | Interval grab samples |
| Contact time | Blind tests: 20 min<br>TC4: 24 min<br>TC5: 30 min | |
| $H_2O_2$ & UV max doses: | TC1: 20 mg $H_2O_2$/L; 11 770 mJ /cm$^2$<br>TC2: 10 mg $H_2O_2$/L; 12 540 mJ /cm$^2$<br>TC3: 20 mg $H_2O_2$/L; 4 749 mJ /cm$^2$<br>TC4: 10 mg $H_2O_2$/L; 2 998 mJ /cm$^2$<br>TC5: 20 mg $H_2O_2$/L; 9 311 mJ /cm$^2$ | 2 UV lamps<br>2 UV lamps<br>1 UV lamp<br>1 UV lamp<br>2 UV lamps |

#### 4.2.1.3.2 Blind tests: Hydrogen peroxide photolysis for OH radical formation

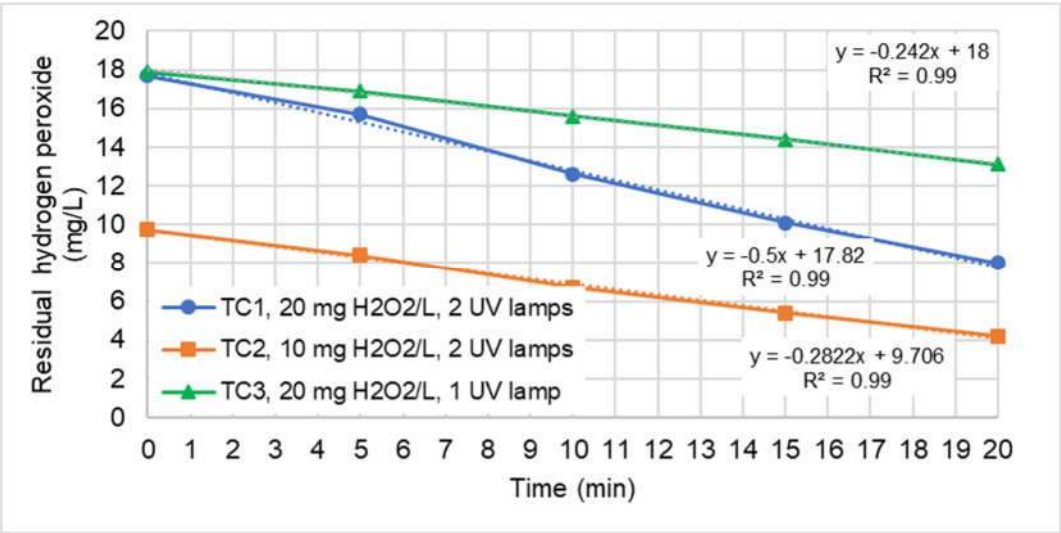



Figure 32: Experiment C - Hydrogen peroxide residual evolution vs test time

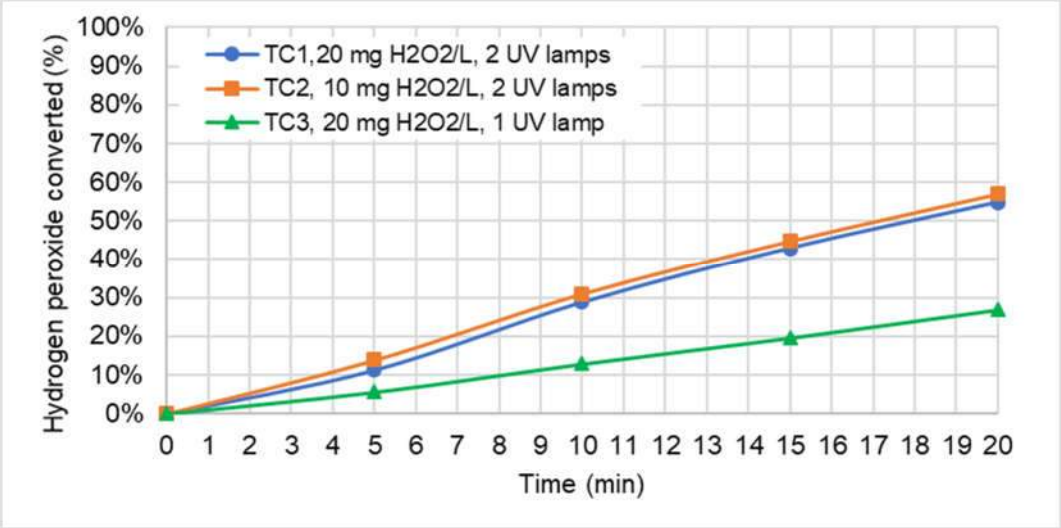



Figure 33: Experiment C - Hydrogen Peroxide conversion into OH radical formation vs test time

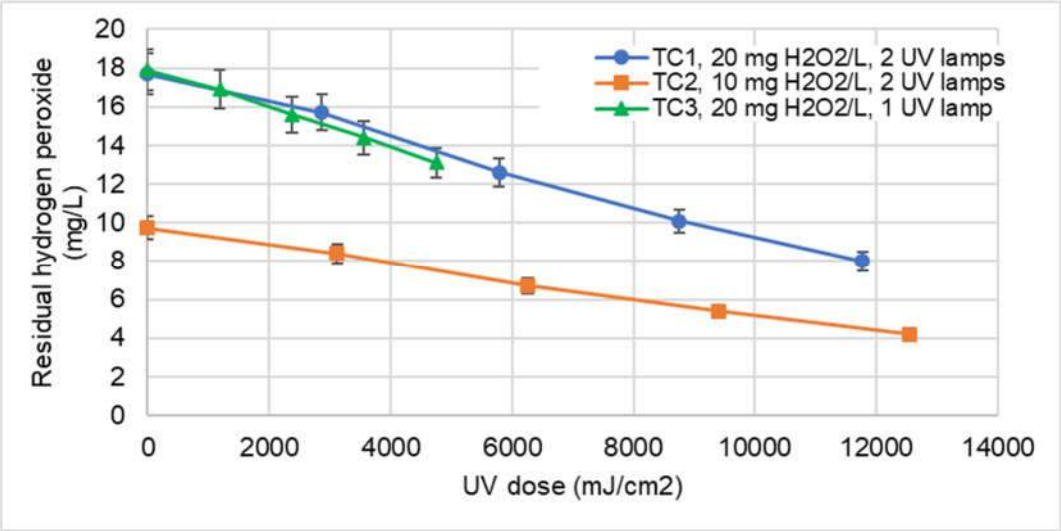



Figure 34: Experiment C - Hydrogen peroxide residual evolution vs UV dose

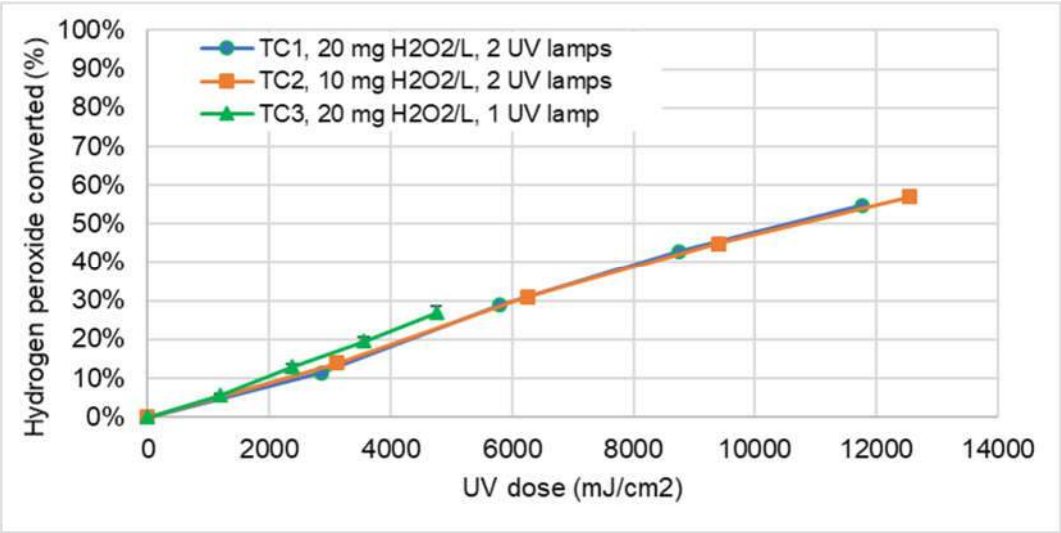



Figure 35: Experiment C - Hydrogen Peroxide conversion into OH radical formation vs UV dose

According to Figure 32, Figure 33, Figure 34, Figure 35, the blind tests with 2 different peroxide concentrations and 2 different UV doses showed that the conversion of the peroxide is linear and proportional to the UV dose.

#### 4.2.1.3.3 Screening tests:

2 screening tests (TC4, TC5) were performed. In TC4 a lower UV dose and a lower peroxide dose was chosen whereas in TC5 higher doses were applied

##### *4.2.1.3.3.1 pH evolution*

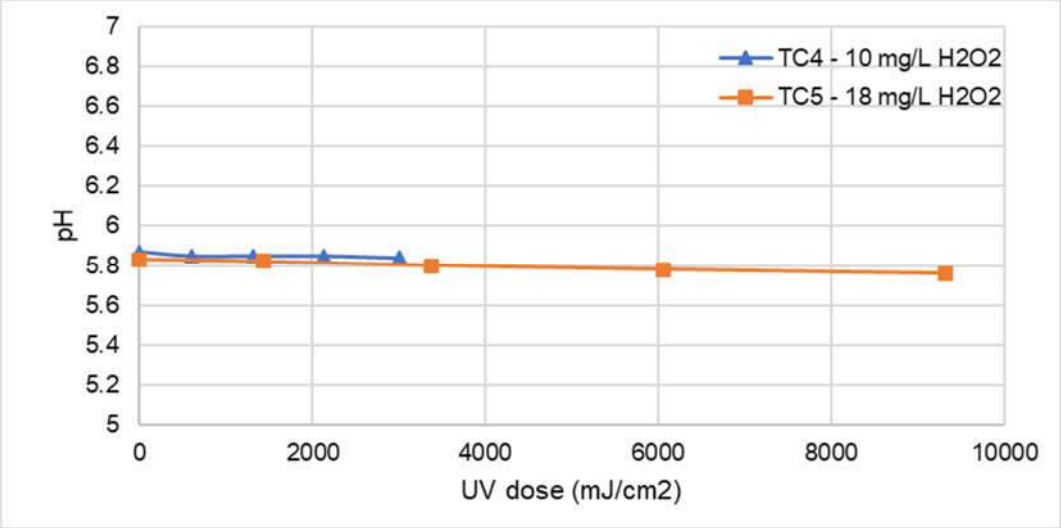



Figure 36: pH evolution vs UV dose

pH decreased is quite stable during AOP test.

##### *4.2.1.3.3.2 COD and DOC evolution*

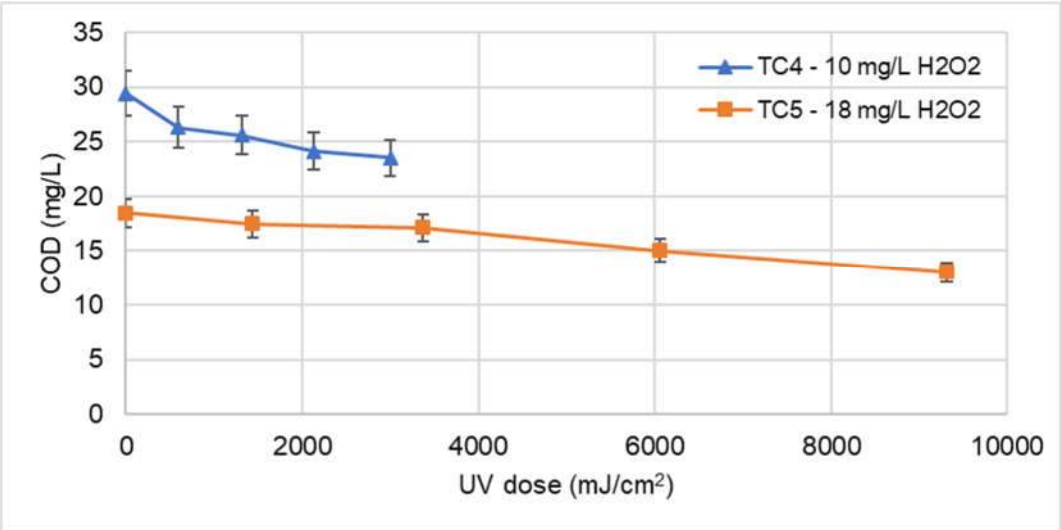



Figure 37: Experiment C - COD evolution vs UV dose

In test TC4, initial concentration of COD is significantly higher than in the other tests. As reminder, residual hydrogen peroxide can increase COD measurements, therefore the residual hydrogen peroxide in the samples have been always measured and quenched before analysis.

Consequently, the difference in both initial COD values is due to other reasons, possibly dissolved iron (II) which interferes with the measurement.

In test TC4 and TC5, COD decreases slowly, and it does seem that a plateau phase is reached.

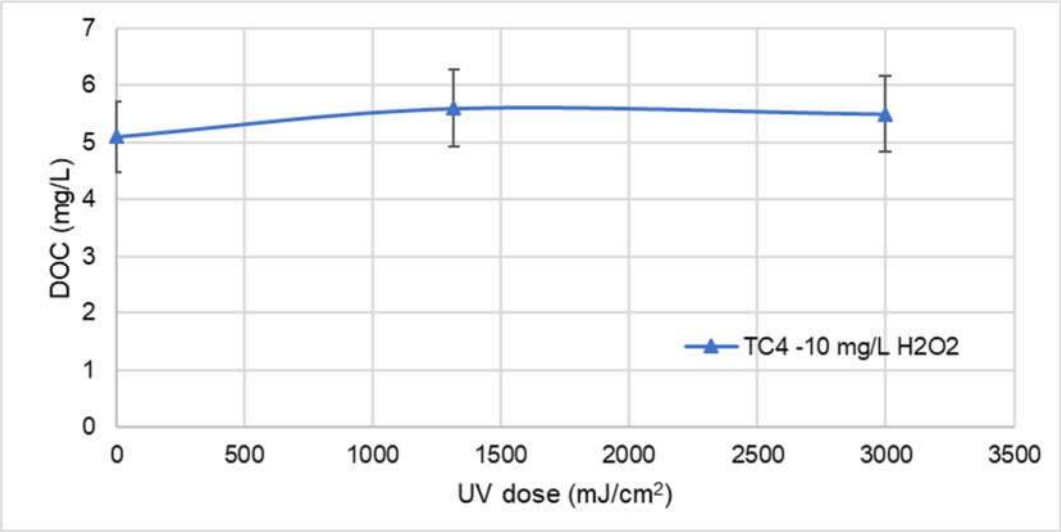



Figure 38: Experiment C - DOC evolution (TC4, low oxidant dose) vs UV dose

Again, due to the high uncertainty and low concentrations, DOC cannot be considered as a good assessment parameter.

Due to low doses applied and high uncertainty

*4.2.1.3.3.3 UV absorption at 254 nm evolution*

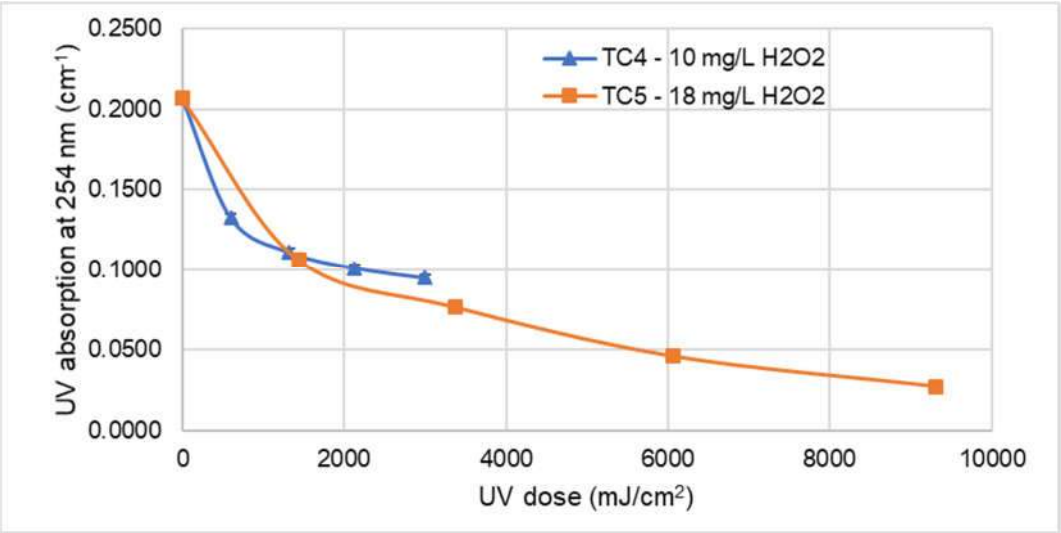



Figure 39: Experiment C - UV absorption at 254 nm evolution vs UV dose

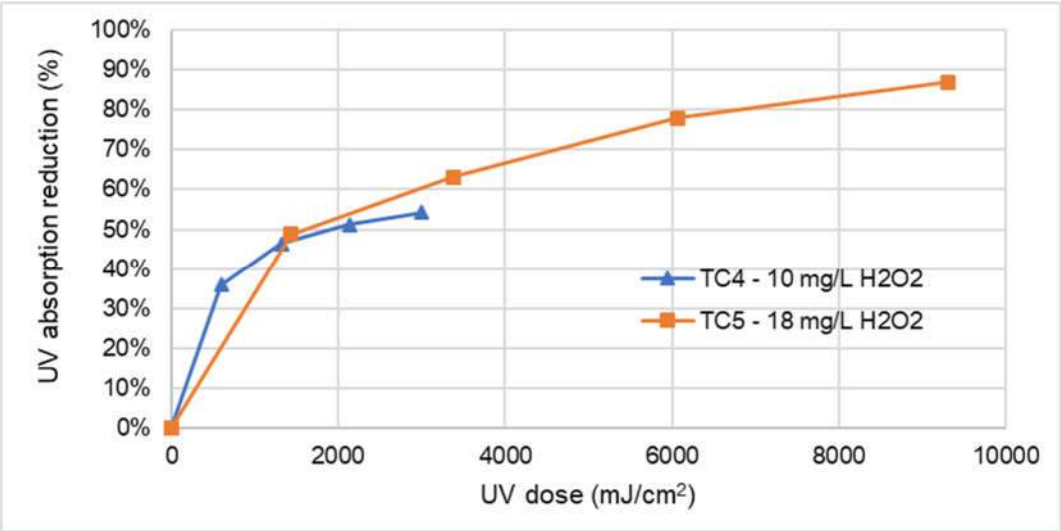



Figure 40: UV absorption reduction during test vs UV dose

UV absorption is reaching nearly 90 % removal with approx. 9000 mJ/cm$^2$ and 18 mg/l hydrogen peroxide.

*4.2.1.3.3.4 Hydrogen peroxide*

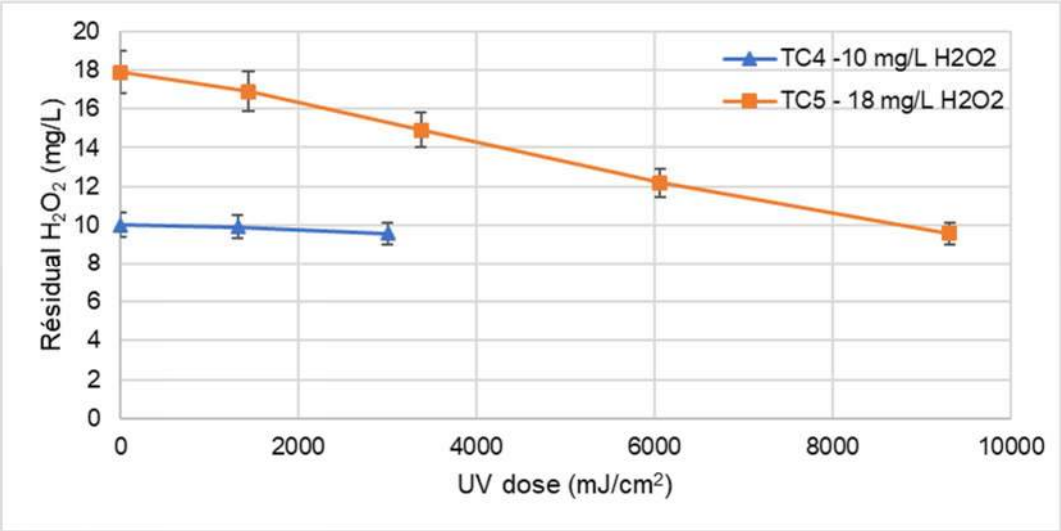



Figure 41: Experiment C - Residual hydrogen peroxide evolution during screening tests vs UV dose

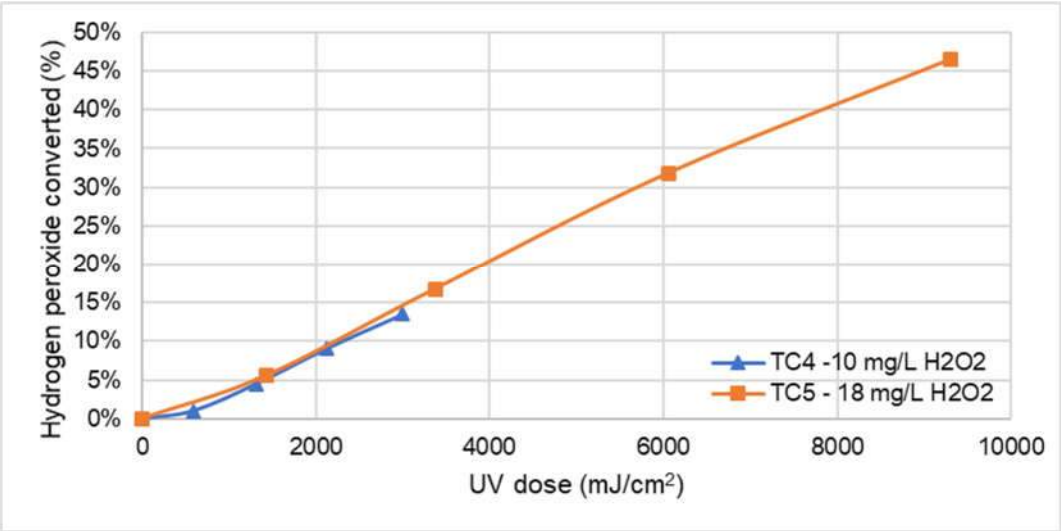



Figure 42: Experiment C - Hydrogen peroxide conversion during screening tests vs UV dose

With a higher initial peroxide dose of 18 mg/L and a higher UV dose, the peroxide conversion was 47% of the initial concentration whereas for the lower peroxide dose (10 mg/L) and lower UV dose it was only 13%.

#### 4.2.1.4 Summary: definition of optimal, high and low dose

##### 4.2.1.4.1 Experiment A - Ozone

In ozone screening tests, bromate formation being one of the limiting parameters for ozone test, has been taken into consideration for the optimal ozone dose definition. Bromate is not detected before approx.13 mg abs. $O_3$/L.
The low dose was defined according to the UV 254 nm absorbance evolution (linked to double bonds systems) which reaches a plateau phase after approx. 7 mg abs. $O_3$/L.
The high dose was defined according to COD, when it reaches a plateau phase (approx. 25 mg abs. $O_3$/L)

Therefore, we chose 13 mg/L as optimal dose and it has been decided to make a complete analysis on samples:

7 mg abs. $O_3$/L (low dosage)
13 mg abs. $O_3$/L (optimal dosage)
25 mg abs. $O_3$/L (high dosage)

##### 4.2.1.4.2 Experiment B – Ozone / hydrogen Peroxide

OH radical formed during ozone/peroxide test should increase the removal efficiency of recalcitrant substances.
In experiment A (Ozone), it was observed that Benzene was removed at a significant rate even if reaction rate constant with ozone alone is very low. This is most probably due to the known effect of OH radical formation when presence of dissolved organic matter within the water matrix. Therefore, taking into account technical and also economic reasons, it has been decided to treat the effluent by applying continuously hydrogen peroxide at 50 % stoichiometric (peroxide/ozone) rate and at original pH.
Like it is for ozone test, bromate formation is one of the limiting parameters for ozone/peroxide and has been taken into consideration for the ozone dose definition.

Therefore, it was decided to treat the raw water at the following doses:

5 mg abs. O3/L (low dosage) when UV gets to the plateau phase
13 mg abs. O3/L (optimal dosage) before bromate formation in ozone test (experiment A)
25 mg abs. O3/L (high dosage) for equal conditions as in experiment A

#### 4.2.1.4.3 Experiment C – UV / hydrogen Peroxide

The assessment parameters for optimal dose choice in experiment A and B were primary UV absorption and bromate formation and secondary COD decreasing. At this optimal dose point experiment, A and B, the UV absorption was 0.044 cm-1 and 0.047 cm-1. In experiment C, the same absorption was achieved after 22 min, with 2 lamps and 20 mg/L of hydrogen peroxide. This setup was considered as optimal dose.

## 4.3 PAC tests: Definition of the PAC doses of the 13 PAC treated effluents

### 4.3.1 Materials and methods

#### 4.3.1.1 PAC references

PAC stands for Powder Activated Carbon.

The PAC used during this study is CAP Norit Sa Super 8043-8

It presents good and wide performances of adsorption, essential for water treatment tests.

SUEZ considers it as a standard for micropollutants removal. It is also often used in the drinking water treatment plants.

Test plan and test conditions for the PAC tests was evaluated and agreed together with SUEZ experts (CIRSEE and Dégremont Technologies)

#### 4.3.1.2 PAC treated effluent presentation

In total 13 effluents are PAC treated:

- Raw water: Untreated Grinsted effluent
- A1 (TA6-SF): effluent oxidized at optimal ozone dose
- A2 (TA7-SF): effluent oxidized at high ozone dose
- A3 (TA8-SF): effluent oxidized at low ozone dose
- B1 (TB6-SF): effluent oxidized at optimal ozone / hydrogen peroxide dose
- B2 (TB7-SF): effluent oxidized at high ozone / hydrogen peroxide dose
- B3 (TB8-SF): effluent oxidized at low ozone / hydrogen peroxide dose
- C1 (TC6-SF): effluent oxidized with UV / hydrogen peroxide at optimal hydrogen peroxide dose
- C2 (TC7-SF): effluent oxidized with UV / hydrogen peroxide at high hydrogen peroxide dose
- C3 (TC8-SF): effluent oxidized with UV / hydrogen peroxide at low hydrogen peroxide dose
- D1 (Sample B): effluent from water IQ
- D2 (Sample E): effluent from water IQ
- D3 (Sample F): effluent from water IQ

#### 4.3.1.3 PAC screening step and installation

Prior to PAC treatment, PAC screening tests were performed on each effluent to be treated to define a PAC dose corresponding to the maximum efficiency contaminant removal rate.
During each PAC screening test, 4 or 5 samples were in contact exactly during 30 min with different known PAC doses (see Figure 43). All tests were performed in identical test conditions (see Table 9). The Analysis of COD, DOC and more important UV absorption at 254 nm were performed on each sample after the 30 min contact time, 30 min settling and filtration at 0.45 um. Tests were conducted at controlled temperature (18 ± 2 °C), defined PAC dose and pH.

Figure 43: PAC screening test installation

Table 9: Screening PAC test conditions and setups

| Test parameter | unit | Value |
|---|---|---|
| Fish size | mm | 40x7x5 |
| Mixing velocity | rpm | Approx. 300 |
| Volume of sample | ml | 500 |
| Temperature | °C | 16 - 20 |
| pH | - | 5.8 – 7.3 |
| PAC concentration | mg/L | • 0, 10, 30, 50, 100 (Oxidized effluents)<br>• 0, 50, 150, 500 (untreated Grinsted ground water) |

#### 4.3.1.4 PAC treatment step and installation

Following PAC screening tests results, a PAC dose was agreed with COWI for each effluent.
Then, enough volume of effluent for ALS analysis and Ecotoxicity tests were in contact with PAC during exactly 2h. Sample was settled for at least 30 min and finally filtrated at 0.45 um, see Figure 61.

Figure 44: PAC treatment - Picture of the filtration installation

#### 4.3.1.5 Particularity for samples from water IQ.

In a first delivery, 3 samples from water IQ were received, sample B, C and D. Samples C and D showed high concentrations of iron (respectively approx. 13 mg/Land approx. 34 mg/L) and therefore also high TSS and COD. It was decided that samples C and D shall be disposed. New samples were produced by water IQ. These new samples E and F showed unsuitable pH for PAC absorption and residual peroxide concentration see Table 10.

Table 10: Main characteristics of Water IQ samples prior PAC tests

| Sample name | Initial pH | Hydrogen peroxide concentration (mg/L) | Iron concentration (mg/L) |
|---|---|---|---|
| B | 3.2 | Not measured | $Fe^{3+}$ = 11.7<br>$Fe^{2+}$ = 1.1 |
| E | 10.3 | 15 (after 10 days storage not including shipping time) | $Fe^{3+}$ = <0.2<br>$Fe^{2+}$ = <0.2 |
| F | 10.2 | 3 (after 10 days shipping not including shipping time) | $Fe^{3+}$ = <0.2<br>$Fe^{2+}$ = <0.2 |

With these characteristics, COD and UV measurements presented inconsistent results. The 3 samples were settled. As pH affects the absorption, the supernatants were pH neutralised before PAC screening tests and PAC treatment (see Figure 45). Quenching of peroxide has been not done. Peroxide was finally removed by PAC treatment. This additional treatment effort was not necessary for effluents from other experiments (A, B, C).

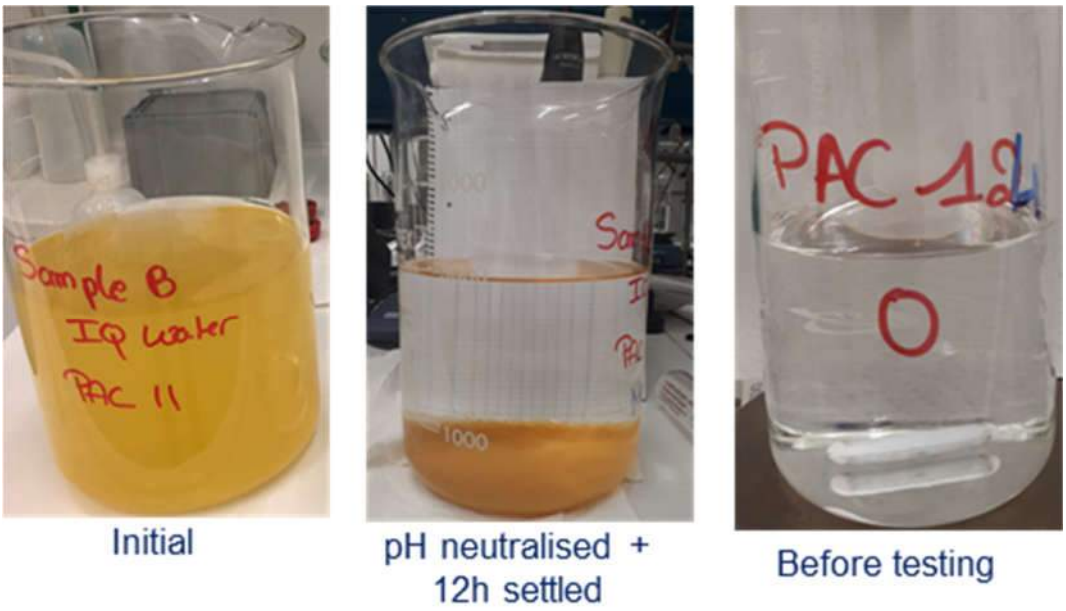



Figure 45: Experiment D - Settling observations on sample B

### 4.3.2 PAC screening tests: Definition of PAC dose for each effluent

#### 4.3.2.1 Raw water- Untreated Grinsted effluent

##### 4.3.2.1.1 COD, DOC evolution

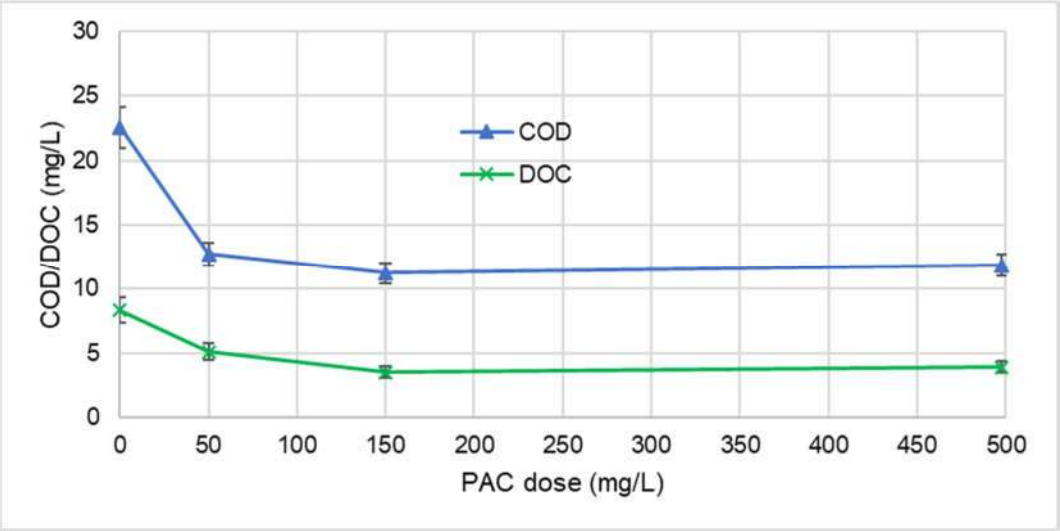



Figure 46: Untreated Grinsted effluent- PAC screening test - COD & DOC vs PAC dose

The minimal achievable values for COD (23 mg/L) and DOC (8 mg/L) were achieved with a PAC dose of 150 mg/L, higher doses did not show any beneficial effect

##### 4.3.2.1.2 UV absorption evolution

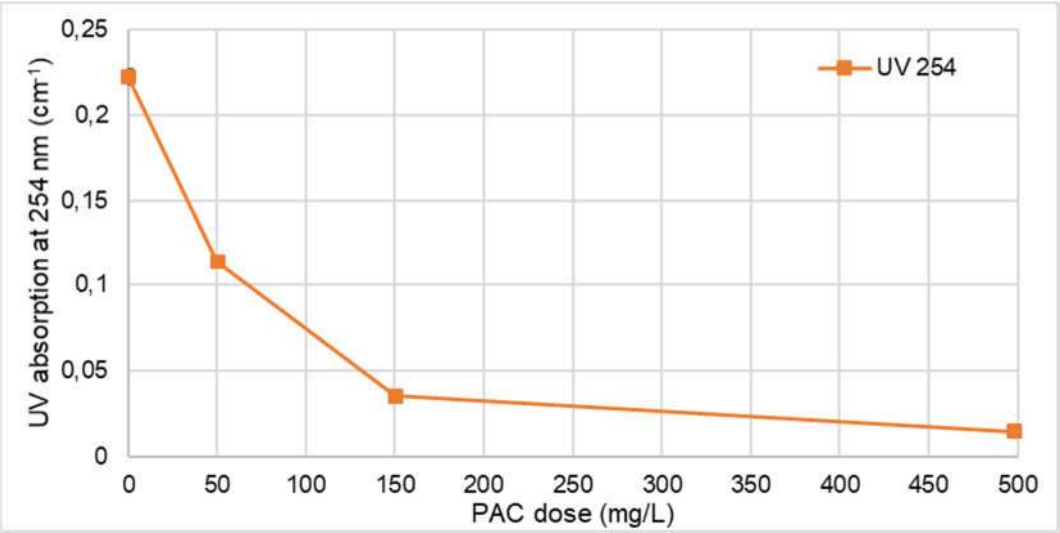



Figure 47: Untreated Grinsted effluent - PAC screening test – UV absorption vs PAC dose

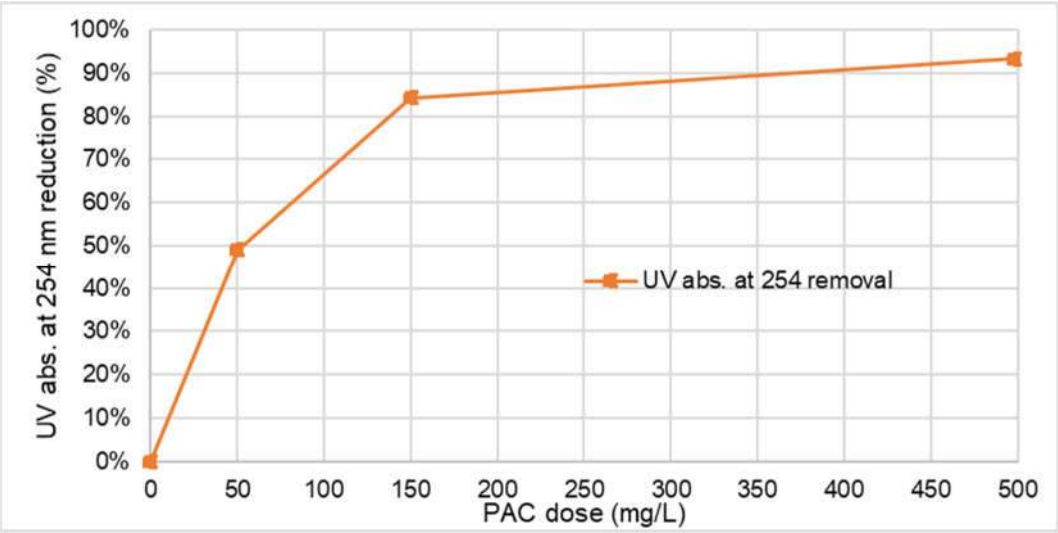



Figure 48: Untreated Grinsted effluent - PAC screening test – UV absorption reduction vs PAC dose

UV reaches a plateau phase after applying 150 mg/L. It has been decided with COWI to apply the maximum PAC dose of 150 mg/L.

### 4.3.2.2 Experiment A (Ozone optimal, high and low dose)

#### 4.3.2.2.1 COD evolution

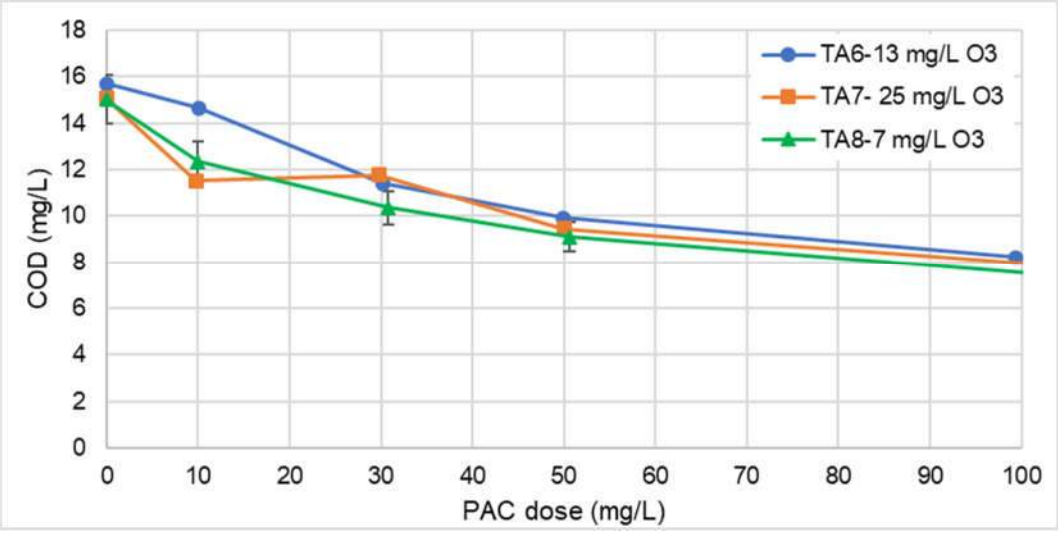



Figure 49: Experiment A - Compilation of PAC screening test - COD vs PAC dose

An irregularity can be observed in TA7 for the 30 mg/L PAC dose, since there is no decrease in the COD concentration and the UV absorption shows the same effect. It can also be observed in test TB7. The reason for this is unknown.

#### 4.3.2.2.2 UV absorption evolution

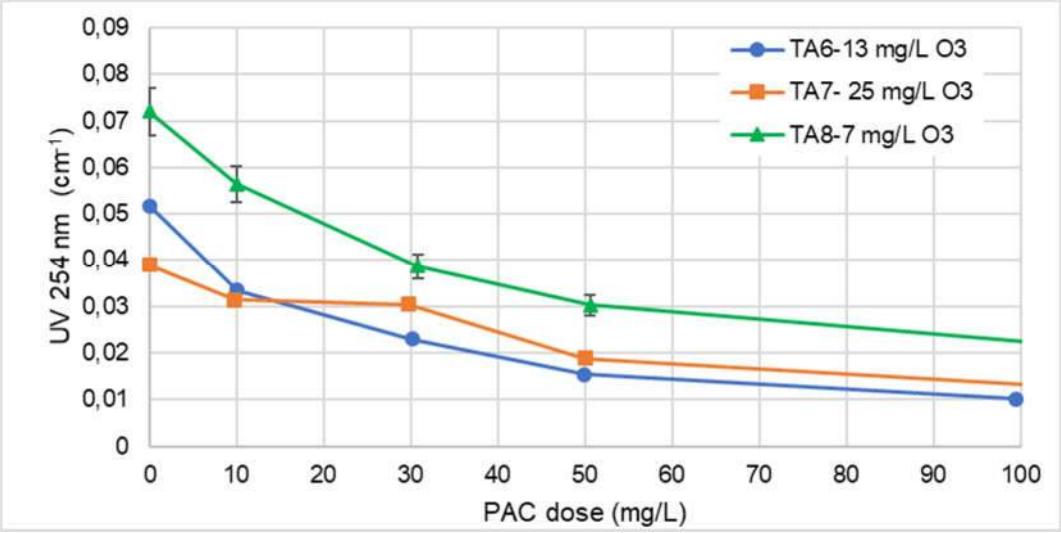



Figure 50: Experiment A - Compilation of PAC screening test – UV absorption vs PAC dose

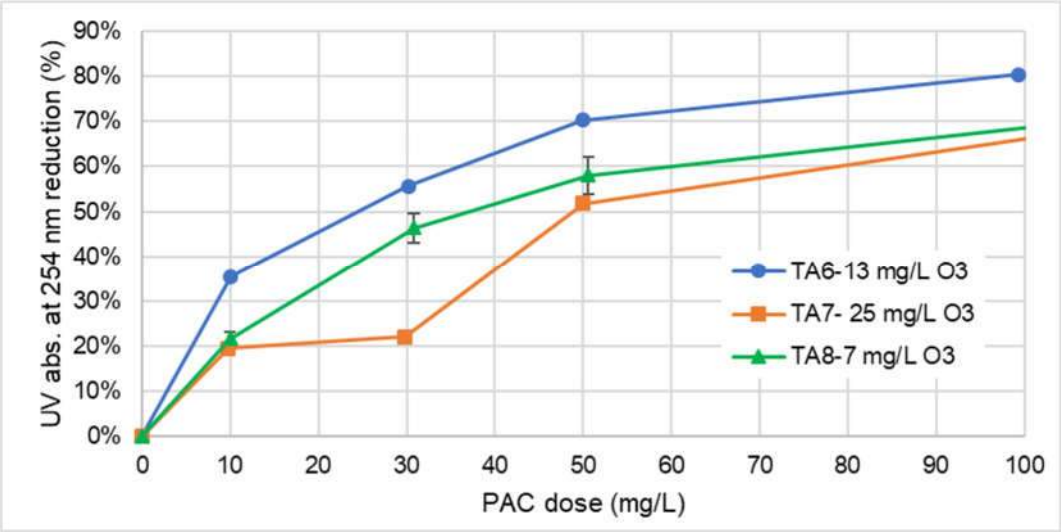



Figure 51: Experiment A - Compilation of PAC screening test – UV reduction vs PAC dose

The sample with a PAC dose of 30 mg/L in the high dose test TA7 seems to be an outlier, maybe due to contamination. Actually, there is no significant difference in UV abs or COD decrease between the optimal and high dose sample. A PAC dose of 50 mg/L appears as sufficient to achieve a very good water quality with a UV254 abs of <0.02 $cm^{-1}$.

### 4.3.2.3 Experiment B (Ozone/peroxide optimal, high and low dose)

#### 4.3.2.3.1 COD evolution

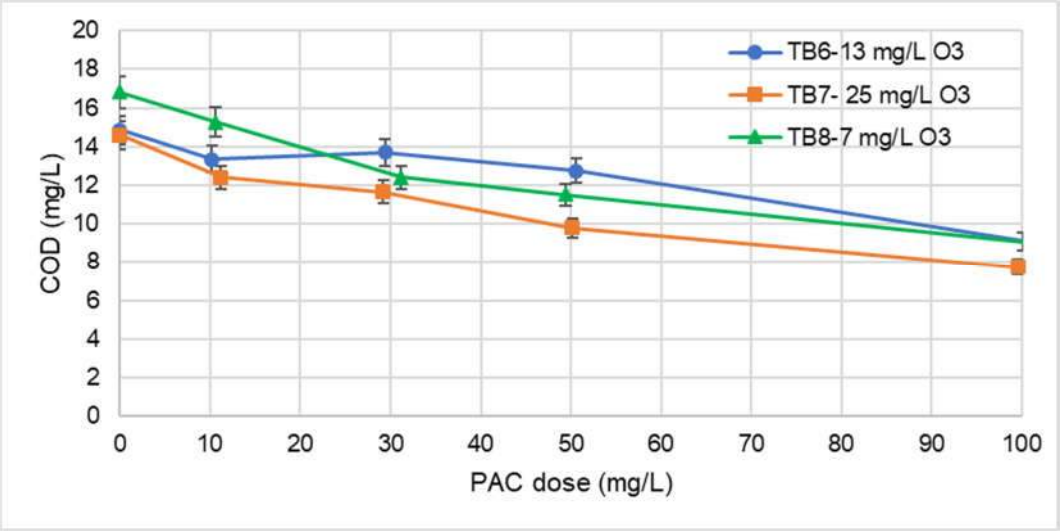



Figure 52: Experiment B - Compilation of PAC screening test - COD vs PAC dose

#### 4.3.2.3.2 UV absorption evolution

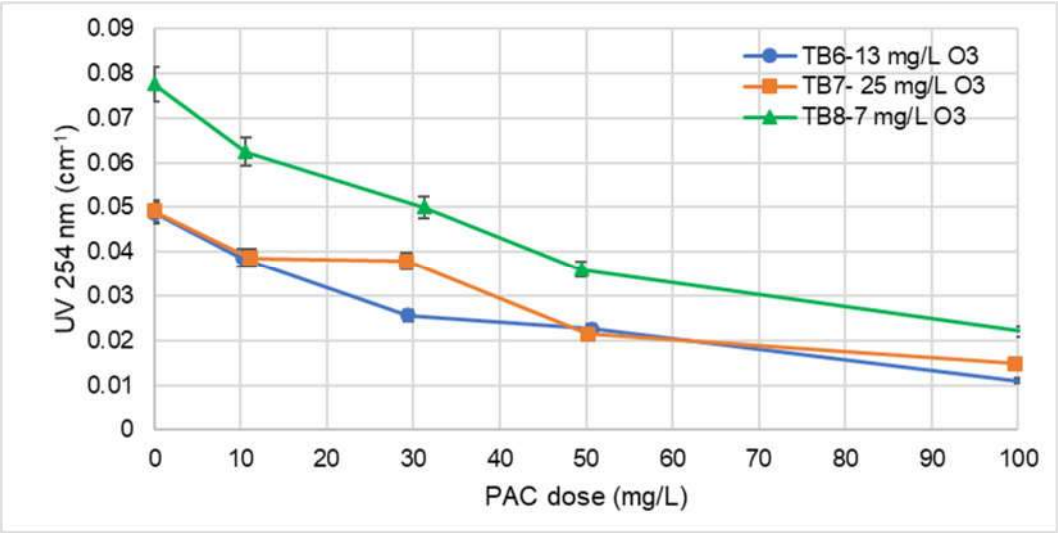



Figure 53: Experiment B - Compilation of PAC screening test – UV absorption vs PAC dose

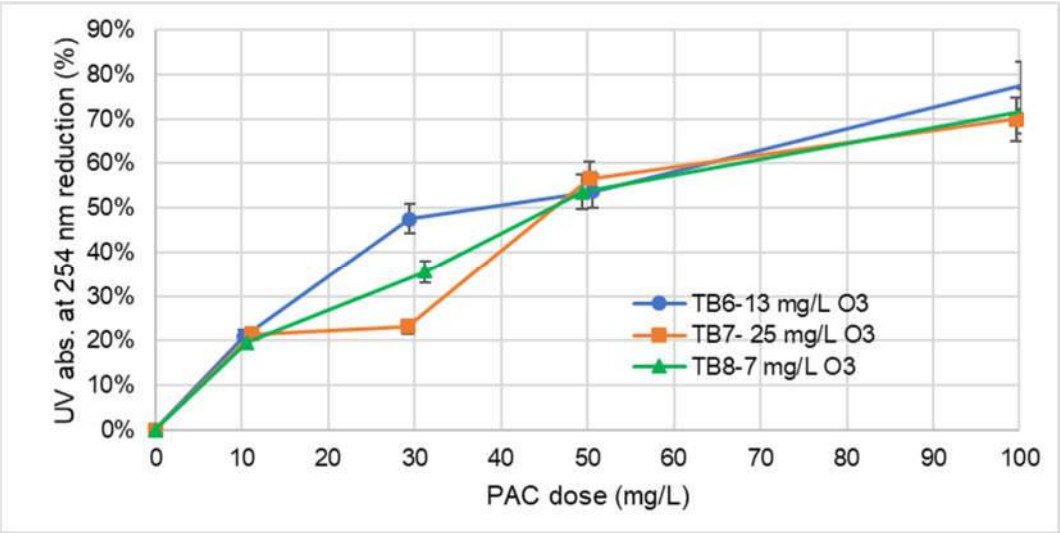



Figure 54: Experiment B - Compilation of PAC screening test – UV reduction vs PAC dose

PAC dose chosen with COWI at 50 mg/L, which finally depends on the water quality requirements. Tendentially, this chosen dose is quite high in terms of economic feasibility.

#### 4.3.2.4 Experiment C (UV / peroxide optimal, high and low dose)

##### 4.3.2.4.1 COD evolution

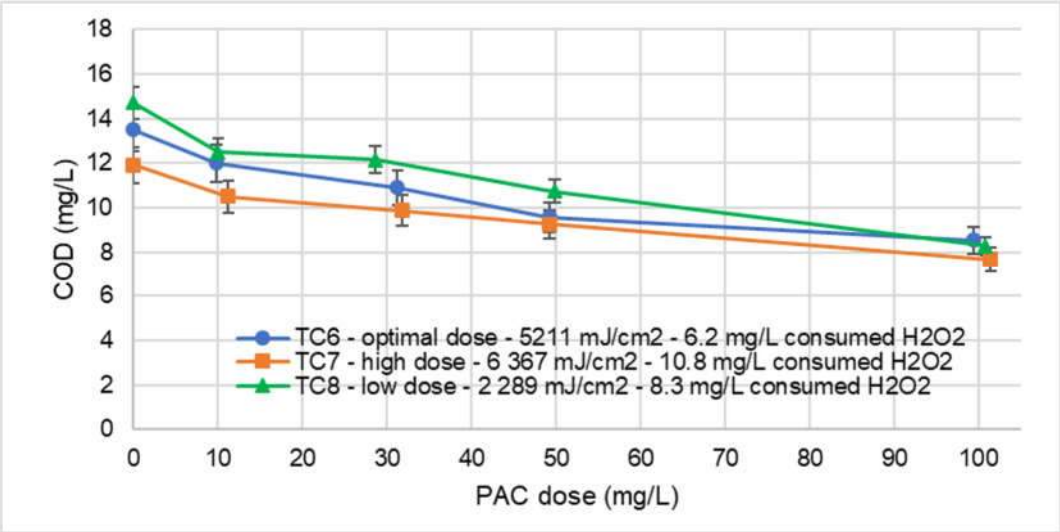



Figure 55: Experiment C - Compilation of PAC screening test - COD vs PAC dose

#### 4.3.2.4.2 UV absorption evolution

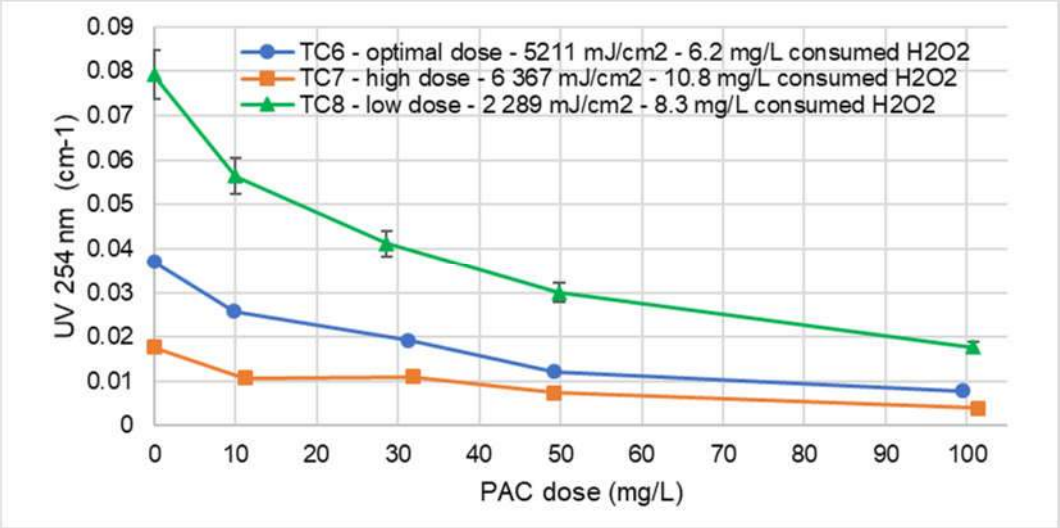



Figure 56: Experiment C - Compilation of PAC screening test – UV absorption vs PAC dose

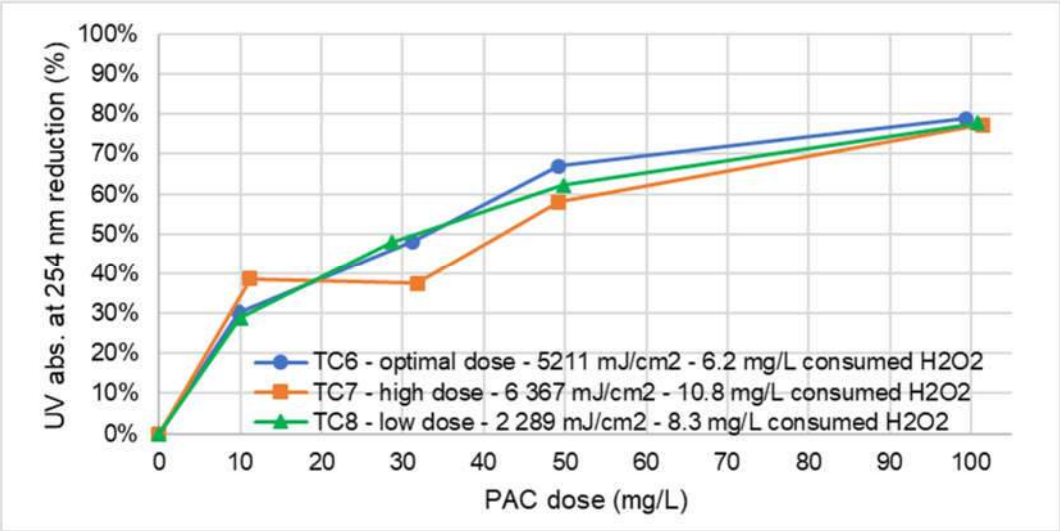



Figure 57: Experiment C - Compilation of PAC screening test – UV reduction vs PAC dose

COD and UV absorption do not seem to reach a plateau phase, therefore it has been decided to treat the effluent with the maximal PAC dose: 100 mg/L (agreed by COWI). Tendentially, this chosen dose is quite high in terms of economic feasibility.

### 4.3.2.5 Experiment D

All results of experiment D must be taken in careful consideration since the water quality of these samples before PAC treatment (see 4.1.1.2) showed quite high concentrations of remaining hydrogen peroxide after 10 days storage (sample E and F) and undetermined days of shipping. Also a high amount of iron precipitation was present in sample B.
In addition, we have no knowledge about the chosen values for high, optimal and low doses.

#### 4.3.2.5.1 COD evolution

COD measurements presented inconsistent results before pH neutralisation. COD has been measured on the optimal sample (sample F) and the overdosed sample (sample B) after pH adjustment.

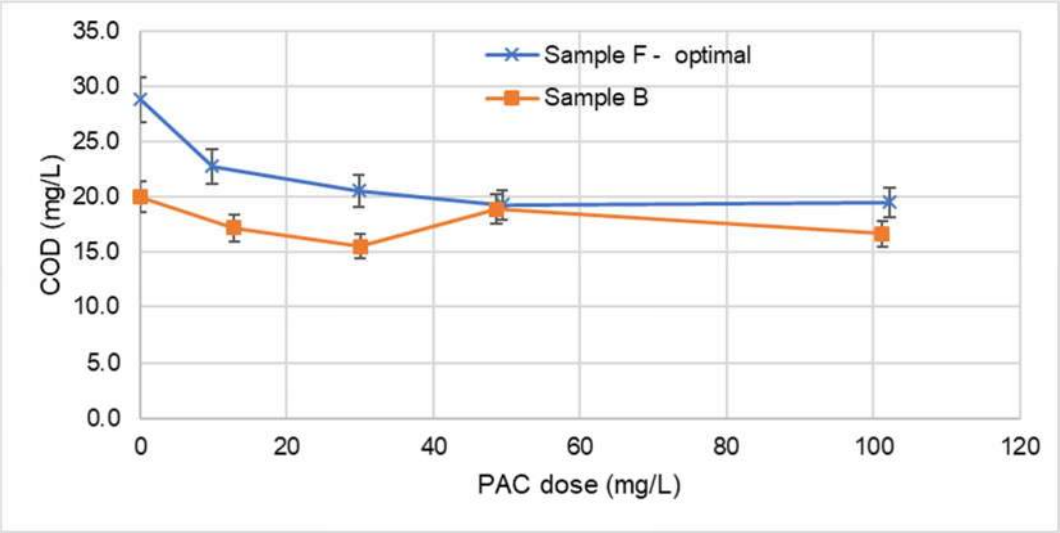



Figure 58: Experiment D - Compilation of PAC screening test - COD vs PAC dose

For sample F, COD gets stable after applying 20 to 30 mg PAC/L. For sample B, COD evolution is not a suitable assessment parameter to define the PAC dose.

#### 4.3.2.5.2 UV Absorption

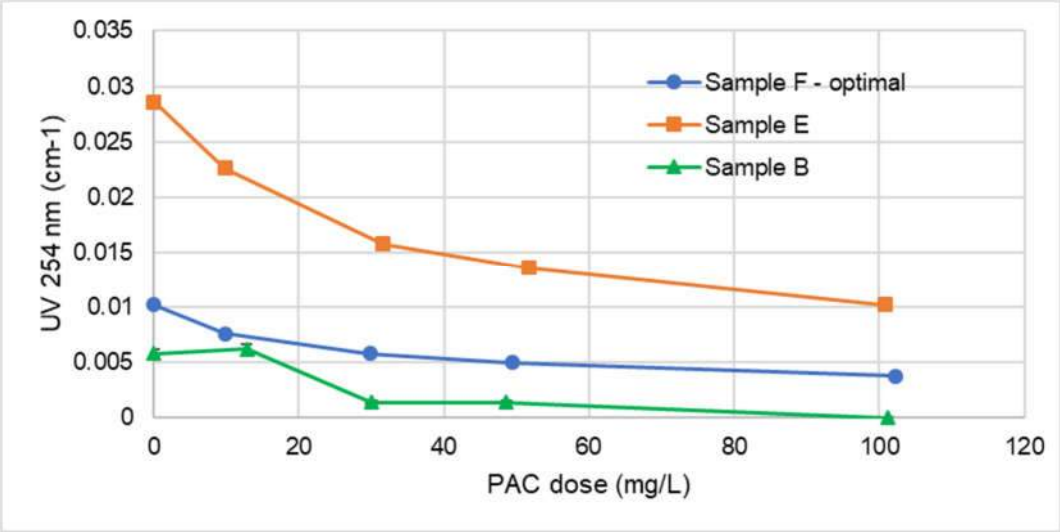



Figure 59: Experiment D - Compilation of PAC screening test – UV absorption vs PAC dose

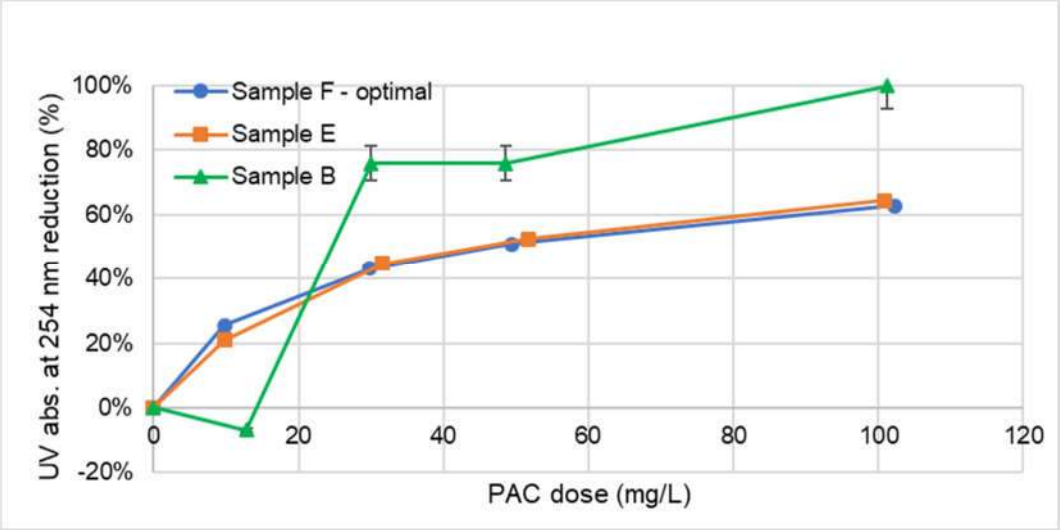



Figure 60: Experiment D - Compilation of PAC screening test – UV reduction vs PAC dose

UV absorption is already below 0.2 $cm^{-1}$ before PAC treatment. It has been decided with COWI to apply the maximum PAC dose to ensure a maximal removal rate: 100 mg/L.

# 5 Part 2: ALS results on the produced effluent

## 5.1 Important considerations for the study

### 5.1.1 Suez sample name list

Table 11: List of sample names

| COWI name | COWI designation | Detail about sample | Sample name SUEZ |
|---|---|---|---|
| **Baseline raw water BE6** | | | |
| Baseline COWI | Not communicated | Not communicated | Out of scope |
| PAC, final test | Not communicated | PAC final test on raw water (sample of 1m$^3$ container) | PAC - raw water |
| **Experiment A** | | | |
| Test 1- $O_3$ dose 1-Optimum | A1 | sample oxidized at optimal $O_3$ dose (TA6) | TA6-SF |
| Test 2- $O_3$ dose 2-High | A2 | sample oxidized at high $O_3$ dose (TA7) | TA7-SF |
| Test 3- $O_3$ dose 3-low | A3 | sample oxidized at low $O_3$ dose (TA8) | TA8-SF |
| PAC test | Not communicated | PAC final test on TA6SF | PAC-A6-SF |
| PAC test | Not communicated | PAC final test on TA7SF | PAC-A7-SF |
| PAC test | Not communicated | PAC final test on TA8SF | PAC-A8-SF |
| **Experiment B** | | | |
| Test 1- $O_3$/ $H_2O_2$ dose 1-Optimum | B1 | sample oxidized at optimal $O_3$/ $H_2O_2$ dose (TB6) | TB6-SF |
| Test 2- $O_3$/ $H_2O_2$ dose 2-High | B2 | sample oxidized at high $O_3$/ $H_2O_2$ dose (TB7) | TB7-SF |
| Test 3- $O_3$/ $H_2O_2$ dose 3-low | B3 | sample oxidized at low $O_3$/ $H_2O_2$ dose (TB8) | TB8-SF |
| PAC test | Not communicated | PAC final test on TB6SF | PAC-B6-SF |
| PAC test | Not communicated | PAC final test on TB7SF | PAC-B7-SF |
| PAC test | Not communicated | PAC final test on TB8SF | PAC-B8-SF |
| **Experiment C** | | | |
| Test 1- $H_2O_2$ dose 1-Optimum | C1 | sample oxidized at optimal UV + $H_2O_2$ dose (TC6) | TC6-SF |
| Test 2- $H_2O_2$ dose 2-High | C2 | sample oxidized at high UV+ $H_2O_2$ dose (TC7) | TC7-SF |
| Test 3- $H_2O_2$ dose 3-low | C3 | sample oxidized at low UV+ $H_2O_2$ dose (TC8) | TC8-SF |
| PAC test | Not communicated | PAC final test on TC6SF | PAC-C6-SF |
| PAC test | Not communicated | PAC final test on TC7SF | PAC-C7-SF |
| PAC test | Not communicated | PAC final test on TC8SF | PAC-C8-SF |
| **Experiment D** | | | |
| Not communicated | Not communicated | PAC test on Water IQ - Sample B | PAC-B-SF |
| Not communicated | Not communicated | PAC test on Water IQ - Sample E | PAC-E-SF |
| Not communicated | Not communicated | PAC test on Water IQ - Sample F | PAC-F-SF |

### 5.1.2 Oxidant and PAC dose

Optimal doses for experiment A, and B were chosen according to UV absorption plateau phase and Bromate formation. For more detailed, see paragraph 4.2.1.4.

Table 12: Ozone, Hydrogen peroxide and UV doses applied on effluents analysed by ALS

| Experiment | Sample | $O_3$ (mg/L) | $H_2O_2$ (mg/L) introduced | $H_2O_2$ (mg/L) Consumed | UV (mJ.cm$^{-2}$) |
|---|---|---|---|---|---|
| A | Optimal (A1) | 13.1 | - | - | - |
| | Over dosed (A2) | 22.6 | - | - | - |
| | Under dosed (A3) | 7.5 | - | - | - |
| B | Optimal (B1) | 11.9 | 2.0 | 0.4 | - |
| | Over dosed (B2) | 22.9 | 4.1 | 2.7 | - |
| | Under dosed (B3) | 5.8 | 1.2 | <0.5 | - |
| C | Optimal (C1) | - | 19.6 | 6.2 | 5 211 |
| | Over dosed (C2) | - | 30.4 | 10.8 | 6 367 |
| | Under dosed (C3) | - | 17.9 | 8.3 | 2 289 |

Table 13: PAC doses applied on effluents analysed by ALS

| Experiment | Sample | PAC (mg/L) |
|---|---|---|
| - | Original water (no oxidation prior PAC) | 150 |
| A | Optimal (A1) | 50 |
| | Over dosed (A2) | |
| | Under dosed (A3) | |
| B | Optimal (B1) | 50 |
| | Over dosed (B2) | |
| | Under dosed (B3) | |
| C | Optimal (C1) | 100 |
| | Over dosed (C2) | |
| | Under dosed (C3) | |
| D * | Optimal (D1) | 100 |
| | Over dosed (D2) | |
| | Under dosed (D3) | |

**Important fact**
Samples were not PAC treated at same PAC dose:
(A1, A2, A3, B1, B2, B3) < (C1, C2, C3, D1, D2, D3) < Original water

### 5.1.3 Water quality considerations

#### 5.1.3.1 Consistency of the analysis results – Organic and Grinsted compounds

Over 2 300 measurements of Organics and Grinsted compounds have been performed by ALS.

It is most unlikely that those compounds could be formed during AOP or PAC treatment, therefore the concentration can only decrease or remain stable with increasing the oxidant dose. Inconsistent results have been detected and classified in 6 categories, see Table 14 and Table 15:

- Category A: Results showing higher values (lower removal rate) with higher oxidant dose or showing lower values (higher removal rate) with lower oxidant dose. Results still in the range of uncertainty of measurement. The inconsistent result is kept for assessment.

- Category B: Results showing higher values (lower removal rate) with higher oxidant dose or showing lower values (higher removal rate) with lower oxidant dose. Results out of the range of uncertainty of measurement. It can be due to possible error of measurement, error of reading/transmission of results or contamination. It can be also due to an error of tagging or reading of tagging. The inconsistent result is kept for assessment.

- Category C: Compound detected after AOP or PAC but not detected in baseline. It can be due to possible error of measurement, error of reading/transmission of results, contamination during measurement or different water quality (baseline vs tested sample). No removal rate can be calculated for the all compound. The parameter is not considered for assessment.

- Category D: Measurements after AOP or PAC treatment higher than measurement in the baseline, in the range of uncertainty of measurement. It can be due to possible measurement uncertainties or difference water quality. The removal rate is negative for such values; therefore, the value is not considered for assessment.

- Category E: Measurements after AOP higher than baseline, out of measurement uncertainty, due to measuring error. Confirmed by ALS. The parameter is not considered for assessment.

- Category F: Measurement after PAC higher than before PAC / After AOP, value out of measurement uncertainty. It can be possibly due to error of measurement or error of reading/transmission or contamination. For all technologies, measurements of the considered compounds on samples after PAC treatment are not considered for assessment.

i: Special attention - Compounds present in the raw water at significant concentrations, values presenting significant inconsistencies.

Green colour: values presenting inconsistencies and kept for the assessment

Black colour: values showing inconsistencies and excluded from the assessment

Red colour: values not showing inconsistencies but excluded from the assessment because compound not evaluable for the whole testing line.

Table 14: Identification and classification of inconsistent analysis values (PART 1)

| Sample name | Benzene | Chloroform | Chloroethane | Vinyl chloride | cis-1.2-dichlorethylene | Butylbarbiturat | Pentobarbital |
|---|---|---|---|---|---|---|---|
| Ini. cc baseline (µg/l) | 520 | 0.3 | 35 | 7100 | 1400 | 110 | 56 |
| $O_3$-low dose | | | | | | | |
| **$O_3$-optimal dose** | | | | | | | A |
| $O_3$-high dose | | | | | | | |
| $O_3/H_2O_2$-low dose | | | | | | | |
| **$O_3/H_2O_2$-optimal dose** | | A | | | | Bi | |
| $O_3/H_2O_2$-high dose | | | | | | | |
| $UV/H_2O_2$- low dose | | | | | | | |
| **$UV/H_2O_2$- optimal dose** | | | | | | | |
| $UV/H_2O_2$ - high dose | Bi | | | | | | |
| PAC raw water | | | | | | | |
| $O_3$-low dose + PAC | | | | | | | |
| **$O_3$-optimal dose + PAC** | | B | B | Bi | | | |
| $O_3$-high dose + PAC | | | | | | | |
| $O_3/H_2O_2$-low dose + PAC | | | | | | | |
| **$O_3/H_2O_2$-optimal dose + PAC** | | B | B | Bi | Bi | | |
| $O_3/H_2O_2$-high dose + PAC | | | | | | | |
| $UV/H_2O_2$- low dose + PAC | | | | | | | |
| **$UV/H_2O_2$- optimal dose + PAC** | | | B | Bi | | | |
| $UV/H_2O_2$- high dose | A | | | | | | |
| Catalyst/ $H_2O_2$ - low dose + PAC | | | | | | | |
| **Catalyst/ $H_2O_2$ – optimal dose + PAC** | | | B | | | | |
| Catalyst/ $H_2O_2$ - high dose + PAC | | | | | | | |

Table 15: Identification and classification of inconsistent analysis values (PART 2)

| Sample name | 1.2-dichlorethane | Dichlormethane | Acetylsulfaguanidin | Barbital | Amobarbital | Meprobamate | Ethyl urethan |
|---|---|---|---|---|---|---|---|
| Ini. cc baseline (µg/l) | <0.020 | <0.10 | <0.1 | 15 | 43 | 61 | 315 |
| $O_3$-low dose | C | C | C | D | D | E | |
| **$O_3$-optimal dose** | C | C | C | D | | E | A |
| $O_3$-high dose | C | C | C | | | E | |
| $O_3/H_2O_2$-low dose | C | C | C | | | E | |
| **$O_3/H_2O_2$-optimal dose** | C | C | C | | | E | |
| $O_3/H_2O_2$-high dose | C | C | C | | | E | |
| $UV/H_2O_2$- low dose | C | C | C | D | | E | |
| **$UV/H_2O_2$- optimal dose** | C | C | C | | | E | A |
| $UV/H_2O_2$ - high dose | C | C | C | | | E | |
| PAC raw water | C | C | C | | | E | F |
| $O_3$-low dose + PAC | C | C | C | | | E | F |
| **$O_3$-optimal dose + PAC** | C | C | C | | | E | F |
| $O_3$-high dose + PAC | C | C | C | | | E | F |
| $O_3/H_2O_2$-low dose + PAC | C | C | C | | | E | F |
| **$O_3/H_2O_2$-optimal dose + PAC** | C | C | C | | | E | F |
| $O_3/H_2O_2$-high dose + PAC | C | C | C | | | E | F |
| $UV/H_2O_2$- low dose + PAC | C | C | C | | | E | F |
| **$UV/H_2O_2$- optimal dose + PAC** | C | C | C | | | E | F |
| $UV/H_2O_2$- high dose | C | C | C | | | E | F |
| Catalyst/ $H_2O_2$ - low dose + PAC | C | C | C | | | E | F |
| **Catalyst/ $H_2O_2$ – optimal dose + PAC** | C | C | C | | | E | F |
| Catalyst/ $H_2O_2$ - high dose + PAC | C | C | C | | | E | F |

## Focus main parameters

- Vinyl chloride: The values after PAC treatment at low and optimal dose for each technology A, B, C are peculiar in a way that the remaining concentration for optimal dose is much higher than for low dose, which is most unlikely.

- Benzene: The value measured after $UV/H_2O_2$ treatment at high dose is higher than at lower doses, which is most unlikely. A realistic result would be a value lower than the ones at lower UV/ $H_2O_2$ doses.

- Cis-1.2-dichlorethylene: The value after $O_3$/ $H_2O_2$ treatment at optimal dose and PAC treatment is higher than the one at low dose, which is most unlikely. A realistic result at optimal dose would be lower than the one at low $O_3$/ $H_2O_2$ dose.

- Butylbarbiturat: The value after $O_3$/ $H_2O_2$ treatment at optimal dose is higher than the one at low $O_3$/H2O2 dose, which is most unlikely. A realistic result at optimal dose would be lower than the one at low $O_3$/ $H_2O_2$ dose.

All compounds which were measured below DL (Detection Limit) in the baseline are excluded from the removal rate calculations.
Two other compounds are also excluded from calculation:
- Meprobamate (from all removal calculations) due to an analytical inconsistency confirmed by ALS
- Ethyl urethan (from carbon removal rate only) which was measured at significant higher level after CAP experiments than after AOP experiments.

#### 5.1.3.2 Water quality of experiment D effluents

As evocated in paragraph 4.3.1.5, sample E and F from water IQ presented significant hydrogen peroxide concentrations after 10 days storage (not including sampling ad shipping time) see Table 10 :

Figure 61: Experiment D - picture of samples received from Water IQ before any PAC pre-treatment

Copy from 4.3.1.5:

In a first delivery, 3 samples from water IQ were received, sample B, C and D. Samples C and D showed high concentrations of iron (respectively approx. 13 mg/Land approx. 34 mg/L) and therefore also high TSS and COD. It was decided that samples C and D shall be disposed, and new samples will be produced by water IQ. The new samples E and F showed a high pH and a residual peroxide concentration of 3 mg/L (E) and 13 mg/L (F)
It is difficult to estimate the influence and reactivity of the peroxide during the shipping and storage time and therefore a comparative assessment of the results from tests A, B and C with the results from test D is questionable.

Cumulating the fact that the baseline is different than the water we treated for experiment A,B,C and the fact that significant amount of peroxide might affect the ALS results, it is even more delicate to compare experiment D results with experiment A, B, C results. It also delicate to assess the treatment performances with a removal rate based on different water quality than the one tested.

## 5.2 Oxidative step performances

### 5.2.1 Inorganic parameters

In total 24 inorganic parameters have been measured.

#### 5.2.1.1 Undetected measured parameters

Fluoride and Bore were measured and undetected in all samples (untreated and ozone and AOP treated).

#### 5.2.1.2 Unaffected measured parameters

Among these 24 inorganic parameters, Manganese, Calcium, Potassium, Sodium, Chloride, Sulphate, Non-volatile organic compounds (NVOC), Barium (metal), Nickel (metal) were not affected by AOP treatment.

#### 5.2.1.3 Metal

Table 16: Metal measurement on ozone and AOP treated effluents.

| Sample name | Arsenic As | Lead Pb | Boron B | Cadmium Cd | Barium Ba | Chrome Cr | Copper Cu | Nickel Ni | Zink Zn |
|---|---|---|---|---|---|---|---|---|---|
| | µg/l | µg/l | µg/l | µg/l | µg/l | µg/l | µg/l | µg/l | µg/l |
| **Baseline** | **3.8** | **0.12** | **<10** | **0.0086** | **160** | **0.51** | **0.8** | **4.7** | **12** |
| TA8-SF | 2.3 | N.M | <10 | N.M | 160 | N.M | N.M | 4.7 | N.M |
| TA6-SF | 2.2 | 0.8 | <10 | 0.02 | 160 | 0.3 | 3.3 | 4.3 | 33 |
| TA7-SF | 1.9 | N.M | <10 | N.M | 160 | N.M | N.M | 4.4 | N.M |
| TB8-SF | 1.0 | N.M | <10 | N.M | 150 | N.M | N.M | 4.3 | N.M |
| TB6-SF | 1.0 | N.M | <10 | N.M | 150 | N.M | N.M | 4.5 | N.M |
| TB7-SF | 2.1 | N.M | <10 | N.M | 160 | N.M | N.M | 4.4 | N.M |
| TC8-SF | 0.4 | N.M | <10 | N.M | 150 | N.M | N.M | 4.4 | N.M |
| TC6-SF | 0.6 | N.M | 10 | N.M | 150 | N.M | N.M | 4.5 | N.M |
| TC7-SF | 0.4 | N.M | 10 | N.M | 150 | N.M | N.M | 4.3 | N.M |

N.M: not measured

Considering the uncertainty of measurement evaluated at 20 %, the comparison of metals concentrations in the baseline effluent with the AOP treated or ozone treated samples shows that lead, Cadmium, Copper and Zink have tendency to increase during AOP tests. That would be considered as metal contamination.

Nevertheless, a metal contamination of such components is highly improbable during AOP tests since our AOP plant is built with glass, stainless steel 904L and Teflon.

Chromium was measured in the effluents and is even decreasing according to the ALS results.

Metal analysis results tend to confirm that the water quality tested, and the baseline effluent quality are slightly different.

#### 5.2.1.4 Focus on iron

Even with a careful sampling and subsequent portioning and transferring into the AOP reactor, it was not possible to avoid having oxygen from air in contact with the water sample. Therefore, it was observed that during the storage time/testing time that the iron precipitation increased in the stored samples. Remaining dissolved iron was oxidised and precipitating during AOP test (brownish colour)

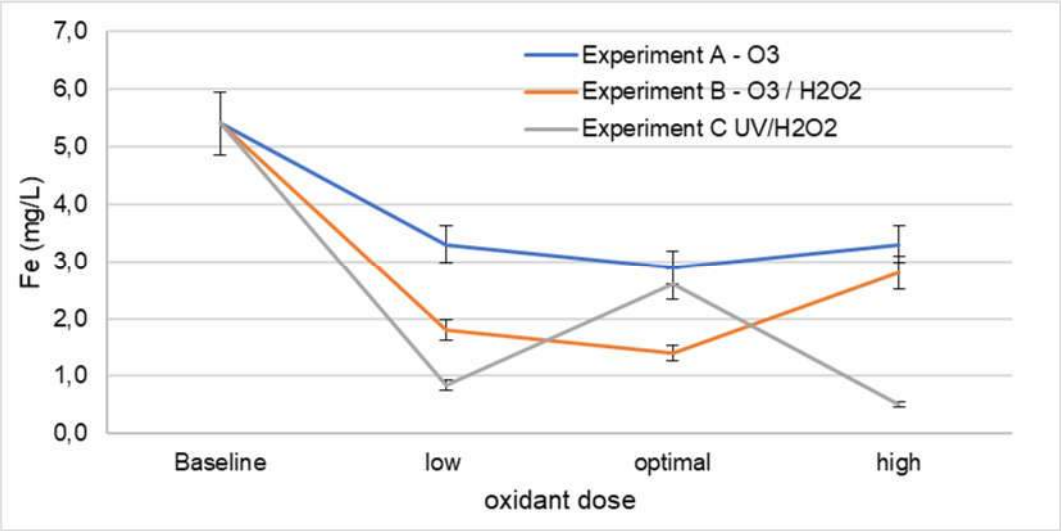



Figure 62: Iron concentration evolution during AOP tests

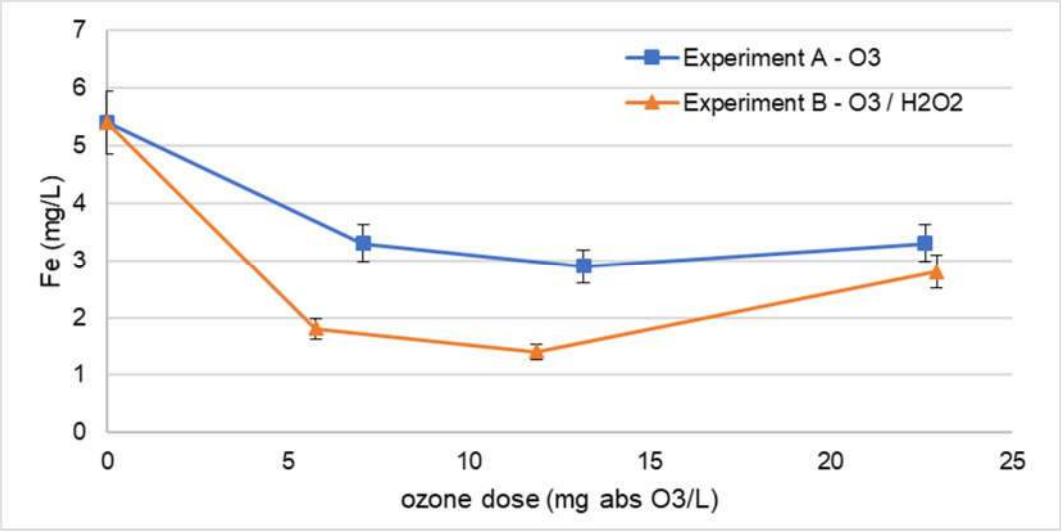



Figure 63: Experiments A & B - Iron concentration evolution vs ozone dose

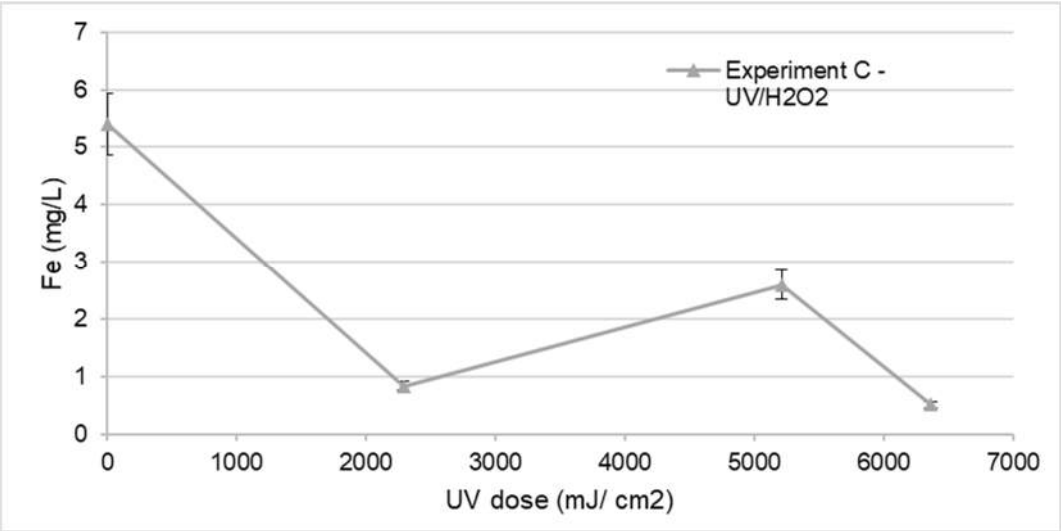



Figure 64: Experiment C - Iron concentration evolution vs UV dose

Due to mentioned reasons, iron is present as precipitation Fe $(OH)_3$ but initially as dissolved $Fe^{2+}$. Since AOP tests were done with supernatant sample (not filtrated), it is possible that analytical samples contain various amount of small concentration of TSS (Fe $(OH)_3$). Therefore, we see some inconsistent values in the iron concentration graphs.

#### 5.2.1.5 Bromate formation during ozonation and ozone/peroxide

Bromate formation is one of the limiting parameters of ozonation. Bromate must be avoided. It is the reason why bromate is measured in experiment A and B. In the baseline (ALS report) and in raw water we received (Bachema report), bromate was not detected before ozonation.

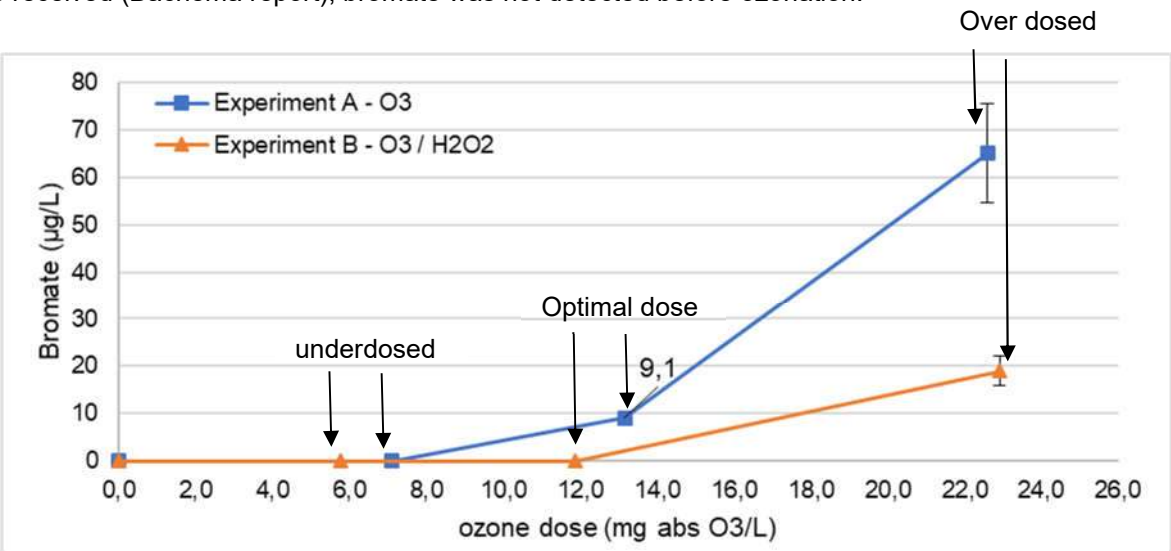



Figure 65: Experiments A & B - Bromate formation vs ozone dose

As expected, bromate concentrations in underdosed and optimal samples are below the 10 ug/L limit.

The bromide conversion into Bromate was calculated from the molar amount of bromide measured in the baseline and the bromate measurements in the effluents of experiment A and B. It is expressed in molar %, see Figure 66.

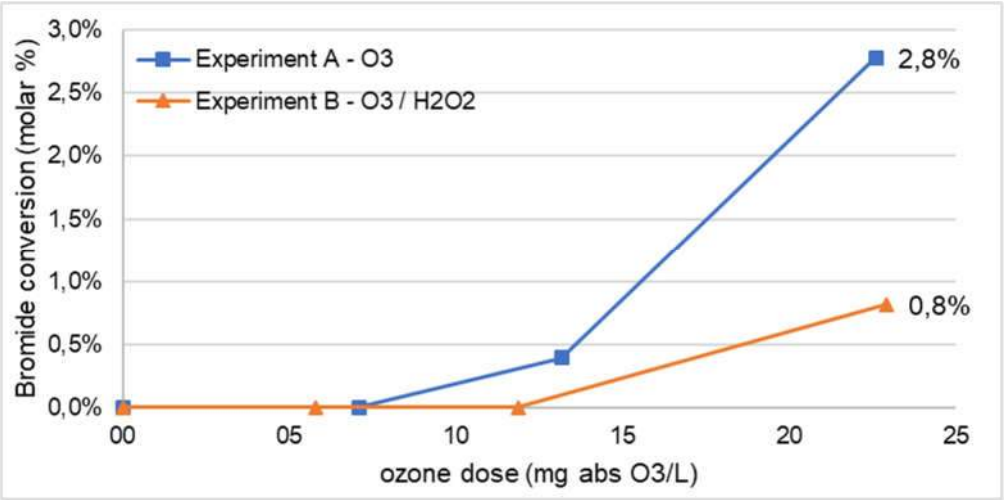



Figure 66: Experiments A & B - Bromide conversion into Bromate vs ozone dose

The bromide conversion reaches at overdose (23 mg $O_3$/L 2.8 % (experiment A) and 0.8 % (Experiment B)

### 5.2.2 Organic parameters

26 organic analysis results have been transmitted.
23 organic parameters have been analysed, 4 of them corresponds to hydrocarbons measurements and 3 of them corresponds to xylene compounds.

#### 5.2.2.1 Undetected compounds

Among the 23 organic compounds, the following compounds were not detected in the baseline and treated effluents:

-Naphthalene
-Hydrocarbons > n-C10-n-C15
-Hydrocarbons > n-C15-n-C20
-Hydrocarbons > n-C20-n-C35
-1.1.1-trichlorethan
-Tetrachloromethane
-1.2-dichlorethan
-Dichloromethane

Most of the hydrocarbons present in the effluent are n-C6-n-C10 hydrocarbons.

#### 5.2.2.2 Main organic compounds (> 100 ug/L)

The main organic compounds present in the baseline effluent are Vinyl chloride (62%*), Cis-1,2-Dichlorethylen (12%*), Benzene (5 %*) and Total hydrocarbons (2.4%*) (mainly n-C6-n-C10).
*based on organic and Grinsted compounds content.

##### 5.2.2.2.1 Experiment A – Ozone alone

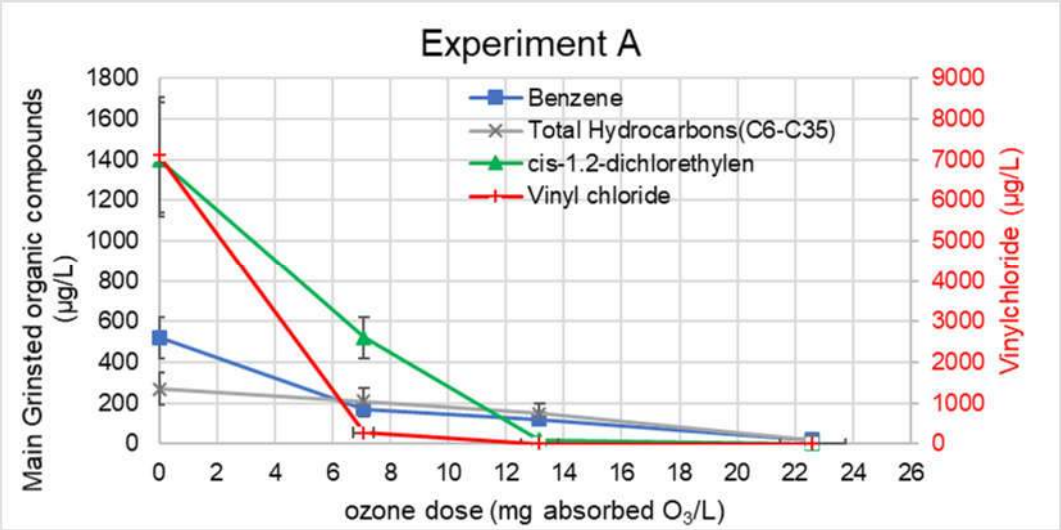



Figure 67: Experiment A - Main organic compounds in Grinsted effluent evolution vs ozone dose

Vinyl chloride and Cis-1.2-dichlorethylen are almost completely oxidized at optimal dose. Their respective removal rates calculated from the baseline results are over 99 %. See Figure 67.
Benzene and total hydrocarbons remain in the effluent after ozonation at optimal dose with concentrations over 100 µg/L. Their removal rates are respectively 77 % and 44 %. See Figure 68.
According to the paragraph 1.2.1.1.1.1 relative to stripping assessment of our AOP plant, approx. 50 % of the Vinyl chloride is stripped during AOP test. The rest of it and the other compounds are removed by oxidation.

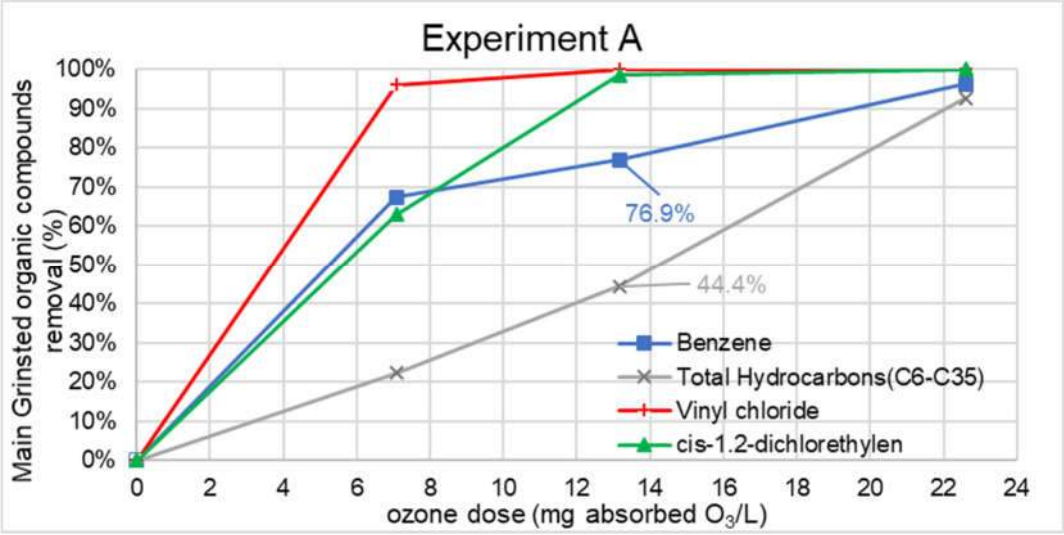



Figure 68: Experiment A - Main organic compounds removal rate vs ozone dose

#### 5.2.2.2.2 Experiment B – Ozone / hydrogen peroxide

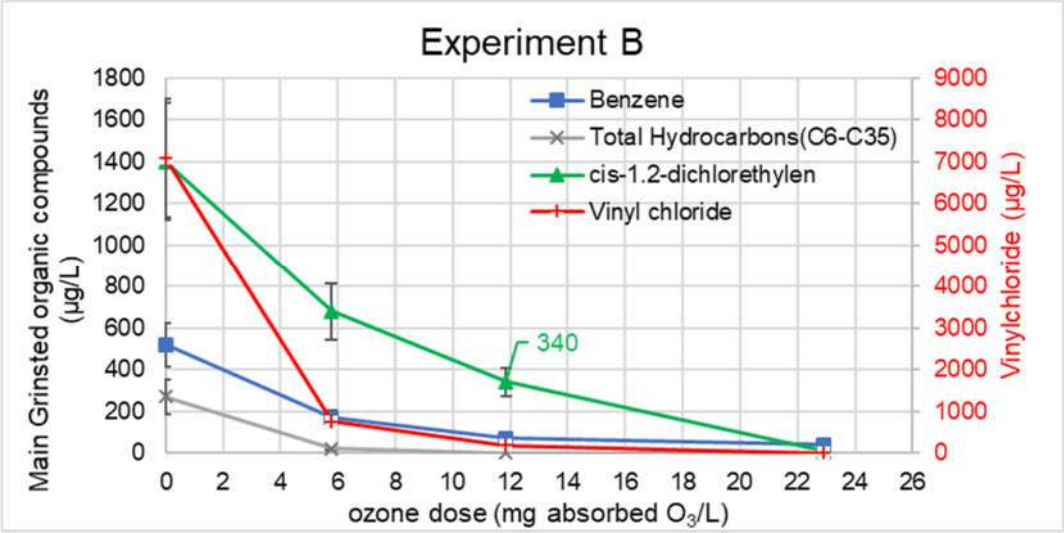



Figure 69: Experiment B - Main organic compounds in Grinsted effluent evolution vs ozone dose

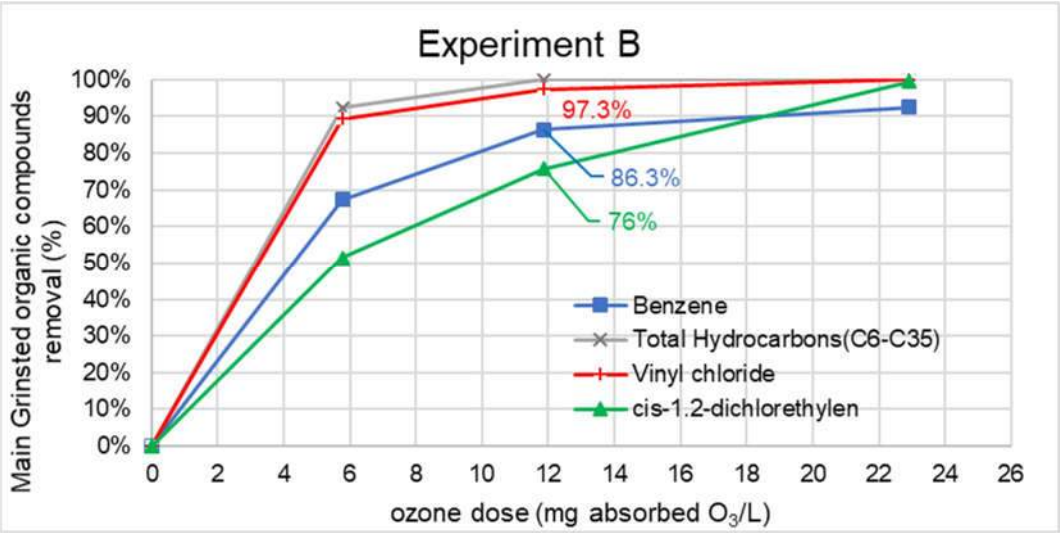



Figure 70: Experiment B - Main Grinsted organic compounds removal rate vs ozone dose

Vinyl chloride and Total hydrocarbons are almost completely oxidized at optimal dose. Their removal rates calculated from the baseline results are over 97 %. See Figure 70.
Benzene removal at optimal dose reaches 86 % and show better performances than with ozone whereas Cis-1.2-dichlorethylen shows only 76 % removal rate.
According to the paragraph 4.2.1.1.2.1 relative to stripping assessment of our AOP plant, approx. 50 % of the Vinyl chloride is stripped during AOP test. The rest of it and the other compounds are removed by oxidation.

#### 5.2.2.2.3 Experiment C – UV / hydrogen Peroxide

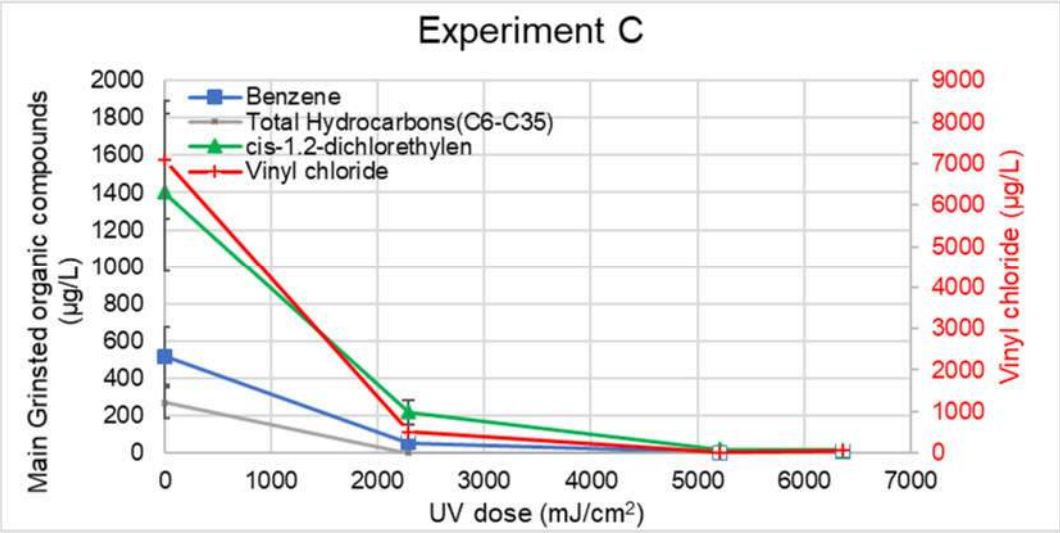



Figure 71: Experiment C - Main organic compounds in Grinsted effluent evolution vs UV dose

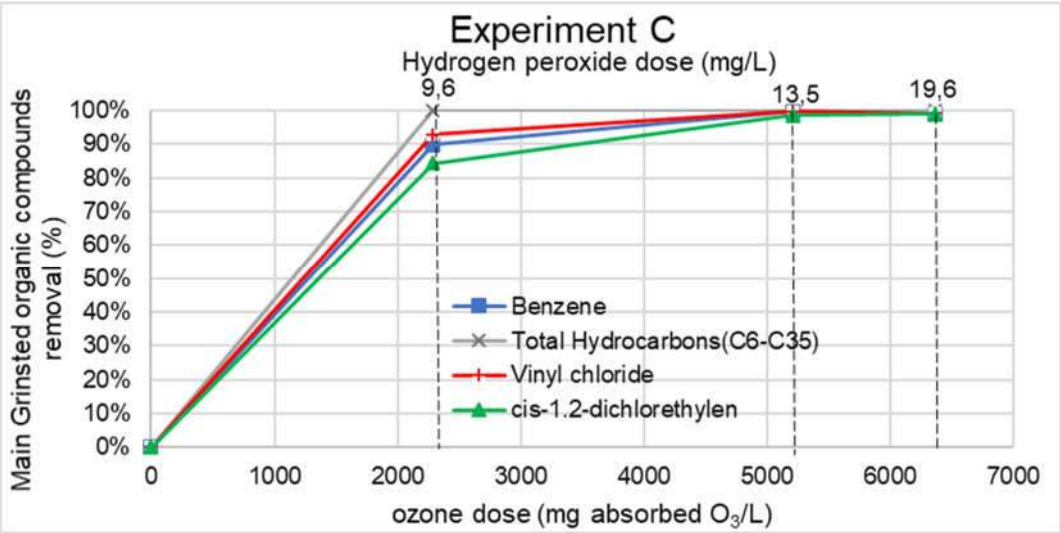



Figure 72: Experiment C - Main organic compounds removal rate vs ozone dose

At optimal dose Total hydrocarbons and cis-1.2-dichlorethylen are removed and undetected. Benzene is less than 10 µg/L and more than 99 % of Vinyl chloride is removed.

#### 5.2.2.3 Secondary organic compounds removal rates (< 100 µg/L)

Detailed removal rates are available annexe 9.2

In general, oxidation performances of UV/$H_2O_2$ > $O_3$/$H_2O_2$ > $O_3$.

More objectively, experiment $O_3$/$H_2O_2$ and UV/$H_2O_2$ treatment, at optimal dose, can achieve removal rates generally around 80% except for chloroform (< 50%).

### 5.2.3 Grinsted package parameters

36 parameters (see in detail paragraph annexe 9.2) were measured in the Grinsted package

#### 5.2.3.1 Undetected parameters

Among the 36 Grinsted package parameters, 9 parameters were not detected, see following list:

- Acetylsulfaguanidin
-Acetylsulfanilsyre
-Phtalylsulfathiazol
-Hexobarbital
-Methoxyproprionitril
-N-methyldiethylbarbitursyre (Metharbital)
-Monoethylbarbitursyre
-Sulfadoxin
-Sulfapyridin

#### 5.2.3.2 Parameters presenting incomprehensible measurements

As mentioned, paragraph 5.1.3.1, because of inconsistency confirmed by ALS, it has been decided to exclude Meprobamate.

#### 5.2.3.3 Main Grinsted compounds (> 100 ug/L)

Among the 26 others detected Grinsted package parameters, 7 compounds presented concentrations over 100 ug/L:

-Butylbarbiturat

-5.5-diallybarbitursyre

-Ethyl urethan

-Isobutylbarbitursyre

-Sulfamethazine

-Sulfacetamide

-Sulfanilylurinstof

Ethyl urethan results after PAC being inconstant were not considered for assessment.

A closer look on them shows that at optimal ozone dose (approx. 13 mg abs. $O_3$/L) and optimal UV/ hydrogen peroxide (5211 mJ/cm2, 13 mg $H_2O_2$/L), the major Grinsted package compounds were removed to non-detected values, except for Ethyl urethan (being ≤ 100 mg/L at optimal dose). See Figure 73, Figure 74, Figure 75.

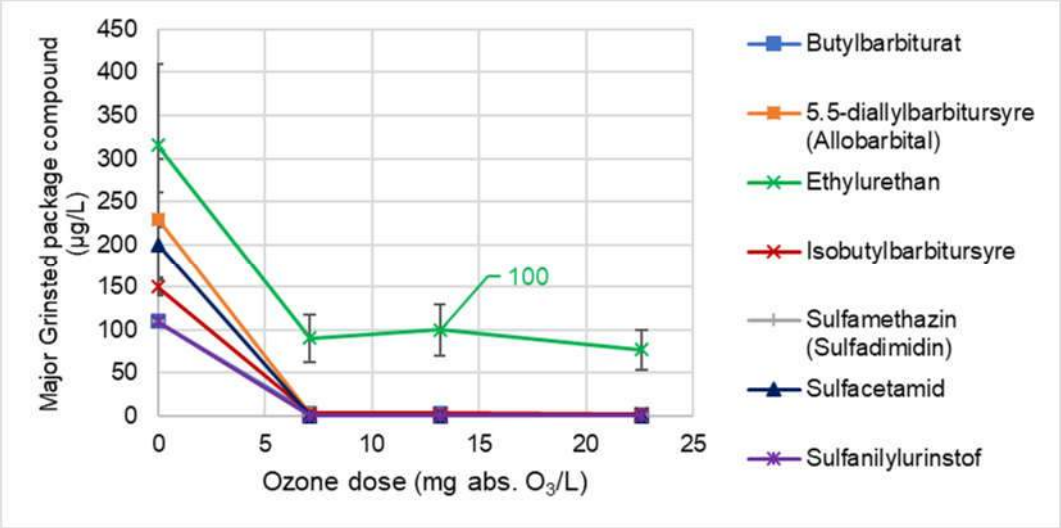



Figure 73: Experiment A - Main Grinsted package parameters (> 100 ug/L) detected in the initial matrix effluent

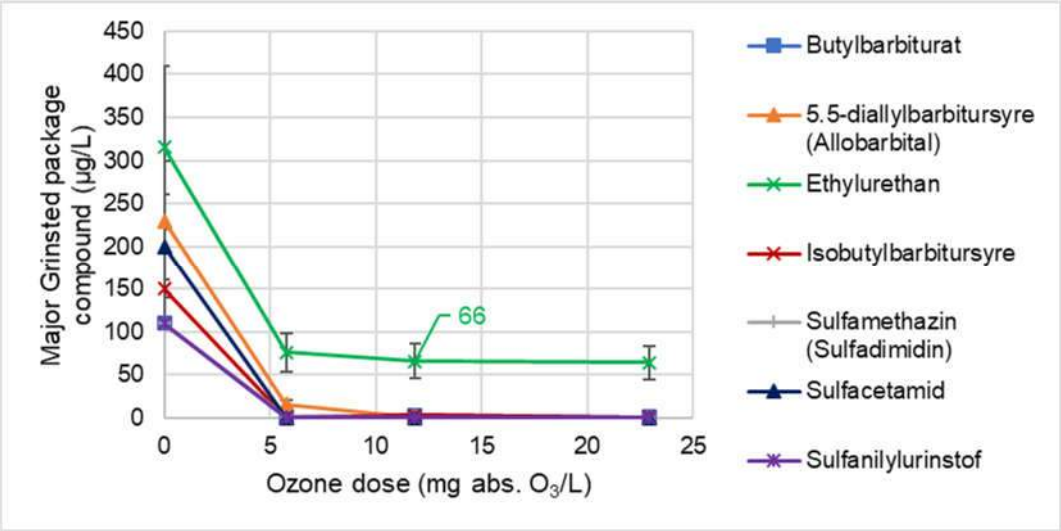



Figure 74: Experiment B - Main Grinsted package parameters (> 100 ug/L) detected in the initial matrix effluent

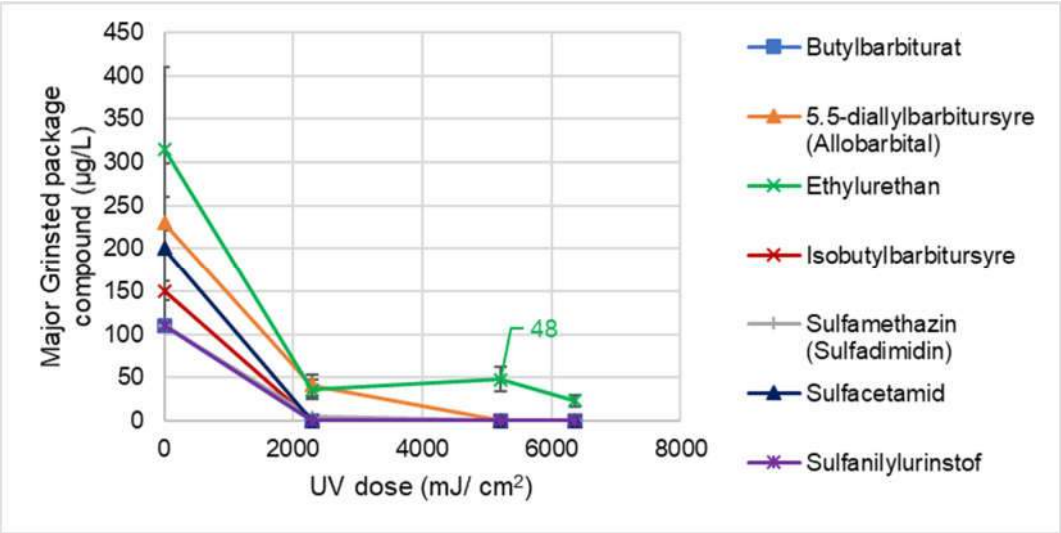



Figure 75: Experiment C - Main Grinsted package parameters (> 100 ug/L) detected in the initial matrix effluent

#### 5.2.3.4 Secondary Grinsted package compounds

The detailed removal rate of secondary compounds is available in annexe 9.2
In general, oxidation performances of UV/$H_2O_2$ > $O_3$/$H_2O_2$ > $O_3$.

More objectively, Barbital is a compound hard to degrade for the 3 experiments. At optimal doses experiment $O_3$ and $O_3$/$H_2O_2$ treatment, less than 10 % is removed by ozone technologies and less than 50 % with $O_3$/$H_2O_2$.

Moreover, $O_3$ and $O_3$/$H_2O_2$ treatment, at optimal dose, can achieve removal rates > 95 %, except for the detected barbital compounds, and ethyl urethan hard to degrade: Barbital, Butobarbital (N-butylethylbarbitursyre), 5-ethyl-5-sec-butylbarbitursyre (Butabarbital), Pentobarbital, Amobarbital.

Table 17: Inlet concentrations of Grinsted package compounds hard to degrade during experiment A, B, C

| Compounds hard to degrade (Experiment A, B, C) | Inlet concentration (baseline) µg/L |
|---|---|
| Barbital | 15 |
| Butobarbital (N-butyl ethyl barbitursyre) | 23 |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | 19 |
| Pentobarbital | 56 |
| Amobarbital | 43 |

## 5.3 PAC treatment effect

Inorganic compounds were not measured by ALS on PAC treated effluents. In this part, only organics compounds and Grinsted package compounds are assessed.
For the reasons exposed in paragraph 5.1.3.2, results and measurements of experiment D (Catalyst + hydrogen peroxide) cannot be directly compared to experiment A, B and C. The results are therefore always exposed in a dedicate part.

### 5.3.1 PAC treatment effect on organic parameters

#### 5.3.1.1 Main organic compounds (> 100 ug/L)

The main organic compounds detected in the baseline effluent remain the same as in paragraph 5.2: Vinyl chloride, Cis-1,2-Dichlorethylene, Benzene and Total hydrocarbons (mainly n-C6-n-C10).

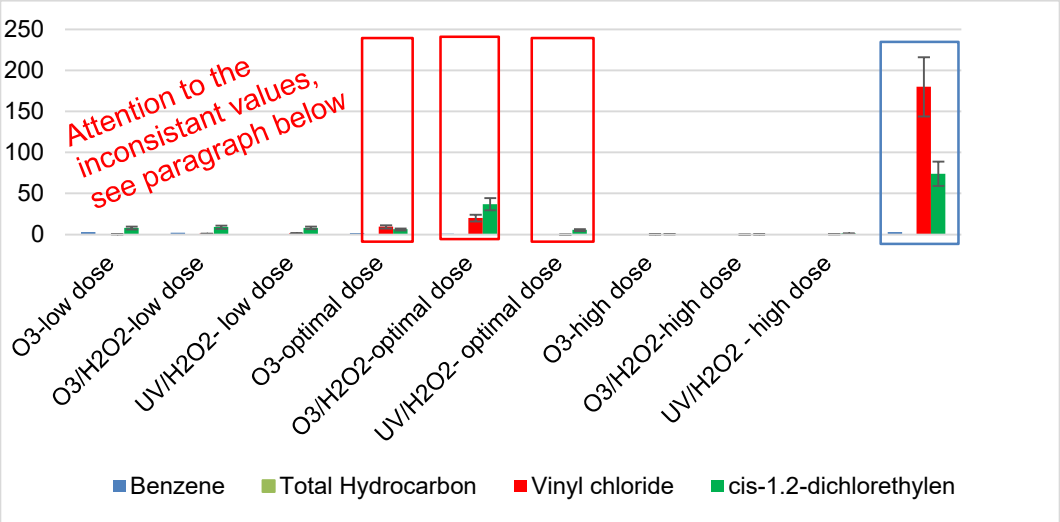



Figure 76: Main organic compounds - Remaining concentrations after ozone and AOP and PAC treatment (Experiments A, B, C)

As expected, PAC treatment alone on raw ground water (see blue frame Figure 76) even at 150 mg PAC/L is not enough to treat this ground water contamination.

Results of effluents treated with optimal oxidant dose are surrounded with red frames.

As mentioned in paragraph 5.1.3.1, for experiment A, B and C, results of Vinyl chloride after AOP treatment at optimal dose and PAC treatment are inconsistent. It seems like the values for low and optimal dose are reversed.

For the same reason, cis-1.2-dichlorethylen after $O_3/H_2O_2$ treatment at optimal dose and PAC treatment should be lower.

Assuming the values are reversed, removal rates should be > 99.9% of Vinyl chloride and > 99 % for Cis-1.2 dichloroethane) at optimal dose. They are still detected at low level in the effluent after ozone or AOP and PAC treatment at optimal dose.

The organic compounds removal rate relative to oxidation and PAC treatment have been calculated for experiments A, B and C repartition in between oxidation and PAC treatment (Experiment A, B, C).

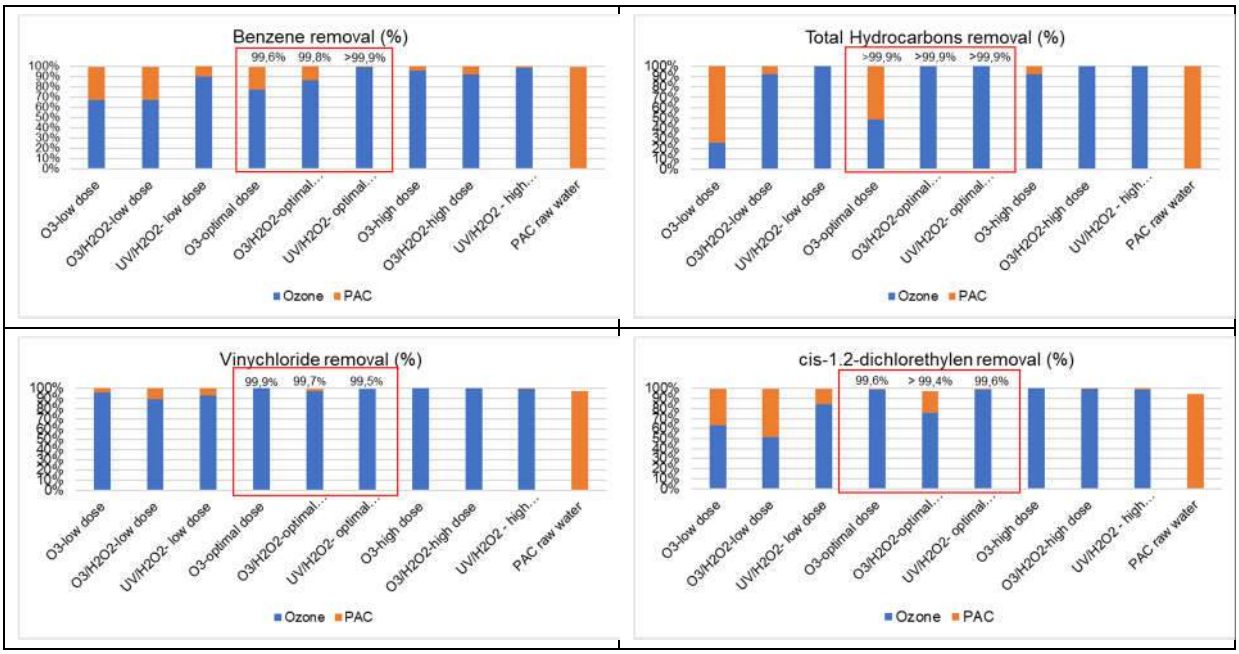



Figure 77: Main organic compounds removal rate repartition in between oxidation and PAC treatment (Experiments A, B, C)

For all doses (under dosed, optimal and over dosed), overall removal rates of main organic compounds after the combination of oxidant and PAC treatment are above 99 %.

The 4 main compounds found in the baseline effluent are not detected in the effluents treated by catalyst and hydrogen peroxide. Unfortunately, no conclusion can be given concerning the performances after PAC treatment for the reason exposed in paragraph 5.1.3.2.

#### 5.3.1.2 Secondary organic compounds removal rate after Ozone or AOP and PAC treatment – Experiment A, B, C

Detailed removal rates are available annexe 9.2

Considering uncertainty of measurements, at optimal dose, removal rates of organic compounds after oxidation and PAC treatment are generally very good, over 99.9 %.

#### 5.3.1.3 Secondary organic compounds removal rate after Ozone or AOP and PAC treatment – Experiment D

The removal rate of organic compounds after PAC treatment cannot be calculated for the reason evocated paragraph 5.1.3.2.

Without considering that the remaining hydrogen peroxide in the effluent during shipping, and 10 days storage might continue the oxidation of the effluent, the measurements after PAC show good results.
At optimal dose (sample F), few organic compounds are still detected, but a low concentration (< 0.22 µg/L): Toluene, o-xylene, Chloroethane, Dichloromethane.

### 5.3.2 PAC treatment effect on Grinsted package parameters

#### 5.3.2.1 Main Grinsted compounds (> 100 ug/L)

The main Grinsted package compounds in the baseline effluent remain the same as it in paragraph 5.2.3.3.
Ethyl urethan results after PAC treatment are inconsistent and therefore not considered in this part.

Beside Ethyl urethan, major compounds are removed to undetected values (low, optimal and high oxidant doses).

The Grinsted package compounds removal rate relative to oxidation and PAC treatment have been calculated for experiments A, B and C repartition in between oxidation and PAC treatment (Experiment A, B, C).

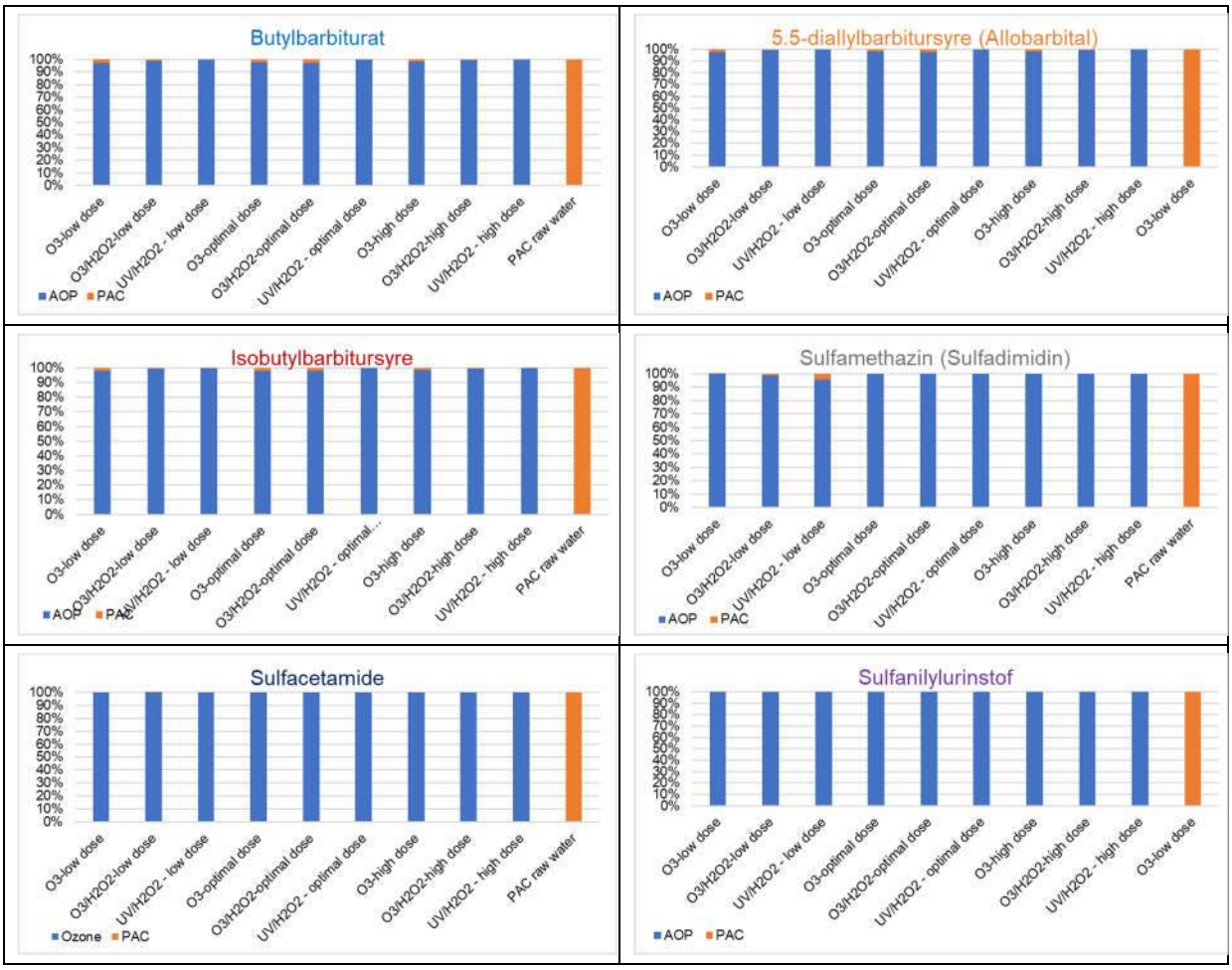



Figure 78: Main Grinsted package compounds removal rate repartition in between oxidation and PAC treatment (Experiments A, B, C)

Again, for all dosages, after PAC treatment the main Grinsted package compounds found in the baseline effluent present removal rate over 99.9 % except for ethyl urethan (inconsistent results). Those compounds are mainly removed during the oxidation stage.

#### 5.3.2.2 Secondary Grinsted package compounds removal rate after Ozone or AOP and PAC treatment

Detailed removal rates are available annexe 9.2
At optimal dose, most of compounds are removed to undetected values.
For experiment A and B, Butobarbital (N-butylethylbarbitursyre), 5-ethyl-5-sec-butylbarbitursyre, Isopropylbarbitursyre, Pentobarbital and Amobarbital (Butabarbital) are not completely removed but present low residual concentration (< 0.8 µg/L) and high removal rates, over 93%.

Only Barbital (present at low concentration, 15 ug/L in the baseline) present removal rate below 50%, whereas it is removed at 95 % in experiment C.
This can be explained by the fact that this compound is mainly removed by adsorption, PAC treatment. But, the dose of PAC applied in experiment C was twice (100 mg/L) than the one applied for experiment A and B (50 mg/L).

### 5.3.3 Overall weighted average removal rate of Organic and Grinsted Package compounds after AOP and PAC treatment

In order to properly evaluate the 3 AOPs performances, all calculable removal rates were weighted by their initial respective concentrations. Nevertheless, as vinyl chloride is presenting approximatively 60% of all weight, it has been decided to calculate the removal rate separately.

Table 18: Overall average removal of Organic and Grinsted Package compounds after AOP and PAC treatment

| Experiment | | AOP Removal rate % | | | |
|---|---|---|---|---|---|
| | | Vinyl chloride | Organic compounds | Grinsted parameters | All parameters |
| After AOP | A - Ozone | 99,98 | 76,5 | 87,1 | 95 |
| | B – Ozone + hydrogen peroxide | 97,32 | 84,1 | 91,6 | 95,1 |
| | C – UV + hydrogen peroxide | 99,75 | 86,8 | 92,6 | 95,7 |
| After AOP + PAC | A - Ozone | 99,87 | 86,7 | 99,18 | 96,8 |
| | B – Ozone + hydrogen peroxide | 99,72 | 86,8 | 99,37 | 96,7 |
| | C – UV + hydrogen peroxide | 99,54 | 86,8 | 99,96 | 96,9 |

1. **Vinyl chloride** was generally highly removed by all AOPs. Ozone has shown the best removal rate certainly due to a higher outgassing effect.
2. **Organic compounds:** UV in combination with hydrogen peroxide reached the best removal rate. That of ozone was significantly lower than the two others, due to a higher selectivity.
3. **Grinsted compounds**, both techniques B & C reached high and close removal rate. Ozone was below for the same reasons than above (2).

## 5.4 AOP and PAC treatment efficiency versus PNEC values in Denmark

### 5.4.1 Generalities and support

PNECs stands for Predicted No Effect Concentration. These values are extracted from the document "Bekendtgørelse om fastlæggelse af miljømål for vandløb, søer, overgangsvande, kystvande og grundvand1), 19 july 2020, p 40-44 & p46-48, *Del B. Miljøkvalitetskrav for forurenende stoffer fastsat for overfladevand, sediment og biota (Part B. Environmental quality requirements for pollutants set for surface water, sediment and biota)*

The extract is available appendix 1.1.

The current assessment is based on paragraphs:

- 1. Nationalt fastsatte miljøkvalitetskrav for vand, paragraph *(1. Nationally established environmental quality requirements for water)*

- 3. EU-fastsatte miljøkvalitetskrav *(EU-established environmental quality requirements)*

The limit values considered are *Generelt kvalitetskrav* [2)] (General quality requirements [2)]) and *Indlands-vand*[4)] *(*inland water[4)])

The following indications have been respected:

[2)] This parameter is the environmental quality requirement expressed as an annual average (general quality requirement). Unless otherwise stated, this applies to the total concentration of all isomers.

[4)] Inland waters include watercourses and lakes and associated artificial or heavily modified water bodies.

Among the 90 analyzed substances (inorganic, organic, and Grinsted package compounds), 24 substances can be assessed with the PNEC limits.

-8 inorganic substances
-15 organic substances
-1 antibiotic (Sulfadiazine) included in the Grinsted package compounds

For some metals, the quality requirement indicated in the PNEC table is:

- The concentration of the substance added to the natural background concentration if (5) is indicated
- The upper concentration of the substance regardless of the natural background concentration. to the maximal if (6) is indicated.

The PNEC assessment was done for the 24 compounds. Detailed assessment per compounds is available in appendix 1.1

### 5.4.2 PAC treatment efficiency regarding PNEC values (Experiment A, B, C)

Inorganic parameters have not been analysed after PAC treatment, therefore only 16 substances can be compared to PNECs.

After AOP treatment (optimal dose) and PAC treatment, 94% of comparable parameters are below PNECs. It represents Vinyl chloride and 1.2-dichlorethylen (Trans + Cis), see Table 19.

Even if Vinyl chloride is removed > 99.9 %, the remaining concentrations (9.4 µg/L to 33 µg/L ± 20 % uncertainty) are higher than the PNECs (0.05 µg/L). Nevertheless, the measured concentrations at optimal doses were above the ones at low doses. Therefore, there is a good chance that real concentrations could be less than 1,4 µg/L (higher value obtained at low dose).

In addition, a relevant design at full scale will increase the treatment performances to meet Vinyl chloride PNEC.

Table 19: List of parameters above PNECs after AOP treatment and PAC treatment

| Sample | parameters * above PNECs |
|---|---|
| PAC raw water | Vinyl chloride and 1.2-dichlorethylen (Trans + Cis) |
| PAC $O_3$-low dose (PAC-A8-SF) | Vinyl chloride and 1.2-dichlorethylen (Trans + Cis) |
| **PAC $O_3$-optimal dose (PAC-A6-SF)** | Vinyl chloride |
| PAC $O_3$-high dose (PAC-A7-SF) | Vinyl chloride |
| PAC $O_3/H_2O_2$-low dose (PAC-B8-SF) | Vinyl chloride and 1.2-dichlorethylen (Trans + Cis) |
| **PAC $O_3/H_2O_2$-optimal dose (PAC-B6-SF)** | Vinyl chloride and 1.2-dichlorethylen (Trans + Cis) (2) |
| PAC $O_3/H_2O_2$-high dose (PAC-B7-SF) | - |
| PAC UV/$H_2O_2$- low dose (PAC-C8-SF) | Vinyl chloride and 1.2-dichlorethylen (Trans + Cis) |
| **PAC UV/$H_2O_2$- optimal dose (PAC-C6-SF)** | Vinyl chloride |
| PAC UV/$H_2O_2$- high dose (PAC-C7-SF) | Vinyl chloride |

(2) PAC-B6 measurement of 1.2-dichlorethylene shows 35 µg/L ± 20 %, higher than PNECs is considered as an outlier value since the measurements in samples oxidized at lower and higher doses are significatively lower (PAC-B7: 0,258 µg/L ± 20 % & PAC-B8: 9,25 µg/L ± 20 %)

### 5.4.3 Experiment D (Oxidation step + PAC treatment) results versus PNEC values

After PAC treatment and with the water quality evocated paragraph 5.1.3.2, all substances measured in sample F(considered as best sample) and in sample B present concentrations below PNECs.
Vinyl chloride is still detected in sample E (0.12 µg/L ± 20 %) and above PNECs.
Nevertheless, SUEZ cannot conclude on the treatment efficiency for the reasons evocated paragraph 5.1.3.2.

## 5.5 Estimative Operational costs from Experiment A, B and C

### 5.5.1 Principles and assumptions

OPEX stands for operational expenditure meaning operating expenses.

Here, the OPEX calculation considers energy and consumable costs. The maintenance of a UV plant or of an ozone plant operating with Pressure swing adsorption (PSA) technologies for oxygen generation are not considered. The calculation is based on the following pricelist (Table 20) used on similar full-scales plant in Denmark:

Table 20: Price list based for OPEX costs calculation

| Item | Unit | price |
|---|---|---|
| Electricity price | €/kWh | 0.15 |
| $H_2O_2$ (33%) price | €/T | 260 |
| Liquid Oxygen (LOX) price | €/kg $O_2$ | 0.4 |

#### 5.5.1.1 Main operational costs for ozone and ozone/hydrogen peroxide plants

The main operating expenses for ozone and ozone/ hydrogen peroxide technologies are:

-Ozone generation (Energy cost)
-Oxygen supplying by Liquid oxygen (LOX -consumable cost) or Oxygen generation by PSA (Energy cost)
-Air compressor & Dryer (Energy cost)
-Ozone destructor (Energy cost).
-Chiller (Energy cost)
-Hydrogen peroxide (consumable cost - only for experiment B)

Ozone is generated from dioxygen (feed gas) or air. The dioxygen can be supplied as Liquid Oxygen or generated onsite with Pressure swing absorption (PSA). PSA is a technology used to separate dioxygen from air under pressure according to the $O_2$ characteristics and affinity for an adsorbent material. LOX is considered as a consumable cost. Oxygen generated by PSA is considered as an energy cost and is generally cheaper than LOX in terms of OPEX.

Ozone destruction considered is the thermal one (>400°C) which generates higher energy costs (approx. + 20 %) than the catalytical ozone destruction.

Energy consumed by piping (pump) and human resource (maintenance) are negligible in ozone plants toward energy costs. Since pH was not adjusted and close to be neutral, no caustic costs are foreseen.

#### 5.5.1.2 Main operational costs for UV/hydrogen peroxide plants

The main operational costs for UV/ hydrogen peroxide technology are:

-UV generation (Energy cost)
-lamp replacement (Consumable cost)
-Hydrogen peroxide (Consumable cost)

Energy consumed by piping (pump) and human resource are negligible.
Here, the lamp replacement has not been considered. The following OPEX estimations for UV/Hydrogen peroxide are therefore rather underestimated.

### 5.5.2 Oxidation step treatment OPEX costs comparison (Experiment A, B, C)

Based on local price assumptions, Operational cost estimations (OPEX) have been calculated for the 3 different treatments (A, B, C) at optimal doses and compared to UV + hydrogen peroxide (highest OPEX):

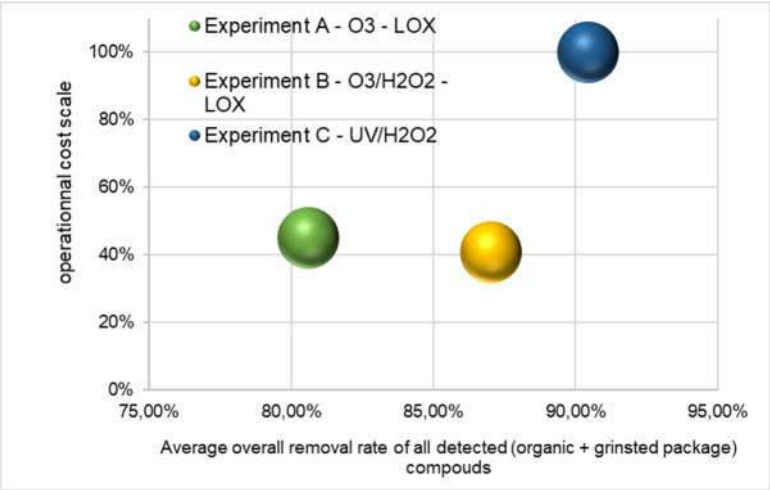



Figure 79: AOP OPEX estimation

*Note: in order not to reduce the OPEX comparison to the case of vinyl chloride, this one is excluded from the calculation*

Ozone + $H_2O_2$ can be considered as the best technical and economical compromise compared to Ozone which does not enables to reach high removal rate for all compounds and UV + $H_2O_2$ which present high OPEX.

# 6 Conclusions

All AOPs (A, B, C) combined with PAC treatment achieved removal rates >90% for more than 90% of the compounds. Weighted average removal rate is close to 97% for each technique.
Only Barbital is still present in concentration up to 10 µg/l for some AOPs. Nevertheless, treatment efficiency can be optimized at full scale (reactor design such as HRT – Hydraulic Retention Time).

As vinylchloride concentration is very high in the raw water and needs to be removed down to < 0,05 µg/l, the required removal rate is > 5 LOG reduction. This parameter has been considered separately. The removal rate achieved was the highest for ozone. Due to the high volatility of this component, outgassing is playing a major role.

Regarding treatment efficiency after PAC, the Catalyst + $H_2O_2$ tests present very high removal rates. Unfortunately, the Catalyst tests cannot be considered in the assessment, because of presence of residual oxidant in the samples.

Within the AOPs assessed, UV + $H_2O_2$ reached most of the best removal rates. Nevertheless, it is a known fact that for UV-AOP to treat contaminated waters having reduced UV transmission and recalcitrant compounds, a high recycling rate is necessary. That requires to bring the contaminants repeatedly to the lamps and therefore having high UV-doses. Consequently, the related OPEX are high.

Ozone + $H_2O_2$ AOP present removal rates very close to UV + $H_2O_2$ but with OPEX less than half. With the determined optimal doses, the bromate formation was kept below 10 ug/L or even not detected. Considering an ozone/peroxide solution it would still give the flexibility to increase the peroxide dose a few percent to mitigate the bromate formation.

Due to a higher selectivity, Ozone was below treatment level of other AOPs above mentioned, except for vinylchloride.

The lab experiment from this study have been conducted with PAC (powdered activated carbon) doses which were chosen due to the conducted screening tests and the assessment of the respective data by our internal Suez expert from CIRSEE. In agreement with COWI, it was decided to use significantly high doses to reach an almost complete removal. In most full-scale applications, the herein applied doses are too high and would certainly be inappropriate in terms of costs.

In order to assess these 3 AOP techniques from cost prospective, OPEX has been estimated at optimal doses. The treatment chain offering the best technical and economic compromise is Ozone + $H_2O_2$ completed by PAC:

1. Technically, this AOP in combination with PAC meet the water quality requirements with a higher removal rate than ozone alone, while avoiding bromate formation;

2. Economically, the solution presents the lowest AOP OPEX.

# 7 Outlook

The combination of an oxidative step followed by activated carbon is an “advanced treatment” which provides efficient treatment capacity. This solution offers two additional benefits: flexibility and independence.
Indeed, since we know the water quality can undergo significant changes in the composition, we are convinced that an ozone solution combined with peroxide is most suitable, giving the possibility to adapt the oxidation potential by adjusting the peroxide concentration. If any excess of peroxide, it would be removed on a subsequent PAC treatment.
In addition, we know from long term experience that ozone systems are very low maintenance costs, especially if feed gas quality meets the standards.

In drinking water production and since decades, combination of ozone followed by activated carbon is known to have strong synergies. In general, there is complementarity within both technologies:

- The Ozone / AOP removes preferably hydrophilic compounds whereas Activated carbon removes hydrophobic ones
- Ozone / AOP breakdown recalcitrant compounds into smaller ones, easier to biodegrade by the biofilm which grows on the AC

This advance treatment is also part of the multi-barrier approach for potable REUSE purpose.

Depending on final water quality objective, several treatment stage could be combined as suggested below:

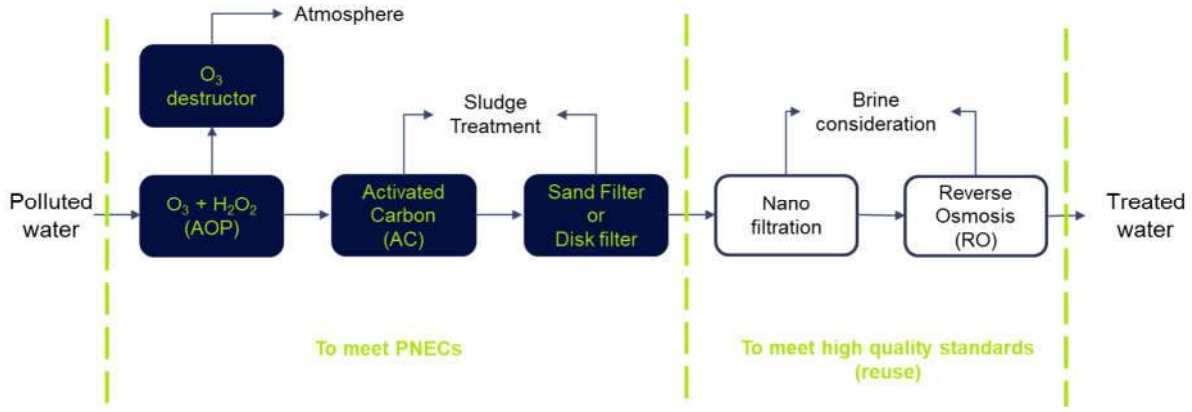



Figure 80: Process solution for Grinsted water – preliminary scheme – depending on treatment objective

To meet higher water quality standards (e.g. reuse), further treatment steps can be implemented.

The global outlet quality of each step would reach the performances below:

Table 21: Perspective - Outlet performances at each treatment step

| Outlet performances | AOP | AC | Filter | Nano | RO |
|---|---|---|---|---|---|
| TSS (% removal) | 0 to 10% | 50 to 90% | 80 to 90% | 100% | 100 % |
| Residual (NTU) | - | < 1 NTU (GAC)<br>< 5 NTU (PAC in reactor) | < 0,5 NTU | < 0,1 NTU | < 0,1 NTU |

All technologies, included in the above suggested treatment line, are mature and could be tested at pilot scale to assess the treatment efficiency in real conditions (considering the water quality variations).

Iron present at a concentration range between 1 and <10 mg/L will not significantly affect the following AOP and PAC stage. Precipitate will be removed within the filtration step.

# 8 Summary

The Region of Southern Denmark has decided to initiate a study of the possibilities of reducing the impact of Grindsted polluted water. The idea is to establish a temporary facility to groundwater pumping for on-site groundwater remediation at the Sewage Treatment Plant West.
COWI as consultant has for the region conducted a screening of relevant purification methods for pumped groundwater, and in this connection, it has been assessed that advanced oxidation processes (AOP) may be suitable for groundwater purification before discharge.
Goal of the present study is the assessment of the feasibility and efficiency of AOP and AC (activated Carbon) combination for the removal of pollutants in groundwater, contaminated by Grinstedvaerket.

Within the study, involving several players, Suez was awarded as sub-contractor 1. Suez Team integrates Degrémont Technologies AG (Ozonia), Cirsee (Suez research center) and Suez Denmark Treatment Infrastructure Team.

As establish within the time-schedule, between March and June 2020 AOP & Carbon laboratory tests were conducted in the AOP and analytical laboratory of Suez-Degrémont Technologies AG in Dübendorf, Switzerland.

### a. Targeted contaminants & raw water quality

Main contaminants to remove are categorized in 2 main families:

1. the so called Grinsted compounds consisting mainly of API's (Active Pharmaceutical ingredients)
2. Organics: hydrocarbons, partly highly volatile, including also chlorinated substances.

The concentration ranges of the pollutants can be quite variable during a sampling period but is in the magnitude of 2 to 15 mg/L for the sum of the Grinsted API's and between 5 and 10 mg/L for the organics. The main hydrocarbon pollutants are Benzene, cis-1,2-dichloroethene and vinylchloride. Pre-assessments during sampling and shipping showed that Vinylchloride concentration decreased significantly due to its high volatility.

In addition, the groundwater contains a quite high bromide concentration of roughly 1.5 mg/l and a significant amount of iron (approx. 5 mg/L). In the study, avoiding Bromate formation was an important issue for ozone based AOP.

### b. Methodology

4 AOP techniques have been tested which were:

- A Ozone
- B Ozone combined with hydrogen peroxide
- C Hydrogen peroxide combined with LPUV
- D Hydrogen peroxide combined with solid catalyst

AOP A, B and C were tested in Ozonia's lab, whereas the tests D were conducted onsite by water IQ. In this report only experiments A, B and C are included in the assessment.

The AOP experiments A, B, C were conducted in 3 phases:

1. **Blind tests** were done to assess the suitability of the test equipment and the formation rates of the hydroxyl radicals. For example, they have shown that only Vinyl chloride is stripped and reduced by approx. 50 % in the AOP lab plant.
2. **Screening tests** were then conducted to define the ranges for test time and oxidant doses to set the appropriate values
3. **creating the final 3 samples** for PAC treatment, having a low dose, a high dose and an optimal dose for each experiment A, B and C.

### c. Blind & screening tests

With the created samples from all AOP test (samples from experiment D were shipped to Ozonia) PAC (Powdered Activated Carbon) tests were conducted:

1. In a first phase, screening tests were done to assess the appropriate PAC dose reaching a high removal rate of the contaminants.
2. Finally, all low, high and optimal dose samples from AOP treatment A, B, C and D were treated with the respective PAC doses (chosen in agreement with COWI) and sent to ALS analytical lab in Denmark for comprehensive analytical assessment.

For the experiment assessment and defining the low, high and optimal dose especially in the screening tests, it turned out that UV254 was the best parameter.
COD was also measured beside DOC. It turned out that COD was only partly useful due to quite high measuring variations. One possible reason could be the decreasing Fe-II concentration over time.
DOC was not a suitable parameter for the assessment due to the fact that with the quite low doses of oxidants, the effect on the DOC was only minor (no important mineralization) and combined with the measurement uncertainty there was no enough significant trend in function of increasing oxidant dose.

After a contact time between 9 min and 24 min, the results have shown very good removal rates for all 3 AOP techniques A, B and C.

Regarding catalyst experiments (Experiment D), no residual pollutant concentration was found after PAC. Nevertheless, residual $H_2O_2$ was measured on the water samples. Unfortunately, these results cannot be taken into account. All excess of oxidant must be quenched before expedition.
**Therefore, comparison between Catalyst and other AOP cannot be done properly**.

### d. Reaction time and doses

AOP optimal Oxidant doses and lab test reaction time defined by Suez are summarized hereunder:

| Experiment | Reaction time (min) | $O_3$ (g/m$^3$) | $H_2O_2$ (g/m$^3$) Introduced | $H_2O_2$ (g/m$^3$) Consumed | UV (mJ.cm$^{-2}$) |
|---|---|---|---|---|---|
| A – Ozone ($O_3$) | 12 | 13.2 | - | - | - |
| B – Ozone + hydrogen peroxide ($O_3$ + $H_2O_2$) | 14 | 11.9 | 2.1 | 0.4 | - |
| C – UV + hydrogen peroxide (UV + $H_2O_2$) | 22 | - | 19.6 | 6.2 | 5 211 |

PAC reaction time define by Suez, PAC doses options defined in agreement with Cowi:

| Experiment | Sample | PAC (g/m$^3$) |
|---|---|---|
| - | Original water (no oxidation prior PAC) | 150 |
| A – Ozone | Optimal (A1) | 50 |
| B – Ozone + hydrogen peroxide | Optimal (B1) | 50 |
| C – UV + hydrogen peroxide | Optimal (C1) | 100 |
| D – Catalyst + hydrogen peroxide | Optimal (D1) – sample F | 100 |

### e. Results consistency

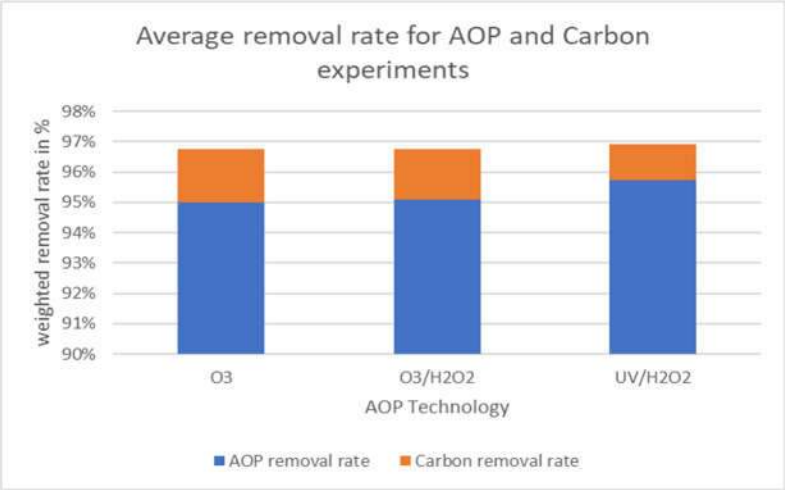
More than 2 300 analytics have been performed by ALS only for experiments A, B, C. Within all the results provided, we noted several inconsistencies which are summarized within 5.1.
All compounds which were measured below DL (Detection Limit) in the baseline are excluded from the removal rate calculations.
In addition:

- Meprobamate was excluded from all removal calculations due to an analytical inconsistency confirmed by ALS
- Ethyl urethan was excluded from carbon removal rate only which was measured at significant higher level after CAP experiments than after AOP experiments.

### f. Removal rate for optimal doses:

In order to properly evaluate the 3 AOPs performances, all calculable removal rates were **weighted by their initial respective concentrations**. Nevertheless, as vinylchloride is presenting approximatively 60% of all weight, it has been decided to calculate the removal rate separately.

As illustrated below, all AOP technologies from A to C, in combination with PAC, have shown global removal rate close to 97%*.




** as an indication, the same removal rate was observed for experiment D*
*Note: As a reminder PAC dose for UV AOP was twice the one for Ozone or Ozone AOP.*

The table below shows the details results for VC (vinyl chloride) and each main family of compounds:

| Experiment | | AOP Removal rate % | | | |
|---|---|---|---|---|---|
| | | Vinyl chloride | Organic compounds | Grinsted parameters | All parameters |
| After AOP | A - Ozone | 99,98 | 76,5 | 87,1 | 95 |
| | B – Ozone + hydrogen peroxide | 97,32 | 84,1 | 91,6 | 95,1 |
| | C – UV + hydrogen peroxide | 99,75 | 86,8 | 92,6 | 95,7 |
| After AOP + PAC | A - Ozone | 99,87 | 86,7 | 99,18 | 96,8 |
| | B – Ozone + hydrogen peroxide | 99,72 | 86,8 | 99,37 | 96,7 |
| | C – UV + hydrogen peroxide | 99,54 | 86,8 | 99,96 | 96,9 |

4. **Vinyl chloride** was generally highly removed by all AOPs. Ozone has shown the best removal rate certainly due to a higher outgassing effect.
5. **Organic compounds:** UV in combination with hydrogen peroxide reached the best removal rate. That of ozone was significantly lower than the two others, due to a higher selectivity.
6. **Grinsted compounds**, both techniques B & C reached high and close removal rate. Ozone was below for the same reasons than above (2).

Except for vinyl chloride, UV in combination with hydrogen peroxide AOP reached the highest removal rates, followed closely by Ozone in combination with hydrogen peroxide AOP.

### g. Residual concentrations after treatment:

For the 90 substances analyzed substances (inorganic, organic, and Grinsted package compounds) only 24 are defined in Danish regulation (BEK nr 1625 af 19/12/2017). Among these 24 substances, only 5 non mineral substances were measured above PNECs in the raw water (baseline):

| | | concentration in µg / l | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | | **Benzene** | **Trichlor-ethylen** | **Tetrachlor-ethylen** | **Vinyl-chloride** | **1.2-dichlor-ethylen (Trans + Cis)** |
| **PNECs** | | **10** | **10** | **10** | **0,05** | **6,8** |
| raw water | | 520 | 22 | 48 | 7 100 | 1 441 |
| AOP optimal doses | $O_3$ | 120 | 3 | 4 | 2 | 20 |
| | $O_3 + H_2O_2$ | 71 | 3 | 4 | 190 | 347 |
| | $UV + H_2O_2$ | 1 | 0 | 0 | 18 | 22 |
| AOP + PAC optimal doses | $O_3$ | 2 | 0 | 0 | *9** | 6 |
| | $O_3 + H_2O_2$ | 1 | 0 | 0 | *20** | *< 9,25*** |
| | $UV + H_2O_2$ | 0 | 0 | 0 | *33** | 6 |

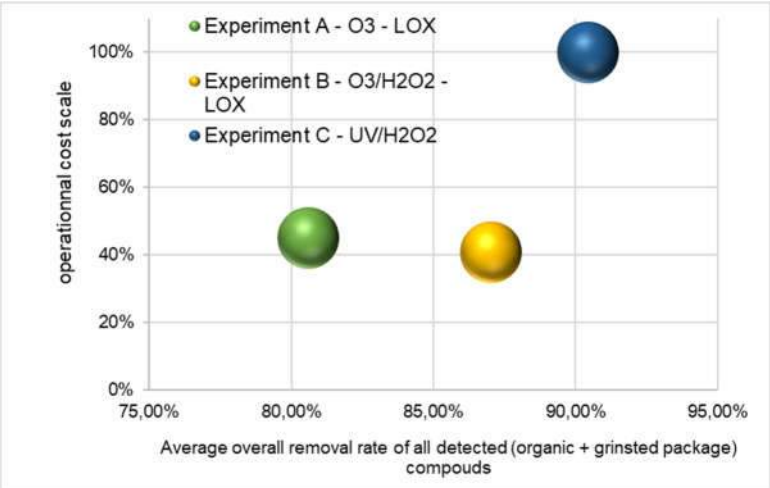
** vinylchloride concentrations are not consistent as they are systematically higher for optimal doses than low doses*
*** 1,2-dichlorethylen after $O_3 + H_2O_2$ AOP is considered as below PNEC*

Combination of AOP and PAC treatment (Experiments A, B; C) can be considered as efficient enough to reach all PNECs except vinylchloride for which design adaptations should be considered at full scale (e.g. higher outgassing).

In addition to this, Barbital is the only compound measured up to 10 µg/l for Ozone AOP after PAC experiments for optimal doses. Other compounds are generally removed below 5 µg/l

### h. Cost estimations

Based on local price assumptions, Operational cost estimations (OPEX) have been calculated for the 3 different treatments (A, B, C) at optimal doses and compared to UV + hydrogen peroxide (highest OPEX):




*Note: vinylchloride is excluded from this calculation because of its high concentration*

Ozone + $H_2O_2$ can be considered as the best technical and economical compromise.

### i. Conclusion

All AOPs (A, B, C) combined with PAC treatment achieved removal rates >90% for more than 90% of the compounds. Weighted average removal rate is close to 97% for each technique.
Only Barbital is still present in concentration up to 10 µg/l for some AOPs. Nevertheless, treatment efficiency can be optimized at full scale (reactor design such as HRT – Hydraulic Retention Time).

As vinylchloride concentration is very high in the raw water and needs to be removed down to < 0,05 µg/l, the required removal rate is > 5 LOG reduction. This parameter has been considered separately. The removal rate achieved was the highest for ozone. Due to the high volatility of this component, outgassing is playing a major role.

Regarding treatment efficiency after PAC, the Catalyst + $H_2O_2$ tests present very high removal rates. Unfortunately, the Catalyst tests cannot be considered in the assessment, because of presence of residual oxidant in the samples.

Within the AOPs assessed, UV + $H_2O_2$ reached most of the best removal rates. Nevertheless, it is a known fact that for UV-AOP to treat contaminated waters having reduced UV transmission and recalcitrant compounds, a high recycling rate is necessary. That requires to bring the contaminants repeatedly to the lamps and therefore having high UV-doses. Consequently, the related OPEX are high.

Ozone + $H_2O_2$ AOP present removal rates very close to UV + $H_2O_2$ but with OPEX less than half. With the determined optimal doses, the bromate formation was kept below 10 ug/L or even not detected. Considering an ozone/peroxide solution it would still give the flexibility to increase the peroxide dose a few percent to mitigate the bromate formation.

Due to a higher selectivity, Ozone was below treatment level of other AOPs above mentioned, except for vinylchloride.

In order to assess these 3 AOP techniques from cost prospective, OPEX has been estimated at optimal doses. The treatment chain offering the best technical and economic compromise is Ozone + $H_2O_2$ completed by PAC:

3. Technically, this AOP in combination with PAC meet the water quality requirements with a higher removal rate than ozone alone, while avoiding bromate formation;

4. Economically, the solution presents the lowest AOP OPEX.

**Outlook**:

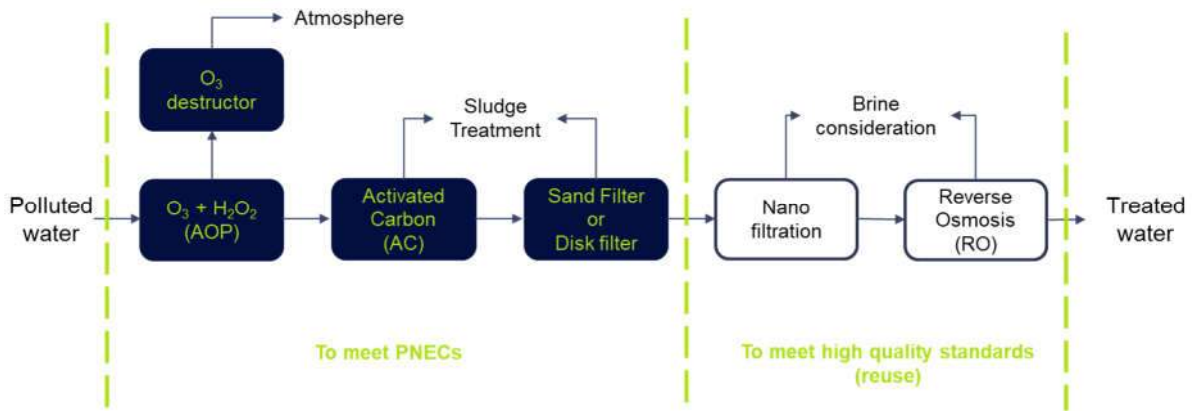
The combination of an oxidative step followed by activated carbon is an “advanced treatment” which provides efficient treatment. This solution offers two additional benefits: flexibility and independence.
Indeed, since we know the water quality can undergo significant changes in the composition, we are convinced that an ozone solution combined with peroxide is most suitable, giving the possibility to adapt the oxidation potential by adjusting the peroxide concentration. If any excess of peroxide, it would be removed in a subsequent PAC treatment step.
In addition, we know from long term experience that ozone systems are very low maintenance costs, especially if feed gas quality meets the standards.

In drinking water production and since decades, combination of ozone followed by activated carbon is known to have strong synergies. In general, there is complementarity within both technologies:

- The Ozone / AOP removes preferably hydrophilic compounds whereas Activated carbon removes hydrophobic ones
- Ozone / AOP breakdown recalcitrant compounds into smaller ones, easier to biodegrade by the biofilm which grows on the AC

This advance treatment is also part of the multi-barrier approach for potable REUSE purpose.

Depending on final water quality objective, several treatment stages could be combined as suggested below:




To meet higher water quality standards (e.g. reuse), further treatment steps can be implemented.

Iron concentrations between 1 and <10 mg/L will not significantly affect the following AOP and PAC stage. Precipitate will be removed within the filtration step.

The global outlet quality of each step would reach the performances below:

| Outlet performances | AOP | AC | Filter | Nano | RO |
|---|---|---|---|---|---|
| TSS (% removal) | 0 to 10% | 50 to 90% | 80 to 90% | 100% | 100 % |
| NTU | - | < 1 NTU (GAC)<br>< 5 NTU (PAC in reactor) | < 0,5 NTU | < 0,1 NTU | < 0,1 NTU |

All technologies, included in the above suggested treatment line, are mature and could be tested at pilot scale to assess the treatment efficiency in real conditions (considering the water quality variations).
To meet PNECs requirements, an optimized design including Ozone + H2O2, activated carbon and filtration stage is a good compromise.
For any further treatment objective, to meet high water quality standards such as REUSE, Suez can support providing the relevant additional treatment solutions required.

# 9 Appendix

## 9.1 Project and laboratory testing planning

Figure 81: Planning the testing period and reporting realized

| MONTH | FEBRUARY 2020 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| TASKS | WEEK 6 | | | | | | | WEEK 7 | | | | | | | WEEK 8 | | | | | | | WEEK 09 | | | | | | | MARCH 2020 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | WEEK 10 | | | | | | | | WEEK 11 | | | | | | | | WEEK 12 | | | | |
| Project Management | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contracting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preparations | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Skype-meeting, 1) kick-off, 2) status-meeting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| Collection/pick-up of water on site (Suez) (Delivery 1) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | |
| Sampling, raw water to DHI and testing lab (Delivery 1) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AOP tests, Water IQ (on-site, Sub-sgreement 2) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-treatment (SUEZ), if necessary | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AOP treated water from water IQ to SUEZ for GAC testing, ALS and DHI (Delivery 2) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **AOP tests, Suez (in lab) (Sub-agreement 1)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment of water from Water IQ** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment, own AOP tests** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Shipping of SUEZ tested water to ALS ( 2,3,4) and DHI (3, 4) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Eoctoxicological tests, DHI (sub-agreement 3) (water delivery 1, 2, 3, 4, 5, 6, 7 ,8 9) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 |
| Analysis, testing lab, Denmark | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| MONTH | MARCH 2020 | | | | | | | | | APRIL 2020 | | | | | | | | | | | | | | | | | | | | | | | |
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| **TASKS** | **WEEK 13** | | | | | | | **WEEK 14** | | | | | | | **WEEK 15** | | | | | | | **WEEK 16** | | | | | | | **WEEK 17** | | | | |
| | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** |
| Project Management | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contracting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preparations | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Skype-meeting, 1)kick-off, 2) status-meeting | | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | 2 | |
| Collection/pick-up of water on site (Suez) (Delivery 1) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sampling, raw water to DHI and testing lab (Delivery 1) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AOP tests, Water IQ (on-site, Sub-sgreement 2) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-treatment (SUEZ), if necessary | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AOP treated water from water IQ to SUEZ for GAC testing, ALS and DHI (Delivery 2) | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **AOP tests, Suez (in lab) (Sub-agreement 1)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment of water from Water IQ** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment, own AOP tests** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Shipping of SUEZ tested water to ALS ( 2,3,4) and DHI (3, 4) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | |
| Eoctoxicological tests, DHI (sub-agreement 3) (water delivery 1, 2, 3, 4, 5, 6, 7 ,8 9) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Analysis, testing lab, Denmark | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| MONTH | MARCH 2020 | | | | MAY 2020 | | | | | | | | | | | | | | | | | | | | | |
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| **TASKS** | **WEEK 18** | | | | | | | **WEEK 19** | | | | | | | **WEEK 20** | | | | | | | **WEEK 21** | | | | |
| | **27** | **28** | **29** | **30** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** |
| Project Management | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contracting | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preparations | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Skype-meeting, 1) kick-off, 2) status-meeting | | | | | | | | | | | | | | | | | 2 | | | | | | | | | |
| Collection/pick-up of water on site (Suez) (Delivery 1) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sampling, raw water to DHI and testing lab (Delivery 1) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AOP tests, Water IQ (on-site, Sub-sgreement 2) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-treatment (SUEZ), if necessary | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AOP treated water from water IQ to SUEZ for GAC testing, ALS and DHI (Delivery 2) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **AOP tests, Suez (in lab) (Sub-agreement 1)** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment of water from Water IQ** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment, own AOP tests** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Shipping of SUEZ tested water to ALS (2,3,4) and DHI (3, 4) | 3 | | | | | | | | | | | | | | | 4 | | | | | | | 4 | | | |
| Eoctoxicological tests, DHI (sub-agreement 3) (water delivery 1, 2, 3, 4, 5, 6, 7 ,8 9) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Analysis, testing lab, Denmark | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | | | | | | | | | | | | | |

| MONTH | MAY 2020 | | | | | | | JUNE 2020 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TASKS** | **WEEK 22** | | | | | | | **WEEK 23** | | | | | | | **WEEK 23** | | | | |
| | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| Project Management | | | | | | | | | | | | | | | | | | | |
| Contracting | | | | | | | | | | | | | | | | | | | |
| Preparations | | | | | | | | | | | | | | | | | | | |
| Skype-meeting, 1) kick-off, 2) status-meeting | | | | | | | | | | 2 | | | | | | | | | |
| Collection/pick-up of water on site (Suez) (Delivery 1) | | | | | | | | | | | | | | | | | | | |
| Sampling, raw water to DHI and testing lab (Delivery 1) | | | | | | | | | | | | | | | | | | | |
| AOP tests, Water IQ (on-site, Sub-sgreement 2) | | | | | | | | | | | | | | | | | | | |
| Pre-treatment (SUEZ), if necessary | | | | | | | | | | | | | | | | | | | |
| AOP treated water from water IQ to SUEZ for GAC testing, ALS and DHI (Delivery 2) | | | | | | | | | | | | | | | | | | | |
| **AOP tests, Suez (in lab) (Sub-agreement 1)** | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment of water from Water IQ** | | | | | | | | | | | | | | | | | | | |
| **Suez post-treatment, own AOP tests** | | | | | | | | | | | | | | | | | | | |
| Shipping of SUEZ tested water to ALS (2,3,4) and DHI (3, 4) | | | | | | | | | | | | | | | | | | | |
| Eoctoxicological tests, DHI (sub-agreement 3) (water delivery 1, 2, 3, 4, 5, 6, 7 ,8 9) | | | | | | | | | | | | | | | | | | | |
| Analysis, testing lab, Denmark | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | | | | | | |

COWI
Suez
Water IQ
DHI
Testing lab (Eurofins or ALS)
All

## 9.2 Removal rate – Main and secondary compounds

The removal rate of all organic compounds are presented Table 22 and the removal rate Grinsted compounds are presented Table 23.The removal rate calculation is based on the analysis results of the baseline effluent.

For an easier reading, tables follow a colour code:

| Colour code | Removal rate limits |
|---|---|
| | < 90 % removal |
| | 90 % - 99.9 % removal |
| | > 99 % removal |
| Orange value | Inconsistent value |

n.d: non detected compounds
n.a: not applicable - removal rate non calculable

Table 22: Main and Secondary Organic compounds – removal rate by Ozone and AOP (experiments A, B, C)

| | | Benzene | Toluene | Ethylbenzene | m/p-xylene | o-xylene | Xylene (o-,m- og p-xylene) | Xylene (o-,m- p-xylene og ethylbenzene) | Naphthalene | Hydrocarbons n-C6 - n-C10 | Hydrocarbons >n-C10 - n-C15 | Hydrocarbons >n-C15 - n-C20 | Hydrocarbons >n-C20 - n-C35 | Total Hydrocarbons(C6-C35) | Trichloro methane (Chloroform) | 1.1.1-trichlorethan | Tetrachloromethane | Trichlorethylene | Tetrachloroethylene | Chloroethane | Vinyl chloride | 1.1-dichlorethylen | trans-1.2-dichloroethylene | cis-1.2-dichlorethylen | 1.2-dichlorethan | 1.1-dichlorethan | Dichloromethane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TA8-SF | $O_3$-low dose | 67.3% | 84.2% | 89.1% | 94.5% | 85.8% | 90.0% | 89.7% | n.d | 25.9% | n.d | n.d | n.d | 22.2% | 50.0% | n.d | n.d | 82.3% | 91.0% | 68.6% | 96.1% | 87.5% | 87.6% | 62.9% | n.a | 51.9% | n.a |
| **TA6-SF** | **$O_3$-optimal dose** | 76.9% | 88.8% | 92.7% | 98.1% | 92.9% | 95.2% | 94.8% | n.d | 48.1% | n.d | n.d | n.d | 44.4% | 50.0% | n.d | n.d | 87.3% | 91.5% | 65.7% | > 99.9% | > 99.9% | 99.7% | 98.6% | n.a | 44.4% | n.a |
| TA7-SF | $O_3$-high dose | 96.2% | 99.1% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | 92.6% | n.d | n.d | n.d | 92.6% | 46.7% | n.d | n.d | 98.5% | 95.2% | 71.4% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.a | 48.1% | n.a |
| TB8-SF | $O_3/H_2O_2$-low dose | 67.3% | 83.2% | 88.0% | 94.8% | 86.7% | 90.4% | 90.0% | n.d | 92.2% | n.d | n.d | n.d | 92.2% | 30.0% | n.d | n.d | 74.5% | 87.7% | 57.1% | 89.3% | 90.5% | 56.1% | 51.4% | n.a | 33.3% | n.a |
| **TB6-SF** | **$O_3/H_2O_2$-optimal dose** | 86.3% | 93.8% | 95.9% | > 99.9% | 94.2% | 97.0% | 96.7% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | 23.3% | n.d | n.d | 86.4% | 91.3% | 60.0% | 97.3% | 95.6% | 82.7% | 75.7% | n.a | 29.6% | n.a |
| TB7-SF | $O_3/H_2O_2$-high dose | 92.5% | 97.0% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | 30.0% | n.d | n.d | 92.7% | 92.9% | 62.9% | > 99.9% | > 99.9% | 99.8% | 99.4% | n.a | 37.0% | n.a |
| TC8-SF | UV/$H_2O_2$- low dose | 89.8% | 98.3% | 96.4% | 98.1% | 94.5% | 96.2% | 96.2% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | 26.7% | n.d | n.d | 85.5% | 95.2% | 51.4% | 92.8% | 92.5% | 9.8% | 84.3% | n.a | 25.9% | n.a |
| **TC6-SF** | **UV/$H_2O_2$- optimal dose** | 99.8% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | 53.3% | n.d | n.d | 98.6% | 99.4% | 75.4% | 99.7% | > 99.9% | 93.9% | 98.6% | n.a | 63.0% | n.a |
| TC7-SF | UV/$H_2O_2$ - high dose | 99.0% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | 40.0% | n.d | n.d | 99.4% | 99.8% | 80.0% | 99.2% | > 99.9% | 97.8% | 98.9% | n.a | 48.1% | n.a |
| PAC raw water | PAC raw water | 99.4% | > 99.9% | > 99.9% | > 99.9% | 97.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | 91.3% | n.d | n.d | 99.7% | > 99.9% | 96.9% | 97.5% | 98.1% | 97.3% | 94.7% | n.a | > 99.9% | n.a |
| PAC-A8-SF | $O_3$-low dose + PAC | 99.4% | > 99.9% | > 99.9% | > 99.9% | 98.3% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | > 99.9% | n.d | n.d | 99.6% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.7% | 99.4% | n.a | > 99.9% | n.a |
| **PAC-A6-SF** | **$O_3$-optimal dose + PAC** | 99.6% | 99.1% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | n.a | n.d | n.d | 99.8% | > 99.9% | n.a | 99.9% | > 99.9% | 99.7% | 99.6% | n.a | 91.5% | n.a |
| PAC-A7-SF | $O_3$-high dose + PAC | > 99.9% | > 99.9% | > 99.9% | 97.0% | 97.3% | 97.1% | 97.7% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | > 99.9% | n.d | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.9% | > 99.9% | n.a | > 99.9% | n.a |
| PAC-B8-SF | $O_3/H_2O_2$-low dose + PAC | 99.6% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | > 99.9% | n.d | n.d | 99.7% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.4% | 99.4% | n.a | > 99.9% | n.a |
| **PAC-B6-SF** | **$O_3/H_2O_2$-optimal dose + PAC** | 99.8% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | n.a | n.d | n.d | 99.8% | > 99.9% | n.a | 99.7% | > 99.9% | 98.9% | 97.4% | n.a | 90.7% | n.a |
| PAC-B7-SF | $O_3/H_2O_2$-high dose + PAC | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | > 99.9% | n.d | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.9% | > 99.9% | n.a | > 99.9% | n.a |
| PAC-C8-SF | UV/$H_2O_2$- low dose + PAC | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | > 99.9% | n.d | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 98.9% | 99.4% | n.a | > 99.9% | n.a |
| **PAC-C6-SF** | **UV/$H_2O_2$- optimal dose + PAC** | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | > 99.9% | n.d | n.d | > 99.9% | > 99.9% | n.a | 99.5% | > 99.9% | 99.4% | 99.6% | n.a | > 99.9% | n.a |
| PAC-C7-SF | UV/$H_2O_2$- high dose | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | > 99.9% | n.d | n.d | n.d | > 99.9% | > 99.9% | n.d | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.9% | > 99.9% | n.a | > 99.9% | n.a |

Table 23: Main and Secondary Grinsted compounds – removal rate by Ozone and AOP (experiments A, B, C)

| | | Acetylsulfaguanidin | Aetallymal | Allyl-n-butylbarbityrat | 5-allyl-5-isobutyl-barbitursyre (Butalbital) | 5-allyl-5-(methyl butyl)-barbitursyre | Barbital | Butobarbital (N-butylethylbarbitursyre) | Butylbarbiturat | 5,5-diallylbarbitursyre (Allobarbital) | N,N-diethylnicotinamid | Dipropenylamin | 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | Ethyl urethan | Isobutylbarbitursyre | Isopropylbarbitursyre | Meprobamate | Pentobarbital | Amobarbital | Sulphaniamide | Sulphaguanidine | Sulfamethazine (Sulfadimidine) | Sulfamethiazol | Sulfadiazine | Sulfanisyre | Sulfacetamide | Sulfamerazin | Sulfanilylurinstof | Sulfathiazol | Acetylsulfanilsyre | Phtalylsulfathiazol | Hexobarbital | Methoxypropionitril | N-methylidiethylbarbitursyre (Metharbital) | Monoethylbarbitursyre | Sulfadoxin | Sulfapyridin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TA8-SF | $O_3$-low dose | n.d | > 99.9% | > 99.9% | 97.8% | 98.1% | n.a | 30.4% | 97.4% | 98.8% | 82.1% | > 99.9% | 21.1% | 71.4% | 98.0% | 97.4% | n.a | 42.9% | n.a | 99.5% | > 99.9% | 99.8% | 99.8% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| **TA6-SF** | **$O_3$-optimal dose** | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.a | 34.8% | 97.8% | > 99.9% | 83.3% | > 99.9% | 15.8% | 68.3% | 98.0% | 98.5% | n.a | 33.9% | 41.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| TA7-SF | $O_3$-high dose | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 6.7% | 73.0% | 98.3% | > 99.9% | 88.6% | > 99.9% | 49.5% | 75.6% | 98.3% | 97.8% | n.a | 64.3% | 72.1% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| TB8-SF | $O_3/H_2O_2$-low dose | n.d | 86.8% | > 99.9% | 93.8% | 90.8% | 0.0% | 47.8% | 98.9% | 93.0% | 84.5% | > 99.9% | 26.3% | 75.9% | 99.3% | 99.2% | n.a | 44.6% | 2.3% | 97.7% | > 99.9% | 98.6% | 98.0% | > 99.9% | > 99.9% | 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| **TB6-SF** | **$O_3/H_2O_2$-optimal dose** | n.d | > 99.9% | > 99.9% | 98.2% | 99.2% | 6.7% | 71.7% | 97.2% | 99.7% | 88.7% | > 99.9% | 50.0% | 79.0% | 97.9% | 97.4% | n.a | 60.7% | 72.1% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| TB7-SF | $O_3/H_2O_2$-high dose | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 13.3% | 76.1% | 99.5% | > 99.9% | 88.9% | > 99.9% | 53.2% | 79.7% | 99.6% | 99.4% | n.a | 66.1% | 72.1% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| TC8-SF | UV/$H_2O_2$- low dose | n.d | 52.0% | 84.2% | 60.9% | 80.8% | n.a | 73.9% | > 99.9% | 82.2% | 85.7% | > 99.9% | 42.1% | 88.6% | > 99.9% | 99.5% | n.a | 86.6% | 72.1% | > 99.9% | > 99.9% | 95.8% | 99.4% | > 99.9% | > 99.9% | > 99.9% | 97.8% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| **TC6-SF** | **UV/$H_2O_2$- optimal dose** | n.d | > 99.9% | 92.6% | 96.5% | > 99.9% | 46.0% | 97.1% | > 99.9% | 99.8% | 94.8% | > 99.9% | 85.8% | 84.8% | > 99.9% | 99.8% | n.a | 98.0% | 95.6% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| TC7-SF | UV/$H_2O_2$ - high dose | n.d | > 99.9% | > 99.9% | 97.6% | > 99.9% | 89.3% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.2% | 92.7% | > 99.9% | > 99.9% | n.a | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| PAC raw water | PAC raw water | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 88.0% | 99.1% | > 99.9% | 97.7% | > 99.9% | > 99.9% | 99.4% | 36.5% | > 99.9% | 99.5% | n.a | 99.8% | 99.7% | 99.1% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| PAC-A8-SF | $O_3$-low dose + PAC | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 0.0% | 87.8% | > 99.9% | 99.7% | > 99.9% | > 99.9% | 93.7% | n.a | > 99.9% | 99.6% | n.a | 97.0% | 96.3% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| **PAC-A6-SF** | **$O_3$-optimal dose + PAC** | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 33.3% | 93.5% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 95.8% | n.a | > 99.9% | 99.8% | n.a | 98.6% | 98.8% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| PAC-A7-SF | $O_3$-high dose + PAC | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 44.0% | 94.8% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 96.6% | n.a | > 99.9% | 99.7% | n.a | 98.5% | 98.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| PAC-B8-SF | $O_3/H_2O_2$-low dose + PAC | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 0.0% | 89.1% | > 99.9% | 98.2% | > 99.9% | > 99.9% | 94.2% | n.a | > 99.9% | > 99.9% | n.a | 97.1% | 97.4% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| **PAC-B6-SF** | **$O_3/H_2O_2$-optimal dose + PAC** | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 46.7% | 96.7% | > 99.9% | 99.9% | > 99.9% | > 99.9% | 97.6% | n.a | > 99.9% | 99.6% | n.a | 99.2% | 99.0% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| PAC-B7-SF | $O_3/H_2O_2$-high dose + PAC | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 48.7% | 97.6% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 98.1% | n.a | > 99.9% | > 99.9% | n.a | 99.4% | 99.4% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| PAC-C8-SF | UV/$H_2O_2$- low dose + PAC | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 71.3% | > 99.9% | > 99.9% | 99.8% | > 99.9% | > 99.9% | > 99.9% | n.a | > 99.9% | 99.8% | n.a | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| **PAC-C6-SF** | **UV/$H_2O_2$- optimal dose + PAC** | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 95.1% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.a | > 99.9% | > 99.9% | n.a | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |
| PAC-C7-SF | UV/$H_2O_2$- high dose | n.d | > 99.9% | > 99.9% | > 99.9% | > 99.9% | 99.2% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.a | > 99.9% | > 99.9% | n.a | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | > 99.9% | n.d | n.d | n.d | n.d | n.d | n.d | n.d | n.d |

## 9.3 PNEC assessment

### 9.3.1 Screen shoot of the support document for NPECs.

Substances which are mentioned by law and measured in the study are underlined in yellow

**Del B. Miljøkvalitetskrav for forurenende stoffer fastsat for overfladevand, sediment og biota**

**1. Nationalt fastsatte miljøkvalitetskrav for vand**

Tabel 3. Miljøkvalitetskrav for vand. Miljøkvalitetskravene refererer til totalt stofindhold, medmindre andet er anført for det enkelte stof.

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| CAS nummer[1)] | Stoffets navn | Generelt kvalitetskrav µg/l[2)] | | Maksimumkoncentration µg/l[3)] | |
| | | Indlandsvand[4)] | Andet overfladevand | Indlandsvand[4)] | Andet overfladevand |
| 75-05-8 | acetonitril | 2000 | 200 | 191000 | 19000 |
| 83-32-9 | acenaphten (PAH) | 3,8 | 0,38 | 3,8 | 3,8 |
| 208-96-8 | acenaphthylen (PAH) | 1,3 | 0,13 | 3,6 | 3,6 |
| 107-02-8 | acrolein (acrylaldehyd) | 0,1 | 0,01 | 1 | 1 |
| 393085-45-5 | 2-amino-4-(methylsulphonyl)benzosyre, AMBA | 77 | 7,7 | 140 | 14 |
| 41668-11-5 | 6-amino-5-chlornicotinsyre, clampyrsyre | 95 | 9,5 | 949 | 95 |
| 26787-78-0 | amoxcillin | 0,078 | 0,078 | 0,37 | 0,37 |
| 118-92-3 | anthranilsyre | 19,4 | 1,94 | 194 | 194 |
| 7440-36-0 | antimon | 113 | 11,3 | 177 | 177 |
| 7440-38-2 | arsen | 4,3 | 0,6[5)] | 43 | 1,1[5)] |

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| | | | | | |
|---|---|---|---|---|---|
| 7440-39-3 | barium | 19 [5] | 5,8 [5] | 145 | 145 |
| 25057-89-0 | bentazon | 45 | 45 | 450 | 450 |
| 56-55-3 | benz(a)anthracen (PAH) | 0,012 | 0,0012 | 0,018 | 0,018 |
| 94-09-7 | benzocain | 7,2 | 0,72 | 72 | 72 |
| 65-85-0 | benzoesyre | 90 | 9 | 900 | 900 |
| 100-51-6 | benzylalkohol | 360 | 36 | 3600 | 3600 |
| 98-87-3 | benzylidenchlorid (alfa, alfa-dichlor-toluen) | 0,21 | 0,021 | 2,1 | 2,1 |
| 50-28-2 | 17-beta-østradiol | 0,0001 | 0,0001 | 4,6 | 4,6 |
| 80-05-7 | bisphenol A<br>2,2-bis(4-hydroxyphenyl)propan | 0,1 | 0,01 | 10 | 10 |
| 7440-42-8 | bor | 94 [5]<br>20000[6] | 94 [5]<br>20000 [6] | 2080 [5] | 2080 [5] |
| 3844-45-9 | Brilliant Blue | 96 | 9,6 | 960 | 960 |
| 7722-84-1 | brintoverilte | 10 [5] | 10 [5] | 100 | 100 |
| 85-68-7 | butylbenzylftalat (BBP) | 7,5 | 0,75 | 15 | 15 |
| 79456-26-1 | chlampyr | 0,08 | 0,08 | 160 | 160 |
| 29091-09-6 | chlonibenz<br>(2,4-dichlor-3,5-dinitro-benzotrifluo-rid) | 0,0006 | 0,00006 | 0,06 | 0,06 |
| 97-00-7 | 1-chlor-2,4-dinitrobenzen (DNCB) | 5 | 0,5 | 37 | 37 |
| 90-13-1<br>91-58-7 | 1-chlornaftalen<br>2-chlornaftalen | Σ = 2,7 | Σ = 0,54 | Σ = 3,7 | Σ = 3,7 |
| 89-63-4 | 4-chlor-2-nitroanilin | 1 | 0,1 | 10 | 10 |
| 59-50-7 | 4-chlor-3-methylphenol (PCMC) | 9 | 0,9 | 90 | 90 |
| 95-74-9 | 3-chlor-p-toluidin | 0,62 | 0,062 | 62 | 62 |
| 130-16-5 | 5-chlor-8-quinolinol (CHO) | 0,027 | 0,0027 | 0,27 | 0,027 |
| 88349-88-6 | 5-chloro-8-quinolinol-oxy (CLOQ-syre)-(9CL) | 30 | 3 | 300 | 30 |
| 57-15-8<br>1320-66-7 | chlorbutanol | 135 | 14 | 1350 | 135 |
| 79-11-8 | chloreddikesyre (MCAA) | 0,58 | 0,058 | 3,3 | 3,3 |
| 126-99-8 | chlorpren (2-chlorbuta-1,3-dien) | 32 | 3,2 | 2000 | 2000 |
| 615-65-6 | 2-chlor-p-toluidin | 0,62 | 0,062 | 62 | 62 |
| 89402-40-4 | 4-(5-chloro-3-fluoro-2-pyridinnyl-oxy)phenol | 2,4 | 0,24 | 24 | 2,4 |
| 114420-56-3 | clodinafop | 3,2 | 0,32 | 450 | 45 |
| 105512-06-9 | clodinafop-propargyl | 10 | 1 | 21 | 2,1 |
| 56-72-4 | coumaphos | 0,0007 | 0,00007 | 0,007 | 0,007 |
| 7440-47-3 | chrom Cr VI<br>Cr III | 3,4<br>4,9 | 3,4<br>3,4 | 17<br>124 | 17<br>124 |
| 218-01-9 | chrysen | 0,014 | 0,0014 | 0,014 | 0,014 |
| 7440-48-4 | cobolt | 0,28 [5] | 0,28 [5] | 18 | 34 |

| | | | | | |
|---|---|---|---|---|---|
| 108-39-4<br>95-48-7<br>106-44-5 | m-cresol<br>o-cresol<br>p-cresol | Σ = 100 | Σ = 10 | Σ = 1000 | Σ = 1000 |
| 504-02-9 | 1,3-cyclohexandion (1,3 CHD) | 24 | 24 | 240 | 240 |
| 913545-19-4<br>1156459-77-6 | 2-cyclohexen-1-on,3hydroxy-2-(6-(methylsulfonyl)-2,1-benzisoxazol-3-yl), M4 | 47,6 | 4,8 | 476 | 47,6 |
| 103-23-1 | di(2-ethylhexyl)adipat (DEHA) | 0,7 | 0,07 | 6,6 | 0,66 |
| 53-70-3 | dibenz(a,h)anthracen (PAH) | 0,0014 | 0,00014 | 0,018 | 0,018 |
| 106-93-4 | 1,2-dibromethan | 0,002 | 0,002 | 0,02 | 0,02 |
| 84-74-2 | dibutylftalat (DBP) | 2,3 | 0,23 | 35 | 35 |
| 69045-84-7 | dichlopyr | 0,53 | 0,53 | 30 | 30 |
| 2008-58-4 | 2,6-dichlorbenzamid (BAM) | 78 | 7,8 | 780 | 780 |
| 91-94-1 | dichlorbenzidiner (3,3'-dichlorbenzidin), (DCB) | 0,001 | 0,001 | 0,01 | 0,01 |
| 75-34-3 | 1,1-dichlorethan | 10 | 10 | | |
| 540-59-0<br>75-35-4 | 1,2-dichlorethylen<br>1,1-dichlorethylen | 6,8 | 0,68 | 68 | 68 |
| 120-83-2 | 2,4-dichlorphenol | 0,2 | 0,2 | 20 | 6 |
| 87-65-0 | 2,6-dichlorphenol | 3,4 | 0,34 | 34 | 34 |
| 15165-67-0<br>120-36-5 | dichlorprop-p<br>(dichlorprop) | 41 | 4,1 | 41 | 41 |
| 342-25-6 | difluorbenzophenon | 0,082 | 0,0082 | 8,2 | 8,2 |
| 887502-60-5 | 3,4-dihydro-6-(methylsulphonyl)-1H-xanthene-1,9(2H)-dion, Xanth | 83 | 8,3 | 830 | 83 |
| 68-12-2 | dimethylforamid | 22800 | 2280 | 22800 | 22800 |
| 576-26-1<br>105-67-9<br>108-68-9<br>95-65-8<br>526-75-0<br>95-87-4<br>1300-71-6 | dimethylphenol<br>(6 isomerer af dimethylphenol) | Σ = 13,1 | Σ = 1,31 | Σ = 132 | Σ = 132 |
| 75-18-3 | dimethylsulfid | 15 | 15 | 230 | 230 |
| 13472-45-2 | dinatriumwolframat | 33 | 3,3 | 330 | 33 |
| 383412-05-3 | eddikesyre, chloro-, 1-methylhexyl ester (ACM-ester) | 0,036 | 0,0036 | 0,36 | 0,036 |
| 99607-70-2 | eddikesyre, ((5-chloro-8-quionolinyl)oxy)-, 1-methylhexyl ester (CLOQ) | 0,02 | 0,002 | 5,3 | 0,53 |
| 57-63-6 | ethinyløstradiol | 0,000075 | 0,000075 | 0,00075 | 0,00075 |

| | | | | | |
|---|---|---|---|---|---|
| 462-06-6 | fluorbenzen | 7,4 | 0,74 | 74 | 74 |
| 445-29-4 | 2-fluorbenzosyre | 900 | 90 | 9000 | 9000 |
| 86-73-7 | fluoren | 2,3 | 0,23 | 21,2 | 21,2 |
| 88374-05-04 | fluorphenylepoxyethan (FOX) | 0,048 | 0,0048 | 4,8 | 4,8 |
| 76674-21-0 | flutriafol | 31 | 3,1 | 31 | 31 |
| 54041-17-7 | FOE-hydroxy | 23 | 2,3 | 230 | 23 |
| 201668-31-7 | FOE-oxalat | 4750 | 475 | 47500 | 4750 |
| 201668-32-8 | FOE-sulfonsyre | 760 | 76 | 980 | 98 |
| 50-00-0 | formaldehyd | 9,2 [5)] | 9,2 [5)] | 46 | 46 |
| 16872-11-0 | $HBF_4$ | 830 | 83 | 8300 | 830 |
| 94050-90-5 | HPPA | 35 | 3,5 | 350 | 35 |
| 514797-96-7 | 2-hydroxy-3-fluor-5-chlor-pyridin (FCHP) | 100 | 10 | 1000 | 100 |
| 611-70-1 | isobutyophenon | 13,2 | 1,32 | 132 | 13 |
| 98-82-8 | isopropylbenzen (cumene) | 22 | 2,2 | 22 | 6 |
| 7553-56-2 | jod | 10 [5)] | 10 [5)] | 10 [5)] | 10 [5)] |
| 562-54-9 | kaliummethylsulfat | 1000 | 100 | 10000 | 10000 |
| 7722-64-7 | kaliumpermanganat | 0,84 | 0,084 | 8,4 | 8,4 |
| 127-65-1 | kloramin-T | 5,8 | 0,58 | 5,8 | 5,8 |
| 7440-50-8 | kobber | 1 [5)7)]<br>4,9 [6)] | 1 [5)]<br>4,9 [6)] | 2 [5)]<br>4,9 [6)] | 2 [5)]<br>4,9 [6)] |
| 68411-30-3 | LAS | 54 | 54 | 160 | 160 |
| 7439-96-5 | mangan | 150 [5)] | 150 [5)] | 420 [5)] | 420 [5)] |
| 16484-77-8<br>93-65-2 | mechlorprop-p<br>(mechlorprop) | 18 | 1,8 | 187 | 187 |
| 104206-82-8 | mesotrion | 0,2 | 0,02 | 0,77 | 0,077 |
| 90-12-0<br>91-57-6<br>28804-88-8<br>28652-77-9 | methylnaftalener (PAH), herunder:<br>1-methylnaftalen<br>2-methylnaftalen<br>mimethylnaftalener (bl. af isomerer)<br>trimethylnaftalen | Σ = 0,12 | Σ = 0,12 | Σ = 2 | Σ = 2 |
| 121-44-8 | triethylamin | 110 | 10 | 800 | 80 |
| 104-96-1 | 4-(methylmercapto)anilin | 1,5 | 0,15 | 15 | 1,5 |
| 1671-49-4 | 1-methyl-4(methylsufonyl)-2-nitro-benzen, NMST | 1000 | 100 | 5900 | 590 |
| 1671-48-3 | 2-methyl-5-(methylsulfonyl)anilin, AMST | 65 | 6,5 | 650 | 65 |
| 110964-79-9 | 4-(methylsulphonyl)-2-nitrobenzsyre, mesosyre | 1000 | 100 | 1300 | 130 |

| | | | | | |
|---|---|---|---|---|---|
| 81-15-2 | moskusxylen | 0,11 | 0,057 | 0,68 | 0,68 |
| 917-61-3 | natriumcyanat | 1 | 0,1 | 47 | 4,7 |
| 14698-29-4 | oxylinsyre | 15 | 15 | 18 | 18 |
| 79-57-2 | oxytetracyklin | 10 | 10 | 21 | 21 |
| 106700-29-2 | pethoxamid | 0,12 | 0,012 | 0,12 | 0,0396 |
| 85-01-8 | phenanthren (PAH) | 1,3 | 1,3 | 4,1 | 4,1 |
| 108-95-2 | phenol | 7,7 | 0,77 | 310 | 310 |
| 129-00-0 | pyren | 0,0046 | 0,0017 | 0,023 | 0,023 |
| 69-72-7 | salicylsyre | 171 | 17,1 | 390 | 39 |
| 7782-49-2 | selen | 0,1 [5)] | 0,08 [5)] | 31 [5)] | 31 [5)] |
| 124774-27-2 | S-triazol | 25 | 2,5 | 250 | 250 |
| 7440-24-6 | strontium | 2100 | 2100 [5)] | 5530 [5)] | 5530 [5)] |
| 68-35-9 | sulfadiazin | 4,6 | 4,6 | 14 | 14 |
| 7440-22-4 | sølv | 0,017 [5)] | 0,2 [5)] | 0,36 [5)] | 1,2 [5)] |
| 79-34-5 | 1,1,2,2-tetrachlorethan | 70 | 7 | 93 | 93 |
| 13674-84-5 | tris(2-chlor-1-methylethyl)fosfat (TCPP) | 640 | 64 | 640 | 640 |
| 7440-28-2 | thallium | 0,48 [5)] | 0,048 [5)] | 1,2 [5)] | 1,2 [5)] |
| 7440-31-5 | tin | 2 | 0,2 | 20 | 20 |
| 108-88-3 | toluen | 74 | 7,4 | 380 | 380 |
| 288-88-0 | 1,2,3-triazol | 64 | 6,4 | 225 | 225 |
| 71-55-6 | 1,1,1-trichlorethan | 21 | 2,1 | 54 | 54 |
| 88-06-2 | 2,4,6-trichlorphenol | 1 | 1 | 160 | 40 |
| 112-27-6 | triethylenglycol | 120000 | 12000 | 390000 | 390000 |
| 126-73-8 | tri-n-butylfosfat | 82 | 8,2 | 170 | 170 |
| 738-70-5 | trimethoprim | 100 | 10 | 160 | 160 |
| 115-86-6 | triphenylfosfat (TPP) | 0,74 | 0,074 | 1,8 | 1,8 |
| 7440-61-1 | uran | 0,015 [5)] | 0,015 [5)] | 2,3 [5)] | 2,3 [5)] |
| 7440-62-2 | vanadium | 4,1 [5)] | 4,1 [5)] | 57,8 | 57,8 |
| 75-01-4 | vinylchlorid | 0,05 | 0,05 | 0,5 | 0,5 |
| 1330-20-71 | xylener (o-, p- og m-xylen) | Σ = 10 | Σ = 1 | Σ = 100 | Σ = 100 |
| 7440-66-6 | zink | 7,8 [5)7)]<br>3,1 [5)8)] | 7,8 [5)] | 8,4 [5)] | 8,4 [5)] |

1) CAS: Chemical Abstracts Service.

2) Denne parameter er miljøkvalitetskravet udtrykt som årsgennemsnit (generelt kvalitetskrav). Medmindre andet er angivet, gælder det for den samlede koncentration af alle isomerer.

3) Denne parameter er miljøkvalitetskravet udtrykt som højeste tilladte koncentration (maksimumkoncentration).

4) Indlandsvand omfatter vandløb og søer og dertil knyttede kunstige eller stærkt modificerede vandområder.

**3. EU-fastsatte miljøkvalitetskrav**

Tabel 5. Miljøkvalitetskrav for prioriterede stoffer og visse andre forurenende stoffer.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|
| Nr | CAS-nummer [1] | Stoffets navn | Generelt kvalitetskrav [2] µg/l | | Maksimumkoncentration [3] µg/l | | Kvalitetskrav Biota [12] µg/kg våd-vægt |
| | | | Indlands-vand [4] | Andet overflade-vand | Indlands-vand [4] | Andet overflade-vand | |
| (1) | 15972-60-8 | alachlor | 0,3 | 0,3 | 0,7 | 0,7 | |
| (2) | 120-12-7 | antracen | 0,1 | 0,1 | 0,1 | 0,1 | |
| (3) | 1912-24-9 | atrazin | 0,6 | 0,6 | 2,0 | 2,0 | |
| (4) | 71-43-2 | benzen | 10 | 8 | 50 | 50 | |
| (5) | 32534-81-9 | bromerede diphenylethere [5] | | | 0,14 | 0,014 | 0,0085 |
| (6) | 7440-43-9 | cadmium og cadmiumforbindelser (afhængigt af vandets hårdhedsgrad) [6] | ≤ 0,08 (klasse 1)<br>0,08 (klasse 2)<br>0,09 (klasse 3)<br>0,15 (klasse 4)<br>0,25 (klasse 5) | 0,2 | ≤ 0,45 (klasse 1)<br>0,45 (klasse 2)<br>0,6 (klasse 3)<br>0,9 (klasse 4)<br>1,5 (klasse 5) | ≤ 0,45 (klasse 1)<br>0,45 (klasse 2)<br>0,6 (klasse 3)<br>0,9 (klasse 4)<br>1,5 (klasse 5) | |
| (6a) | 56-23-5 | tetrachlormethan [7] | 12 | 12 | anvendes ikke | anvendes ikke | |
| (7) | 85535-84-8 | $C_{10-13}$-chloralkaner [8] | 0,4 | 0,4 | 1,4 | 1,4 | |
| (8) | 470-90-6 | chlorfenvinphos | 0,1 | 0,1 | 0,3 | 0,3 | |
| (9) | 2921-88-2 | chlorpyrifos (chlorpyrifosethyl) | 0,03 | 0,03 | 0,1 | 0,1 | |
| (9a) | 309-00-2<br>60-57-1<br>72-20-8<br>465-73-6 | cyclodien-pesticider:<br>aldrin [7]<br>dieldrin [7]<br>endrin [7]<br>isoendrin [7] | Σ = 0,01 | Σ = 0,005 | anvendes ikke | anvendes ikke | |
| (9b) | anvendes ikke | DDT i alt [7] [9] | 0,025 | 0,025 | anvendes ikke | anvendes ikke | |
| | 50-29-3 | para-para-DDT [7] | 0,01 | 0,01 | anvendes | anvendes | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (11) | 75-09-2 | dichlormethan | 20 | 20 | anvendes ikke | anvendes ikke | |
| (12) | 117-81-7 | di(2-ethylhexyl)ftalat (DEHP) | 1,3 | 1,3 | anvendes ikke | anvendes ikke | |
| (13) | 330-54-1 | diuron | 0,2 | 0,2 | 1,8 | 1,8 | |
| (14) | 115-29-7 | endosulfan | 0,005 | 0,0005 | 0,01 | 0,004 | |
| (15) | 206-44-0 | fluoranthen | 0,0063 | 0,0063 | 0,12 | 0,12 | 30 |
| (16) | 118-74-1 | hexachlorbenzen | | | 0,05 | 0,05 | 10 |
| (17) | 87-68-3 | hexachlorbutadien | | | 0,6 | 0,6 | 55 |
| (18) | 608-73-1 | hexachlorcyclohexan | 0,02 | 0,002 | 0,04 | 0,02 | |
| (19) | 34123-59-6 | isoproturon | 0,3 | 0,3 | 1,0 | 1,0 | |
| (20) | 7439-92-1 | bly og blyforbindelser | 1,2 [13)] | 1,3 | 14 | 14 | |
| (21) | 7439-97-6 | kviksølv og kviksølvforbindelser | | | 0,07 | 0,07 | 20 |
| (22) | 91-20-3 | naftalen | 2 | 2 | 130 | 130 | |
| (23) | 7440-02-0 | nikkel og nikkelforbindelser | 4 [13)] | 8,6 | 34 | 34 | |
| (24) | 84852-15-3 | nonylphenoler (4-nonylphenol) | 0,3 | 0,3 | 2,0 | 2,0 | |
| (25) | 140-66-9 | octylphenoler (4-(1,1',3,3'-tetramethylbutyl)-phenol) | 0,1 | 0,01 | anvendes ikke | anvendes ikke | |
| (26) | 608-93-5 | pentachlorbenzen | 0,007 | 0,0007 | anvendes ikke | anvendes ikke | |
| (27) | 87-86-5 | pentachlorphenol | 0,4 | 0,4 | 1 | 1 | |
| (28) | anvendes ikke | polyaromatiske kulbrinter (PAH) [11)] | anvendes ikke | anvendes ikke | anvendes ikke | anvendes ikke | |
| | 50-32-8 | benz(a)pyren | $1,7 \times 10^{-4}$ | $1,7 \times 10^{-4}$ | 0,27 | 0,027 | 5 |
| | 205-99-2 | benz(b)fluoranthen | se fodnote 11 | se fodnote 11 | 0,017 | 0,017 | se fodnote 11 |
| | 207-08-9 | benz(k)fluoranthen | se fodnote 11 | se fodnote 11 | 0,017 | 0,017 | se fodnote 11 |
| | 191-24-2 | benz(g,h,i)perylen | se fodnote 11 | se fodnote 11 | $8,2 \times 10^{-3}$ | $8,2 \times 10^{-4}$ | se fodnote 11 |
| | 193-39-5 | indeno(1,2,3-cd)-pyren | se fodnote 11 | se fodnote 11 | anvendes ikke | anvendes ikke | se fodnote 11 |
| (29) | 122-34-9 | simazin | 1 | 1 | 4 | 4 | |
| (29a) | 127-18-4 | tetrachlorethylen [7)] | 10 | 10 | anvendes | anvendes | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (30) | 36643-28-4 | tributyltin-forbindelser (tributyltinkation) | 0,0002 | 0,0002 | 0,0015 | 0,0015 | |
| (31) | 12002-48-1 | trichlorbenzener | 0,4 | 0,4 | anvendes ikke | anvendes ikke | |
| (32) | 67-66-3 | trichlormethan | 2,5 | 2,5 | anvendes ikke | anvendes ikke | |
| (33) | 1582-09-8 | trifluralin | 0,03 | 0,03 | anvendes ikke | anvendes ikke | |
| (34) | 115-32-2 | dicofol | $1,3 \times 10^{-3}$ 15) | $3,2 \times 10^{-5}$ 15) | anvendes ikke 10) | anvendes ikke 10) | 33 15) |
| (35) | 1763-23-1 | perfluoroctansulfonsyre og derivater heraf (PFOS) | $6,5 \times 10^{-4}$ 15) | $1,3 \times 10^{-4}$ 15) | 36 15) | 7,2 15) | 9,1 15) |
| (36) | 124495-18-7 | quinoxyfen | 0,15 15) | 0,015 15) | 2,7 15) | 0,54 15) | |
| (37) | Se fodnote 9 til tabel 2 | dioxiner og dioxinlignende forbindelser | | | anvendes ikke | anvendes ikke | Summen af PCDD + PCDF + PCB-DL 0,0065 $\mu g\ kg^{-1}$ TEQ 14) 15) |
| (38) | 74070-46-5 | aclonifen | 0,12 15) | 0,012 15) | 0,12 15) | 0,012 15) | |
| (39) | 42576-02-3 | bifenox | 0,012 15) | 0,0012 15) | 0,04 15) | 0,004 15) | |
| (40) | 28159-98-0 | cybutryn | 0,0025 15) | 0,0025 15) | 0,016 15) | 0,016 15) | |
| (41) | 52315-07-8 | cypermethrin | $8 \times 10^{-5}$ 15) | $8 \times 10^{-6}$ 15) | $6 \times 10^{-4}$ 15) | $6 \times 10^{-5}$ 15) | |
| (42) | 62-73-7 | dichlorvos | $6 \times 10^{-4}$ 15) | $6 \times 10^{-5}$ 15) | $7 \times 10^{-4}$ 15) | $7 \times 10^{-5}$ 15) | |
| (43) | Se fodnote 11 til tabel 2 | hexabromcyclo-dodecan (HBCDD) | 0,0016 15) | 0,0008 15) | 0,5 15) | 0,05 15) | 167 15) |
| (44) | 76-44-8/1024-57-3 | heptachlor og heptachlorepoxid | $2 \times 10^{-7}$ 15) | $1 \times 10^{-8}$ 15) | $3 \times 10^{-4}$ 15) | $3 \times 10^{-5}$ 15) | $6,7 \times 10^{-3}$ 15) |
| (45) | 886-50-0 | terbutryn | 0,065 15) | 0,0065 15) | 0,34 15) | 0,034 15) | |

1) CAS: Chemical Abstracts Service.

2) Denne parameter er miljøkvalitetskravet udtrykt som årsgennemsnit (generelt kvalitetskrav). Medmindre andet er angivet, gælder det for den samlede koncentration af alle isomerer.

3) Denne parameter er miljøkvalitetskravet udtrykt som højeste tilladte koncentration (maksimumkoncentration). Hvis der under maksimumkoncentration er anført "anvendes ikke", betragtes det generelle kvalitetskrav som beskyttelse mod kortvarig høj forurening i kontinuerlige udledninger, da det er væsentligt lavere end de værdier, der er afledt af den akutte toksicitet.

4) Indlandsvand omfatter vandløb og søer og dertil knyttede kunstige eller stærkt modificerede vandområder.

### 9.3.2 Detailed qualitative assessment of treatment efficiency of comparable parameters versus PNECs.

Table 24:Detailed qualitative assessment of comparable inorganics PNECs (green: measurements below PNECs / red: measurements above PNECs)

| **Sample name** | **Mangan. Mn** | **Arsan. As** | **Bor. B** | **Barium. Ba** | **Chrome. Cr** | **Copper. Cu** | **Nickel. Ni** | **Zink. Zn** |
|---|---|---|---|---|---|---|---|---|
| **NPECs (µg/L)** | **150 (5)** | **4.3** | **94 (5)** | **19 (5)** | **3.4** | **1 (5)** | **4** | **7.8 (5)** |
| raw water | - | | | - | | | | - |
| $O_3$-low dose (TA8-SF) | | | | | - | - | | - |
| **$O_3$-optimal dose (TA6-SF)** | | | | | | | | |
| $O_3$-high dose (TA7-SF) | | | | | - | - | | - |
| $O_3/H_2O_2$-low dose (TB8-SF) | | | | | - | - | | - |
| **$O_3/H_2O_2$-optimal dose (TB6-SF)** | | | | | - | - | | - |
| $O_3/H_2O_2$-high dose (TB7-SF) | | | | | - | - | | - |
| UV/$H_2O_2$- low dose (TC8-SF) | | | | | - | - | | - |
| UV/$H_2O_2$**- optimal dose (TC6-SF)** | | | | | - | - | | - |
| UV/$H_2O_2$- high dose (TC7-SF) | | | | | - | - | | - |
| PAC raw water | - | - | - | - | - | - | - | - |
| PAC $O_3$-low dose (PAC-A8-SF) | - | - | - | - | - | - | - | - |
| PAC **$O_3$-optimal dose (PAC-A6-SF)** | - | - | - | - | - | - | - | - |
| PAC $O_3$-high dose (PAC-A7-SF) | - | - | - | - | - | - | - | - |
| PAC $O_3/H_2O_2$-low dose (PAC-B8-SF) | - | - | - | - | - | - | - | - |
| PAC **$O_3/H_2O_2$-optimal dose (PAC-B6-SF)** | - | - | - | - | - | - | - | - |
| PAC $O_3/H_2O_2$-high dose (PAC-B7-SF) | - | - | - | - | - | - | - | - |
| PAC UV/$H_2O_2$- low dose (PAC-C8-SF) | - | - | - | - | - | - | - | - |
| PAC UV/$H_2O_2$**- optimal dose (PAC-C6-SF)** | - | - | - | - | - | - | - | - |
| PAC UV/$H_2O_2$- high dose (PAC-C7-SF) | - | - | - | - | - | - | - | - |
| PAC-E-SF | - | - | - | - | - | - | - | - |
| PAC-F-SF | - | - | - | - | - | - | - | - |
| PAC-B-SF | - | - | - | - | - | - | - | - |

NB: Nicckel is not affected by AOP. Copper and Zinc measurements are inconsistent.

Table 25: Detailed qualitative assessment of comparable organics PNECs PART 1 (green: measurements below PNECs / red: measurements above PNECs)

| **Sample name** | **Benzene** | **Toluene** | **Ethyl-Benzene** | **Naphthalene** | **Trichloroethane (Chloroform)** | **1.1.1-trichloroethane** | **Tetra-chloromethane** | **Tri-chloroethylene** |
|---|---|---|---|---|---|---|---|---|
| NPECs (µg/L) | 10 | 74 | 20 | 2 | 2.5 | 21 | 12 | 10 |
| raw water | | | | | | | | |
| $O_3$-low dose (TA8-SF) | | | | | | | | |
| **$O_3$-optimal dose (TA6-SF)** | | | | | | | | |
| $O_3$-high dose (TA7-SF) | | | | | | | | |
| $O_3/H_2O_2$-low dose(TB8-SF) | | | | | | | | |
| **$O_3/H_2O_2$-optimal dose (TB6-SF)** | | | | | | | | |
| $O_3/H_2O_2$-high dose (TB7-SF) | | | | | | | | |
| UV/$H_2O_2$- low dose (TC8-SF) | | | | | | | | |
| **UV/$H_2O_2$- optimal dose (TC6-SF)** | | | | | | | | |
| UV/$H_2O_2$- high dose (TC7-SF) | | | | | | | | |
| PAC raw water | | | | | | | | |
| PAC $O_3$-low dose (PAC-A8-SF) | | | | | | | | |
| PAC **$O_3$-optimal dose (PAC-A6-SF)** | | | | | | | | |
| PAC $O_3$-high dose (PAC-A7-SF) | | | | | | | | |
| PAC $O_3/H_2O_2$-low dose (PAC-B8-SF) | | | | | | | | |
| PAC **$O_3/H_2O_2$-optimal dose (PAC-B6-SF)** | | | | | | | | |
| PAC $O_3/H_2O_2$-high dose (PAC-B7-SF) | | | | | | | | |
| PAC UV/$H_2O_2$- low dose (PAC-C8-SF) | | | | | | | | |
| PAC UV/**$H_2O_2$- optimal dose (PAC-C6-SF)** | | | | | | | | |
| PAC UV/$H_2O_2$- high dose (PAC-C7-SF) | | | | | | | | |
| PAC-E-SF | | | | | | | | |
| PAC-F-SF | | | | | | | | |
| PAC-B-SF | | | | | | | | |

Table 26: Detailed qualitative assessment of comparable organics PNECs PART 2 (green: measurements below PNECs / red: measurements above PNECs)

| **Sample name** | **Tetra chloroethylene** | **Vinyl chloride** | **1.1-dichloroethylene** | **1.2-dichloroethylene (Trans + Cis)** | **1.2-Dichloroethane** | **1.1-Dichloroethane** | **Di-chloromethane** | **Sulfadiazine** |
|---|---|---|---|---|---|---|---|---|
| NPECs (µg/L) | 10 | 0.05 | 6.8 | 6.8 | 10 | 10 | 20 | 4.6 |
| raw water | | | | | | | | |
| $O_3$-low dose (TA8-SF) | | | | | | | | |
| **$O_3$-optimal dose (TA6-SF)** | | | | | | | | |
| $O_3$-high dose (TA7-SF) | | | | | | | | |
| $O_3/H_2O_2$-low dose(TB8-SF) | | | | | | | | |
| **$O_3/H_2O_2$-optimal dose** | | | | | | | | |
| $O_3/H_2O_2$-high dose (TB7-SF) | | | | | | | | |
| UV/$H_2O_2$- low dose (TC8-SF) | | | | | | | | |
| UV/$H_2O_2$**- optimal dose** | | | | | | | | |
| UV/$H_2O_2$- high dose (TC7-SF) | | | | | | | | |
| PAC raw water | | | | | | | | |
| PAC $O_3$-low dose (PAC-A8-SF) | | | | | | | | |
| PAC **$O_3$-optimal dose** | | | | | | | | |
| PAC $O_3$-high dose (PAC-A7-SF) | | | | | | | | |
| PAC $O_3/H_2O_2$-low dose (PAC-B8-SF) | | | | | | | | |
| PAC **$O_3/H_2O_2$-optimal dose** | | | | | | | | |
| PAC $O_3/H_2O_2$-high dose (PAC-B7-SF) | | | | | | | | |
| PAC UV/$H_2O_2$- low dose (PAC-C8-SF) | | | | | | | | |
| PAC UV/$H_2O_2$**- optimal dose** | | | | | | | | |
| PAC UV/$H_2O_2$- high dose (PAC-C7-SF) | | | | | | | | |
| PAC-E-SF | | | | | | | | |
| PAC-F-SF | | | | | | | | |
| PAC-B-SF | | | | | | | | |

(5) The concentration of the substance added to the natural background concentration if (5) is indicated

- The upper concentration of the substance regardless of the natural background concentration. to the maximal if (6) is indicated.

# Bilag D Rapport fra DHI

# Ecotoxicology testing of water samples from laboratory tests with AOP methods performed on the pollution plume from Grindstedværket

## Accredited Test Report No. BWL193

Acute test with *Daphnia magna* and algal growth inhibition test with *Raphidocelis subcapitata*

*Test results relate only to the item(s) tested.*
*The test report may only be reproduced in extract, if the laboratory has approved the extract.*

Region Syddanmark

Accredited Test Report No.: BWL193

June 2020

| | |
|---|---|
| This report has been prepared under the DHI A/S Business Management System certified by Bureau Veritas to comply with ISO 9001 (Quality Management). | DANAK participates in the multilateral agreements for testing and calibration under the European co-operation for Accreditation (EA) and under the International Laboratory Accreditation Cooperation (ILAC) based on peer evaluation. The use of the accreditation mark on this test report documents that the service is provided as an accredited service under the company's DANAK accreditation. |

| Approved by |
|---|
| 29-06-2020<br>X<br>Approved by<br>Signed by: Torben Madsen |

# Ecotoxicology testing of water samples from laboratory tests with AOP methods performed on the pollution plume from Grindstedværket

## Accredited Test Report No. BWL193

Acute test with *Daphnia magna* and algal growth inhibition test with *Raphidocelis subcapitata*

| | |
|---|---|
| Prepared for | Region Syddanmark |
| Represented by | Hanne Nielsen |

*DHI Laboratory, Hørsholm Denmark*

| | |
|---|---|
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| | |
|---|---|
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# APPENDICES


**A Data from the tests with the contaminated raw water sample**
A.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)
A.2 *Raphidocelis subcapitata* growth inhibition test (without pH-adjustment of the sample)
A.3 *Daphnia magna* acute immobilisation test

**B Data from the test with "PAC-A6-SF"**
B.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)
B.2 *Daphnia magna* acute immobilisation test

**C Data from the test with "PAC-A6-SF"**
C.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)
C.2 *Daphnia magna* acute immobilisation test

**D Data from the test with "PAC-F-SF"**
D.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)
D.2 *Daphnia magna* acute immobilisation test

**E Data from the test with "PAC-C6-SF"**
E.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)
E.2 *Daphnia magna* acute immobilisation test

# 1 Summary

Ecotoxicological studies on freshwater algae and crustaceans were performed with contaminated, untreated raw water as well as treated water from the pollution plume from Grindstedværket. The results from the tests are summarised in Table 1.1.

Table 1.1 Results from the toxicity tests conducted.

| Sample | DHI ID No. | Algal growth inhibition test with *Raphidocelis subcapitata* (mL/L) | | | | Immobilisation test with *Daphnia magna* (mL/L) | |
|---|---|---|---|---|---|---|---|
| | | NOEC | LOEC | EC10 | EC50 | EC10 | EC50 |
| Contaminated raw water sample | 20-1242 | 800[1)]<br>500[2)] | >800[1)]<br>>500[2)] | >800[1)]<br>>500[2)] | >800[1)]<br>>500[2)] | >900 | >900 |
| PAC-A6-SF | 20-1245 | 500 | 800 | 483<br>(393-572) | >800 | >900 | >900 |
| PAC-B6-SF | 20-1246 | 500 | 800 | 544<br>(• - •)[3)] | >800 | >900 | >900 |
| PAC-F-SF | 20-1247 | 200 | 300 | 257<br>(204-310) | >800 | >900 | >900 |
| PAC-C6-SF | 20-1248 | 300 | 500 | 305<br>(222-389) | >800 | >900 | >900 |

1) With pH-adjustment of the sample before initiation of the test
2) Highest test concentration without pH-adjustment of the sample
3) Data did not allow statistical calculation of the 95% confidence interval

# 2 Study objective

The objective of the studies was to investigate the effects on the freshwater algae *Raphidocelis subcapitata* (formerly known as *Pseudokirschneriella subcapitata*) and the freshwater crustacean *Daphnia magna* of:

- Sample of contaminated, untreated raw water from the pollution plume at Grindstedværket (hereafter contaminated raw water).
- Contaminated water samples originating from the same pollution plume after treatment with Advanced Oxidation Process (AOP) methods at the subcontracted laboratories

The studies were performed in accordance with the procedures in the OECD Guideline for the Testing of Chemicals No. 201 “Freshwater Alga and Cyanobacteria, Growth Inhibition Test” /1/ and OECD Guideline for the Testing of Chemicals No. 202 “*Daphnia* sp., Acute Immobilisation test” /2/. The studies were performed as accredited studies in compliance with ISO/IEC 17025 (2017) /3/.

# 3 Contract and client details

Contract under the thresholds with a clear cross-border interest. Lab tests of AOP-methods for treatment of contaminated groundwater from the pollution plume at Grindstedværket as well as ecotoxicological tests. Sub-agreement 3.

Client: Region Syddanmark, Hanne Nielsen

# 4 Test facility

DHI A/S, Agern Allé 5, DK-2970 Hørsholm, Denmark. Project Manager Anja Kamper (M.Sc.).

# 5 Water samples received

## 5.1 Identification and appearance

DHI received contaminated raw water labelled “Grindsted drilling No. BE6” as well as four treated water samples from the laboratories performing the AOP laboratory tests. The samples were assigned a unique identification number upon arrival. Table 5.1 shows the identification and appearance of the water samples.

Table 5.1 Identification and appearance of the water samples.

| DHI ID No. | Received date | Description | Sample date | Appearance |
|---|---|---|---|---|
| 20-1242 | 2020.03.11 | Contaminated raw water. Grindsted Drilling No. BE6 | 2020.03.10 | Clear water with few particles. Headspace in the bottles. |
| 20-1245 | 2020.05.07 | PAC-A6-SF | 2020.04.29 | Clear water (no particles). |
| 20-1246 | 2020.05.07 | PAC-B6-SF | 2020.04.29 | Clear water (no particles). |
| 20-1247 | 2020.05.07 | PAC-F-SF | 2020.05.04 | Clear water (no particles). |
| 20-1248 | 2020.05.13 | PAC-C6-SF | 2020.05.11 | Clear water (no particles). |

## 5.2 Handling of the samples

The samples were collected in 1-L Blue-cap glass bottles and stored at 4ºC until the test was initiated.

The pre-treatment of the water samples, e.g., pH-adjustment, and the observations made prior to testing can be found in Table 5.2

Table 5.2 Pre-treatment of the water samples prior to testing.

| Sample description | DHI ID No. and ID No. on sample | Organism and test date | pH | | | Observations at pre-treatment |
|---|---|---|---|---|---|---|
| | | | Initial pH | Adjusted to pH | Adjusted with | |
| Contaminated raw water sample | 20-1242 | Algae test, with pH-adjustment 2020.03.17 | 5.6 | 8.0 | 6 M NaOH | Precipitation (ochre-like) in the sample after pH-adjustment. |
| | | Daphnia test 2020.03.17 | 5.6<br>6.3[1)] | No adjustment | - | Precipitation (ochre-like) occurred when the daphnia media was added. |
| | | Algae test, without pH-adjustment 2020.03.24 | 5.8 | No adjustment | - | The sample contained precipitations (ochre-like) developed during storage and was agitated before use. |
| PAC-A6-SF | 20-1245<br>Algae test: 11824528-9<br>Daphnia test: 11824528-11 | Algae test, with pH-adjustment 2020.05.12 | 7.5 | 8.2 | 1 M NaOH | - |
| | | Daphnia test 2020.05.13 | 7.5 | No adjustment | - | - |
| PAC-B6-SF | 20-1246<br>Algae test: 11824528-10<br>Daphnia test: 11824528-12 | Algae test, with pH-adjustment 2020.05.12 | 7.3 | 8.2 | 1 M NaOH | - |
| | | Daphnia test 2020.05.26 | 7.2 | No adjustment | - | - |
| PAC-F-SF | 20-1247<br>Algae test: 11824528-5<br>Daphnia test: 11824528-6 | Algae test, with pH-adjustment 2020.05.12 | 8.7 | 8.1 | 1 M HCl | - |
| | | Daphnia test 2020.05.28 | 8.7 | No adjustment | - | - |
| PAC-C6-SF | 20-1248<br>Algae test: 11824528-7<br>Daphnia test: 11824528-8 | Algae test, with pH-adjustment 2020.05.19 | 6.8 | 8.1 | 1 M NaOH | - |
| | | Daphnia test 2020.05.28 | 6.8 | No adjustment | - | - |

1) After addition of test media.

# 6 Experimental design

## 6.1 Algal growth inhibition test with *Raphidocelis subcapitata*

The effect of the samples on the growth rate of the freshwater alga *Raphidocelis subcapitata* was determined according to the OECD Guideline for the Testing of Chemicals No. 201 “Freshwater Alga and Cyanobacteria, Growth Inhibition Test” /1/.

Due to a low pH measured in the contaminated raw water, this sample was furthermore tested without pH adjustment with reference to the ISO International Standard 14442 “Water quality – Guidelines for algal growth inhibition tests with poorly soluble materials, volatile compounds, metals and waste water” /5/, chapter 11, “pH buffering”.

The test mixtures were prepared as serial dilutions of the samples with laboratory medium. Nutrients and algae were added to each of the test mixtures as described in the OECD 201 guideline /1/. The highest possible test concentration was 800 mL/L when the pH in the sample was adjusted and 500 mL/L without adjustment.

The test conditions are summarized in Table 6.1 and the modifications made in the test without pH-adjustment of the sample can be found in Table 6.2 (for sample 20-1242 only).

Table 6.1 Test conditions for the growth inhibition test with *Raphidocelis subcapitata*[1)].

| | |
|---|---|
| **Test guideline** | OECD 201 /1/ |
| **Test organism** | *Raphidocelis subcapitata* (clone: NIVA CHL 1) [1)] |
| **Test organism source** | NIVA, Norway, cultured at DHI |
| **Test organism life stage** | The alga is kept in log phase growth for at least 7 days before testing |
| **Test concentrations** | 0; 50; 80; 120; 200; 300; 500 and 800 mL/L |
| **Test duration** | 72 ± 2 hours |
| **Test container** | 250-mL conical glass flask with air permeable lid, with 100 mL test solution |
| **Initial algal concentration** | 4.5-10 x $10^3$ cells/mL |
| **Replicates** | • 6 × controls<br>• 3 × test concentration (treated discharge water)<br>• 1 × blank control for each concentration without algae |
| **Method** | Determination of specific growth rate by fluorescence measurements as a surrogate parameter for biomass.<br>At the beginning of the test and after 24, 48 and 72 ± 2 hours of incubation in all replicates.<br>The conversion factor between fluorescence (RFU) and biomass (µg/L DW) is determined to: 7.0 µg DW × $L^{-1}$ per RFU |
| **Endpoint** | Growth rate |
| **Laboratory control medium** | Medium as described in OECD 201, Annex 3 /1/. |

| | |
|---|---|
| **Nutrient medium** | According to OECD 201 /1//4/ |
| **Photoperiod** | Constant fluorescent light |
| **Light intensity** | 60-120 µmol $\times m^{-2} \times sec^{-1}$ |
| **Shaking** | 120-140 rpm |
| **Temperature** | 23°C ± 2 °C |
| **Initial pH** | In the laboratory control medium: 8.4 ± 0.1<br>The sample were adjusted to 8.1 ± 0.2 before dilution in series |
| **Validity criteria** | • Average growth rate in laboratory controls: ≥ 1.4 $d^{-1}$<br>• pH increase in laboratory controls: ≤ 1.5<br>• Laboratory control variation coefficient: ≤ 7%<br>• The mean coefficient of variation for section-by-section specific growth rates (days 0-1, 1-2 and 2-3) must not exceed 35% in the laboratory control |
| **Reference test** | Verification of organism sensitivity with 3,5-dichlorophenol |

1) Our supplier of algae, NIVA Culture Collection of Algae, has changed the name of from *Pseudokirchneriella subcapitata* (NIVA-CHL 1) to *Raphidocelis subcapitata* (NIVA-CHL 1).

Table 6.2 Modifications made for test with contaminated raw water (sample 20-1242) without pH-adjustment of the sample

| Standard | Modifications to OECD 201 /1/ according to ISO 14442 /5/ |
|---|---|
| **Test concentrations** | 0; 50; 80; 120; 200; 300 and 500 mL/L (maximum concentration) |
| **Laboratory control medium** | Medium as described in OECD 201 added 0.3 g/L $NaHCO_3$ and adjusted to pH 7.2 with HCl |
| **Initial pH** | In the laboratory control medium: 7.2 ± 0.2<br>pH in the sample were not adjusted |

pH was measured and recorded at the initiation and termination of the test. The temperature was recorded continuously with a temperature logger.

The density of algae at the initiation of the test was calculated based on counts of the algae stock by use of a counting chamber.

The algal growth was measured as in vivo fluorescence by use of a Turner TD-700 Laboratory Fluorometer or a Turner Trilogy Laboratory Fluorometer.

The identity and normal appearance of *Raphidocelis subcapitata* in the control was confirmed by microscopy at the end of the test.

## 6.2 Acute immobilisation test with *Daphnia magna*

The toxicity of the samples to the freshwater crustacean *Daphnia magna* was determined according to the OECD Guideline for the Testing of Chemicals No. 202 "*Daphnia* sp., Acute Immobilisation Test" /2/.

To be able to test at the highest possible test concentration, 900 mL/L, the following modification to the guideline were made. The four stock solutions normally used for the preparation of the dilution water was added directly to the sample. The lower test concentrations were prepared as serial dilutions of the modified sample with the dilution water.

The test conditions are summarized in Table 6.3.

Table 6.3 Summary of test conditions for the acute immobilisation test with *Daphnia magna*.

| | |
|---|---|
| **Test guideline** | OECD 202 /2/ |
| **Test organism** | *Daphnia magna* |
| **Test organism source** | DHI Denmark (Langedam, Birkerød, Denmark) |
| **Test organism life stage** | <24 hours |
| **Test concentrations** | 0; 56.3; 113; 225; 450 and 900 mL/L |
| **Test duration** | 48 hours, static test |
| **Test container** | 50-mL glass beaker with 25 mL test solution |
| **Replicates** | • 6 × laboratory control<br>• 4× test concentration |
| **Test organisms per test container** | 5 |
| **Test organisms per concentration** | • 30 per control<br>• 20 per test concentration |
| **Endpoint** | Immobility |
| **Laboratory control and dilution medium** | ISO 6341 medium /6/<br>As a modification, the medium was also added directly to the sample as described above. |
| **Food regime** | No food during testing |
| **Photoperiod** | Total darkness |
| **Temperature** | 20 ± 1°C |
| **Initial pH** | In the laboratory control medium: 7.8 ± 0.5<br>No adjustment of the pH in the samples, if the test mixtures pH is within 6 - 9. |

| | |
|---|---|
| **Validity criteria** | • Dissolved oxygen ≥ 70%<br>• Immobility in the laboratory control ≤ 10%<br>• Reference substance, 3,5-dichlorophenol EC50 (24h) as normally obtained in the laboratory. |
| **Reference test** | Verification of organism sensitivity with 3,5-dichlorophenol |

The pH and dissolved oxygen were measured at the initiation and termination of the test. The test temperature was measured continuously by a temperature logger.

Mobile and immobile individuals were reported on daily basis until termination of the test.

## 6.3 Statistical analysis

The results obtained in the tests with the alga *Raphidocelis subcapitata* were used to estimate the no observed effect concentration (NOEC) and the lowest observed effect concentration (LOEC). And furthermore, the effect concentrations (EC) causing 10% and 50% effect in comparison with the laboratory control (i.e. EC10 and EC50) in the algae and *Daphnia magna* tests were estimated from the results obtained.

All the analyses were run using the free software R /7/.

The LOEC/NOEC values were determined by use of the Dunnett's test /8/. The NOEC values ($p>0.05$) were determined as the highest tested concentration, at which no significant negative effect was observed compared with the control. The LOEC ($t<0$ and $p<0.05$) is the concentration just above the NOEC.

To comply with the conditions of the Dunnett's test, the normality of the data were assessed but only by a visual description using a boxplot /9/. The variance was analysed with a Levene's test /10/.

When a significant effect was observed associated with a dose response, a Probit analysis was conducted to estimate the EC10 and EC50, if possible.

The EC values were calculated to attain the closest possible curve fit with following equations: LL.4 /11/, W1.4 /12/ W2.4 /12/.

# 7 Results of the ecotoxicological tests

## 7.1 Validity

The validity criteria for the algal growth inhibition tests with *Raphidocelis subcapitata* prescribed in the OECD 201 guideline were fulfilled except in the single test without pH adjustment. No further test without pH-adjustment was performed.

The validity criteria for the acute immobilisation tests with *Daphnia magna* prescribed in the OECD 202 guideline were fulfilled. In a few test a 100% immobilisation occurred in one of the six controls after 24 hours. These incidents were interpreted as outliers and not included in the estimation of the effect concentrations.

A reference test with 3,5-dichlorophenol (2020/02/25) with *Raphidocelis subcapitata* resulted in an EC50 of 2.75 (2.59 - 2.92) mg/L, which is within the range normally obtained in the laboratory. This result indicates good test procedures and normal sensitivity of the test organism.

The reference test with 3,5 dichlorophenol (2020/03/12) with *Daphnia magna* resulted in a 24h EC50 of 2.24 (2.05 - 2.43) mg/L, which is within the range normally obtained in the laboratory. This indicates good test procedures and normal sensitivity of test organism.

## 7.2 Results obtained in the ecotoxicological tests

The primary data, as well as the calculations and estimations made, from the growth inhibition tests with the alga *Raphidocelis subcapitata* and the acute immobilisation tests with *Daphnia magna* are presented in Appendix A to E.

The algae growth inhibition testing of the contaminated raw water sample with and without pH-adjustment led to the conclusion, that the water samples had to be pH-adjusted, if the pH in the highest test concentration exceeded ± 0.5 compared to the control pH.

A summary of the results of the toxicity tests with the received samples is presented in Table 7.1.

Table 7.1 Results from the toxicity tests conducted.

| **Sample** | **DHI ID No.** | **Algal growth inhibition test with *Raphidocelis subcapitata* (mL/L)** | | | | **Immobilisation test with *Daphnia magna* (mL/L)** | |
|---|---|---|---|---|---|---|---|
| | | **NOEC** | **LOEC** | **EC10** | **EC50** | **EC10** | **EC50** |
| Contaminated raw water sample | 20-1242 | 800[1)]<br>500[2)] | >800[1)]<br>>500[2)] | >800[1)]<br>>500[2)] | >800[1)]<br>>500[2)] | >900 | >900 |
| PAC-A6-SF | 20-1245 | 500 | 800 | 483<br>(393-572) | >800 | >900 | >900 |
| PAC-B6-SF | 20-1246 | 500 | 800 | 544<br>(• - •)[3)] | >800 | >900 | >900 |
| PAC-F-SF | 20-1247 | 200 | 300 | 257<br>(204-310) | >800 | >900 | >900 |
| PAC-C6-SF | 20-1248 | 300 | 500 | 305<br>(222-389) | >800 | >900 | >900 |

1) With pH-adjustment of the sample before initiation of the test
2) Highest test concentration without pH-adjustment of the sample
3) Data did not allow statistical calculation of the 95% confidence interval

# 8 Conclusion

The results of the toxicity tests with the contaminated raw water sample showed no toxicity to algae and daphnia. Low toxicity to algae was observed in all treated samples. The lowest toxic effects were observed in the test with PAC-A6-SF and PAC-B6-SF. The highest toxicity was observed for the sample treatments PAC-F-SF and PAC-C6-SF.

# 9 References


/1/ OECD Guideline for Testing of chemicals No. 201: “Freshwater Alga and Cyanobacteria, Growth Inhibition Test". Adopted 2006.03.26. Annex 5 corrected 2011.07.28.

/2/ OECD Guideline for Testing of chemicals No. 202: “*Daphnia* sp., Acute Immobilisation Test”. Adopted 2004.04.13

/3/ ISO/IEC 17025:2017: General requirements for the competence of testing and calibration laboratories.

/4/ ISO 8692 (2012): “Water quality – Fresh-water algal growth inhibition test with unicellular green algae”. Third edition. 2012.02.15.

/5/ ISO 1442 (2006): “Water quality – Guidelines for algal growth inhibition tests with poorly soluble materials, volatile compounds, metals and waste water”. Second edition. 2006.04.01.

/6/ ISO 6341 (2012): “Water quality – Determination of the inhibition of the mobility of *Daphnia magna* Straus (*Cladocera, Crustacea*) – Acute toxicity test”. Fourth edition. 2012.10.15.

/7/ R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

/8/ Frank Bretz, Torsten Hothorn and Peter Westfall (2010) (Dunnett’s test), Multiple Comparisons Using R, CRC Press, Boca Raton.

/9/ Fox, J. (2005) The R Commander: A Basic Statistics Graphical User Interface to R. Journal of Statistical Software, 14(9): 1–42

/10/ Fox, J. and Weisberg, S. (2011) *An R Companion to Applied Regression*, Second Edition, Sage.

/11/ Seber, G. A. F. and Wild, C. J (1989) Nonlinear Regression, New York: Wiley \& Sons (p. 330).

/12/ Ritz, C (2010). Towards a unified approach to dose-response modelling in ecotoxicology. *Environmental Toxicology & Chemistry*, 29, 220–229.

# APPENDICES

# APPENDIX A

## Data from the test with the contaminated raw water sample

# A Data from the tests with the contaminated raw water sample

## A.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)

### A.1.1 Primary measurements

Table A.1 Raw data of the fluorescence (RFU) generated in the algal growth inhibition test with the contaminated raw water sample (DHI ID No. 20-1242). The blanks were prepared exactly as the dilution series but did not contain algae.

| Test concentration | Replicate | 0 hour | 23.5 hours | 48 hours | 71 hours |
|---|---|---|---|---|---|
| Control | A | 26 | 89 | 684 | 3,888 |
| Control | B | 26 | 94 | 595 | 3,591 |
| Control | C | 26 | 88 | 631 | 3,006 |
| Control | D | 26 | 103 | 801 | 3,870 |
| Control | E | 26 | 96 | 722 | 3,654 |
| Control | F | 26 | 105 | 851 | 3,807 |
| Control blank | | 16 | 15 | 16 | 17 |
| 50 mL/L | A | 27 | 106 | 836 | 4,401 |
| 50 mL/L | B | 27 | 105 | 835 | 3,492 |
| 50 mL/L | C | 27 | 100 | 783 | 4,086 |
| 50 mL/L blank | | 16 | 15 | 16 | 17 |
| 80 mL/L | A | 28 | 105 | 795 | 3,834 |
| 80 mL/L | B | 28 | 103 | 812 | 3,987 |
| 80 mL/L | C | 28 | 102 | 781 | 4,014 |
| 80 mL/L blank | | 16 | 16 | 16 | 18 |
| 120 mL/L | A | 28 | 111 | 799 | 3,240 |
| 120 mL/L | B | 28 | 100 | 740 | 3,888 |
| 120 mL/L | C | 28 | 90 | 661 | 3,744 |
| 120 mL/L blank | | 17 | 16 | 17 | 17 |
| 200 mL/L | A | 29 | 104 | 711 | 3,573 |
| 200 mL/L | B | 29 | 95 | 656 | 3,816 |
| 200 mL/L | C | 29 | 103 | 733 | 3,312 |
| 200 mL/L blank | | 18 | 16 | 17 | 17 |
| 300 mL/L | A | 29 | 104 | 723 | 3,663 |
| 300 mL/L | B | 29 | 105 | 689 | 4,068 |
| 300 mL/L | C | 29 | 97 | 661 | 3,780 |
| 300 mL/L blank | | 18 | 16 | 17 | 17 |
| 500 mL/L | A | 30 | 95 | 616 | 3,339 |
| 500 mL/L | B | 30 | 97 | 652 | 3,834 |

| Test concentration | Replicate | 0 hour | 23.5 hours | 48 hours | 71 hours |
|---|---|---|---|---|---|
| 500 mL/L | C | 30 | 96 | 642 | 3,717 |
| 500 mL/L blank | | 19 | 16 | 18 | 17 |
| 800 mL/L | A | 31 | 102 | 653 | 3,924 |
| 800 mL/L | B | 31 | 98 | 650 | 4,086 |
| 800 mL/L | C | 31 | 95 | 662 | 3,834 |
| 800 mL/L blank | | 19 | 17 | 17 | 18 |

Table A. 2 Measurements of pH during the algal growth inhibition test with the contaminated raw water sample.

| Date | 2020-03-17 – Day 0 | 2020-03-20 – Day 3 |
|---|---|---|
| **Test concentration** | **pH** | **pH** |
| Control | 8.3 | 9.4 |
| 50 mL/L | 8.3 | 10 |
| 80 mL/L | 8.3 | 10 |
| 120 mL/L | 8.3 | 10 |
| 200 mL/L | 8.3 | 9.9 |
| 300 mL/L | 8.3 | 9.8 |
| 500 mL/L | 8.3 | 9.8 |
| 800 mL/L | 8.3 | 9.6 |

Table A. 3 Physical parameters – temperature monitoring from 2020-03-17 to 2020-03-20.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 23.0 | 0.1 | 22.8 | 23.1 |

## A.1.2 Statistical analysis – Determination of effect concentrations after exposure

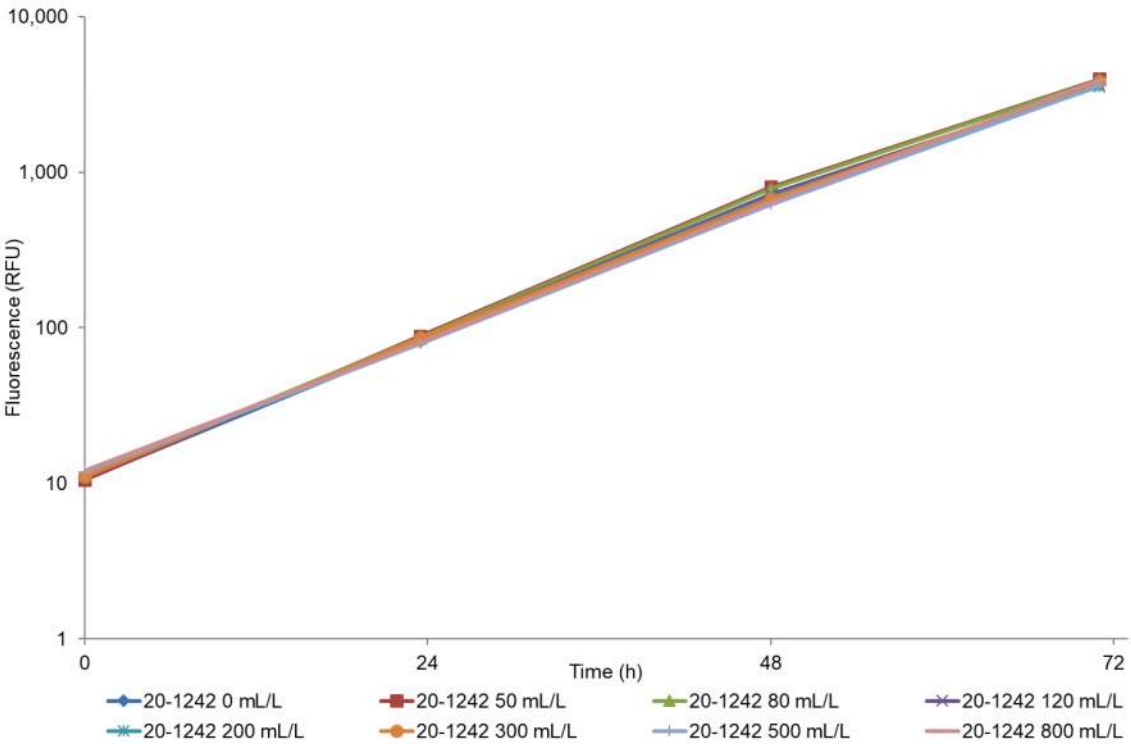


Figure A. 1 Fluorescence versus time in test with *Raphidocelis subcapitata* exposed to different concentrations of contaminated raw water sample (DHI ID No. 20-1242).

### A.1.2.1 Results of the statistical analysis of the growth rate

- Growth rate

Table A. 4 Experimental data of the growth rate ($h^{-1}$) in the tested concentrations.

| Replicate No. | Control | 50 mL/L | 80 mL/L | 120 mL/L | 200 mL/L | 300 mL/L | 500 mL/L | 800 mL/L |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.084 | 0.085 | 0.083 | 0.081 | 0.082 | 0.082 | 0.080 | 0.082 |
| 2 | 0.082 | 0.083 | 0.084 | 0.083 | 0.083 | 0.083 | 0.082 | 0.082 |
| 3 | 0.080 | 0.085 | 0.083 | 0.083 | 0.081 | 0.082 | 0.081 | 0.082 |
| 4 | 0.084 | - | - | - | - | - | - | - |
| 5 | 0.083 | - | - | - | - | - | - | - |
| 6 | 0.084 | - | - | - | - | - | - | - |
| Count | 6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| mean | 0.083 | 0.084 | 0.083 | 0.082 | 0.082 | 0.083 | 0.081 | 0.082 |
| Significance[1)] | - | | | | | | | |

1) Signif. codes: 0 '***' 0.001'**' 0.01 '*' 0.05 '.'0.1 ''1

- Normality

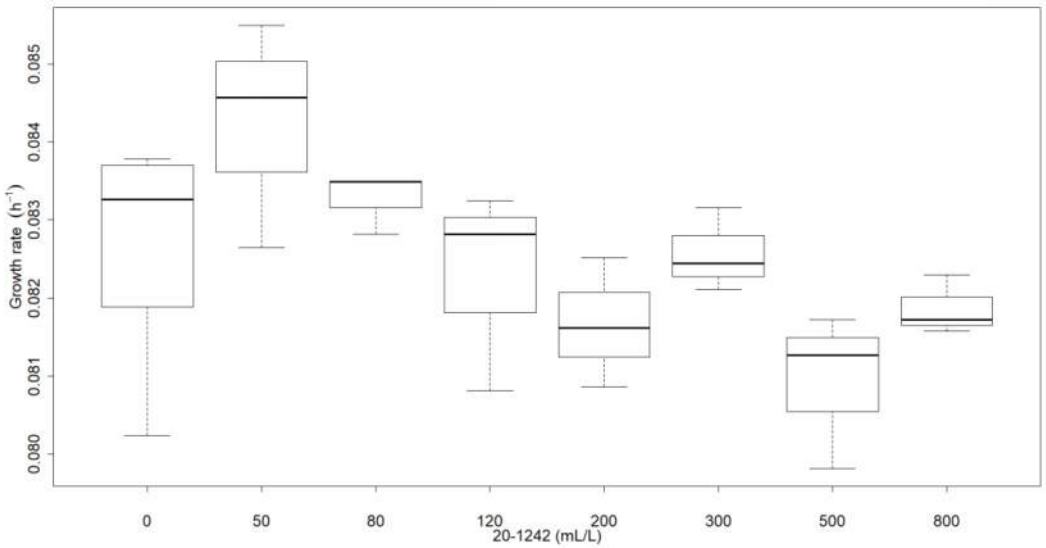


Figure A. 2 Boxplot of every test group for the growth rate.

The boxplot patterns show the data distribution (Figure A. 2). A normal distribution in each test group will be assumed in the following study.

As no significant negative effect was observed among the test groups, the data to estimate the ECX were not computed.

The test results can be seen in Table A. 5

Table A. 5 Growth rate endpoint, estimations of NOEC, LOEC, EC10 and EC50.

| Endpoint | NOEC | LOEC | EC10 | EC50 | Unit |
|---|---|---|---|---|---|
| Growth rate | 800 | >800 | >800 | >800 | mL/L |

## A.1.3 Calculation of the mean coefficient of variation for section-by-section specific growth rates

Table A. 6 Calculation of the mean coefficient of variation for section-by-section specific growth rates (between 0-1, 1-2 and 2-3 days) in the laboratory control cultures.

| Replicate | Growth rate per section (growth per hour) | | | Average growth | Variation coefficient |
|---|---|---|---|---|---|
| | 0-23.5 hours | 23.5-48 hours | 48-71 hours | | |
| Control 1 | 0.083 | 0.089 | 0.076 | 0.083 | 8% |
| Control 2 | 0.086 | 0.081 | 0.079 | 0.082 | 4% |
| Control 3 | 0.082 | 0.087 | 0.069 | 0.079 | 12% |
| Control 4 | 0.090 | 0.089 | 0.069 | 0.083 | 14% |
| Control 5 | 0.087 | 0.088 | 0.071 | 0.082 | 11% |
| Control 6 | 0.091 | 0.091 | 0.066 | 0.083 | 18% |
| Mean value | 0.087 | 0.087 | 0.072 | 0.082 | 11% |

### A.1.4 Validity criteria

Table A. 7 Validity criteria for the growth inhibition test with *Raphidocelis subcapitata* according to OECD 201 /1/.

| Criteria in the control | Target value | Fulfilled |
|---|---|---|
| Control pH increase during test | ≤ 1.5 (observed: 1.1) | yes |
| Control specific growth rate | ≥ 1.4 per day (observed: 2.0 per day) | yes |
| Control variation coefficient | ≤ 7.0% (observed: 1.7%) | yes |
| The mean coefficient of variation for section-by-section specific growth rates (0-1, 1-2 and 2-3 days) | ≤ 35% in the control (observed: 11%) | yes |

## A.2 *Raphidocelis subcapitata* growth inhibition test (without pH-adjustment of the sample)

### A.2.1 Primary measurements

Table A.8 Raw data of the fluorescence (RFU) generated in the algal growth inhibition test with the contaminated raw water sample (DHI ID No. 20-1242). The blanks were prepared exactly as the dilution series but did not contain algae.

| Test concentration | Replicate | 0 hour | 23.5 hours | 47.5 hours | 70 hours |
|---|---|---|---|---|---|
| Control | A | 6.1 | 40.7 | 134 | 439 |
| Control | B | 6.1 | 46.8 | 226 | 1,127 |
| Control | C | 6.1 | 44.0 | 166 | 580 |
| Control | D | 6.1 | 39.7 | 144 | 544 |
| Control | E | 6.1 | 42.7 | 192 | 867 |
| Control | F | 6.1 | 47.0 | 222 | 1,102 |
| Control blank | | 0.0 | 0.1 | 0 | 0 |
| 50 mL/L | A | 6.1 | 42.5 | 331 | 2,730 |
| 50 mL/L | B | 6.1 | 45.5 | 390 | 3,068 |
| 50 mL/L | C | 6.1 | 53.0 | 429 | 2,580 |
| 50 mL/L blank | | 0.0 | 0.2 | 0 | 0 |
| 80 mL/L | A | 6.3 | 47.8 | 379 | 3,094 |
| 80 mL/L | B | 6.3 | 46.4 | 389 | 2,977 |
| 80 mL/L | C | 6.3 | 45.9 | 366 | 2,909 |
| 80 mL/L blank | | 0.0 | 0.1 | 0 | 0 |
| 120 mL/L | A | 6.5 | 46.0 | 414 | 3,454 |
| 120 mL/L | B | 6.5 | 45.4 | 369 | 2,897 |
| 120 mL/L | C | 6.5 | 48.3 | 402 | 3,470 |
| 120 mL/L blank | | 0.1 | 0.1 | 0 | 0 |
| 200 mL/L | A | 6.9 | 44.4 | 356 | 2,740 |
| 200 mL/L | B | 6.9 | 53.5 | 428 | 3,054 |
| 200 mL/L | C | 6.9 | 47.8 | 396 | 3,195 |
| 200 mL/L blank | | 0.2 | 0.2 | 0.1 | 0.1 |
| 300 mL/L | A | 6.5 | 51.6 | 429 | 2,598 |
| 300 mL/L | B | 6.5 | 57.0 | 434 | 3,344 |
| 300 mL/L | C | 6.5 | 48.0 | 373 | 2,909 |
| 300 mL/L blank | | 0.3 | 0.3 | 0.2 | 0.2 |
| 500 mL/L | A | 6.6 | 61.6 | 489 | 2,047 |
| 500 mL/L | B | 6.6 | 58.4 | 464 | 1,850 |
| 500 mL/L | C | 6.6 | 50.9 | 456 | 2,036 |
| 500 mL/L blank | | 0.4 | 0.5 | 0.4 | 0.3 |

Table A. 9 Measurements of pH during the algal growth inhibition test with the contaminated raw water sample.

| Date | 2020-03-24 – Day 0 | 2020-03-27 – Day 3 |
|---|---|---|
| **Test concentration** | **pH** | **pH** |
| Control | 7.2 | 8.7 |
| 50 mL/L | 7.1 | 9.4 |
| 80 mL/L | 7.0 | 9.4 |
| 120 mL/L | 7.0 | 9.6 |
| 200 mL/L | 6.9 | 9.6 |
| 300 mL/L | 6.8 | 9.7 |
| 500 mL/L | 6.7 | 9.3 |

Table A. 10 Physical parameters – temperature monitoring from 2020-03-24 to 2020-03-27.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 22.4 | 0.1 | 22.2 | 22.6 |

## A.2.2 Statistical analysis – Determination of effect concentrations after exposure

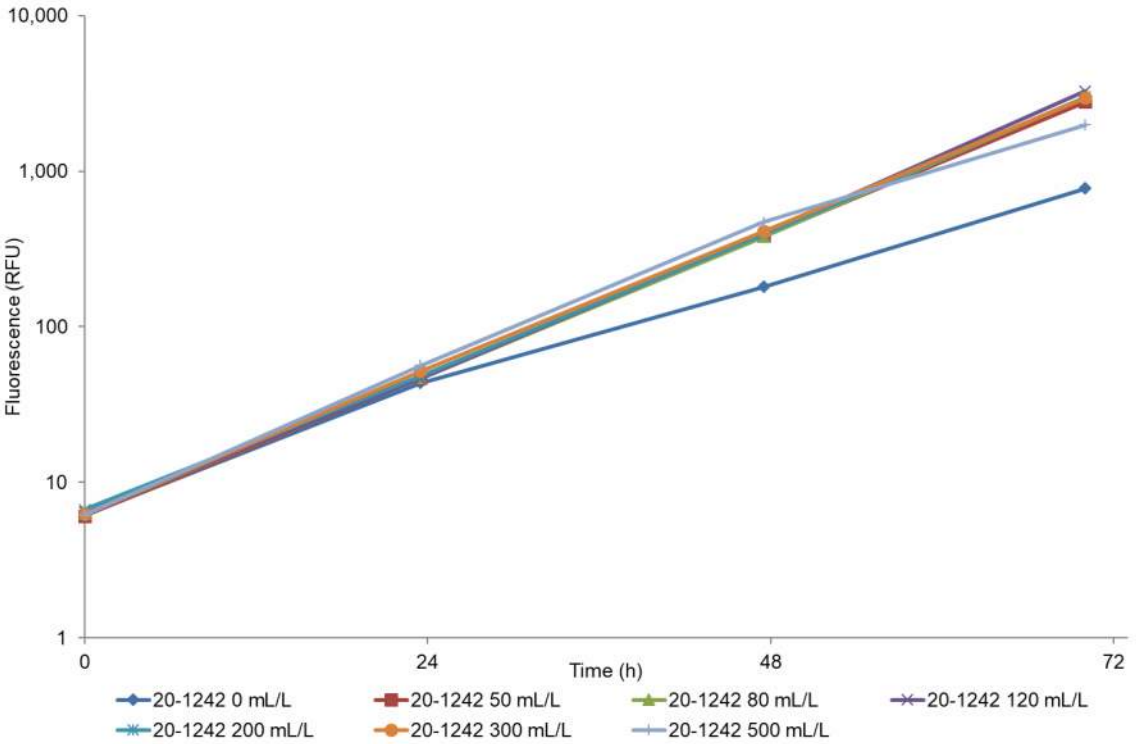


Figure A. 3 Fluorescence versus time in test with *Raphidocelis subcapitata* exposed to different concentrations of the contaminated raw water sample (DHI ID No. 20-1242).

## A.2.3 Results of the statistical analysis of the growth rate

- Growth rate

Table A. 11 Experimental data of the growth rate ($h^{-1}$) in the tested concentrations.

| Replicate No. | Control | 50 mL/L | 80 mL/L | 120 mL/L | 200 mL/L | 300 mL/L | 500 mL/L |
|---|---|---|---|---|---|---|---|
| 1 | 0.060 | 0.087 | 0.088 | 0.090 | 0.086 | 0.086 | 0.083 |
| 2 | 0.074 | 0.089 | 0.088 | 0.087 | 0.087 | 0.089 | 0.082 |
| 3 | 0.064 | 0.087 | 0.088 | 0.090 | 0.088 | 0.087 | 0.084 |
| 4 | 0.063 | - | - | - | - | - | - |
| 5 | 0.070 | - | - | - | - | - | - |
| 6 | 0.073 | - | - | - | - | - | - |
| Count | 6 | 3 | 3 | 3 | 3 | 3 | 3 |
| mean | 0.067 | 0.087 | 0.088 | 0.089 | 0.087 | 0.088 | 0.083 |
| Significance[1)] | - | ***[2)] | ***[2)] | ***[2)] | ***[2)] | ***[2)] | ***[2)] |

1) Signif. codes: 0 '***' 0.001'**' 0.01 '*' 0.05 '.'0.1 ''1
2) Significantly higher than the control

- Normality

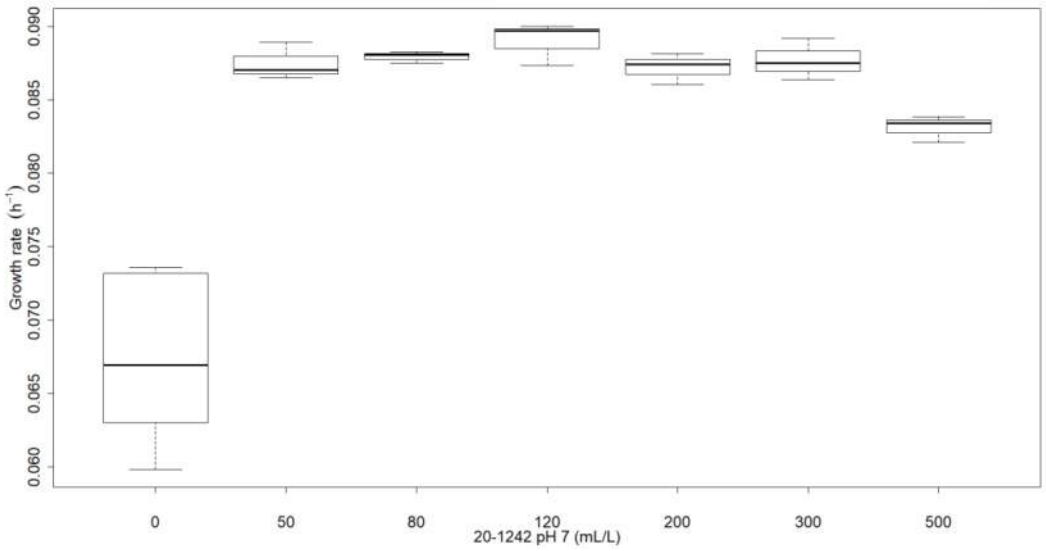


Figure A. 4 Boxplot of every test group for the growth rate.

The boxplot patterns show the data distribution (Figure A. 4). A normal distribution in each test group will be assumed in the following study.

As no negative effect was observed among the test groups, the data to estimate the ECX were not computed.

The test results can be seen in Table A. 12.

Table A. 12 Growth rate endpoint, estimations of NOEC, LOEC, EC10 and EC50.

| Endpoint | NOEC | LOEC | EC10 | EC50 | Unit |
|---|---|---|---|---|---|
| Growth rate | 500 | >500 | >500 | >500 | mL/L |

## A.2.4 Calculation of the mean coefficient of variation for section-by-section specific growth rates

Table A. 13 Calculation of the mean coefficient of variation for section-by-section specific growth rates (between 0-1, 1-2 and 2-3 days) in the laboratory control cultures.

| Replicate | Growth rate per section (growth per hour) | | | Average growth | Variation coefficient |
|---|---|---|---|---|---|
| | 0-23.5 hours | 23.5-47.5 hours | 47.5-70 hours | | |
| Control 1 | 0.080 | 0.050 | 0.053 | 0.061 | 28% |
| Control 2 | 0.086 | 0.066 | 0.071 | 0.074 | 14% |
| Control 3 | 0.084 | 0.055 | 0.056 | 0.065 | 25% |
| Control 4 | 0.079 | 0.054 | 0.059 | 0.064 | 21% |
| Control 5 | 0.082 | 0.063 | 0.067 | 0.071 | 15% |
| Control 6 | 0.087 | 0.065 | 0.071 | 0.074 | 15% |
| Mean value | 0.083 | 0.059 | 0.063 | 0.068 | 20% |

## A.2.5 Validity criteria

Table A. 14 Validity criteria for the growth inhibition test with *Raphidocelis subcapitata* according to OECD 201 /1/.

| Criteria in the control | Target value | Fulfilled |
|---|---|---|
| Control pH increase during test | ≤ 1.5 (observed: 1.5) | yes |
| Control specific growth rate | ≥ 1.4 per day (observed: 1.6 per day) | yes |
| Control variation coefficient | ≤ 7.0% (observed: 8.5%) | no |
| The mean coefficient of variation for section-by-section specific growth rates (0-1, 1-2 and 2-3 days) | ≤ 35% in the control (observed: 20%) | yes |

# A.3 *Daphnia magna* acute immobilisation test

## A.3.1 Primary data on the immobilisation test

Table A. 15 Daily observations of the total number mobile and immobile daphnids in the immobilisation test.

| **Date** | | **17 March 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **0** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

| **Date** | | **18 March 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **1** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 0 | 5 | 5 | 5 | 5 | 5 | 5[1)] | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

1) This result is considered an outlier and not included in the estimations.

| Date | | 19 March 2020 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accumulated days | | 2 | | | | | | | | | | | |
| Concentration | Initial number of daphnids | Number of mobile daphnids | | | | | | Number of immobile daphnids | | | | | |
| | | A | B | C | D | E | F | A | B | C | D | E | F |
| Control | 25 (30) | - | 5 | 5 | 5 | 5 | 5 | - | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

Table A. 16 Measurement of dissolved oxygen and pH during the immobilisation test - Day 0 and Day 2.

| Concentration | Dissolved oxygen (% sat) | | pH | |
|---|---|---|---|---|
| | Day 0 | Day 2 | Day 0 | Day 2 |
| Control | 100 | 97 | 7.9 | 7.9 |
| 56.3 mL/L | 100 | 97 | 7.9 | 8.0 |
| 113 mL/L | 100 | 97 | 7.7 | 8.0 |
| 225 mL/L | 100 | 96 | 7.6 | 8.0 |
| 450 mL/L | 100 | 96 | 7.4 | 8.0 |
| 900 mL/L | 97 | 96 | 6.3 | 8.0 |

Table A. 17 Physical parameters – temperature monitoring from 2020-03-17 to 2020-03-19.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 19.3 | 0.1 | 19.1 | 19.6 |

## A.3.2 Statistical analysis – Determination of effect concentrations after exposure

### A.3.2.1 Determination of the immobilisation ratio

Determination of the percentage immobilisation for each concentration in relation to the total number and estimation of the EC values.

Table A. 18 Experimental data of the immobilisation ratio (number of adults immobile per concentration)

| Concentration | No. of daphnids exposed | No. of immobile daphnids 24h | No. of immobile daphnids 48h | Immobilisation 24 h (%) | Immobilisation 48 h (%) |
|---|---|---|---|---|---|
| Control | 25[1)] | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 0 | 0 | 0 | 0 |
| 113 mL/L | 20 | 0 | 0 | 0 | 0 |
| 225 mL/L | 20 | 0 | 0 | 0 | 0 |
| 450 mL/L | 20 | 0 | 0 | 0 | 0 |
| 900 mL/L | 20 | 0 | 0 | 0 | 0 |

1) Control replicate A was considered an outlier and not included in the calculation.

### A.3.2.2 Results of the Probit analysis

As no negative effect was observed among the test groups, the data to estimate the ECX were not computed.

The test results can be seen in Table A. 19

Table A. 19 Immobilisation endpoint, estimations of EC10 and EC50.

| Endpoint | EC10 | EC50 | Unit |
|---|---|---|---|
| Immobilisation | >900 | >900 | mL/L |

## A.3.3 Validity criteria

Table A. 20 Validity criteria of the test according to the OECD No. 202 /2/ in the acute immobilisation test with *Daphnia magna.*

| Criteria | Target value | Fulfilled |
|---|---|---|
| Control immobilisation ratio | ≤ 10% (observed: 0%)[1)] | Yes |
| Dissolved oxygen | ≥70% (observed: ≥96%) | Yes |

1) 100% immobilisation seen in Control replicate A after 24 hours was considered an outlier.

# APPENDIX B

## Data from the test with “PAC-A6-SF”

# B Data from the test with “PAC-A6-SF”

## B.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)

### B.1.1 Primary measurements

Table B. 1 Raw data of the fluorescence (RFU) generated in the algal growth inhibition test with “PAC-A6-SF” (DHI ID No. 20-1245). The blanks were prepared exactly as the dilution series but did not contain algae.

| Test concentration | Replicate | 0 hour | 24 hours | 47 hours | 71 hours |
|---|---|---|---|---|---|
| Control | A | 8.3 | 41.0 | 181 | 807 |
| Control | B | 8.3 | 39.9 | 162 | 781 |
| Control | C | 8.3 | 42.7 | 197 | 952 |
| Control | D | 8.3 | 37.8 | 143 | 530 |
| Control | E | 8.3 | 43.6 | 206 | 1,081 |
| Control | F | 8.3 | 41.0 | 198 | 959 |
| Control blank | | 0 | 0 | 0 | 0 |
| 50 mL/L | A | 8.0 | 38.1 | 201 | 863 |
| 50 mL/L | B | 8.0 | 44.4 | 260 | 1,204 |
| 50 mL/L | C | 8.0 | 42.8 | 203 | 725 |
| 50 mL/L blank | | 0 | 0 | 0 | 0 |
| 80 mL/L | A | 7.6 | 41.3 | 236 | 1,215 |
| 80 mL/L | B | 7.6 | 40.4 | 175 | 680 |
| 80 mL/L | C | 7.6 | 35.2 | 150 | 504 |
| 80 mL/L blank | | 0 | 0 | 0 | 0 |
| 120 mL/L | A | 8.2 | 41.6 | 227 | 889 |
| 120 mL/L | B | 8.2 | 40.6 | 206 | 771 |
| 120 mL/L | C | 8.2 | 33.0 | 162 | 694 |
| 120 mL/L blank | | 0 | 0 | 0 | 0 |
| 200 mL/L | A | 7.5 | 39.8 | 201 | 968 |
| 200 mL/L | B | 7.5 | 36.3 | 183 | 857 |
| 200 mL/L | C | 7.5 | 37.4 | 192 | 748 |
| 200 mL/L blank | | 0 | 0 | 0 | 0 |
| 300 mL/L | A | 8.1 | 35.9 | 167 | 865 |
| 300 mL/L | B | 8.1 | 32.9 | 145 | 725 |
| 300 mL/L | C | 8.1 | 33.4 | 147 | 538 |
| 300 mL/L blank | | 0 | 0 | 0 | 0 |
| 500 mL/L | A | 7.9 | 26.9 | 115 | 476 |
| 500 mL/L | B | 7.9 | 27.0 | 112 | 523 |
| 500 mL/L | C | 7.9 | 24.2 | 89.2 | 420 |

| Test concentration | Replicate | 0 hour | 24 hours | 47 hours | 71 hours |
|---|---|---|---|---|---|
| 500 mL/L blank | | 0 | 0 | 0 | 0 |
| 800 mL/L | A | 8.2 | 21.3 | 65.1 | 308 |
| 800 mL/L | B | 8.2 | 19.4 | 46.4 | 205 |
| 800 mL/L | C | 8.2 | 20.0 | 59.7 | 221 |
| 800 mL/L blank | | 0 | 0 | 0 | 0 |

Table B. 2 Measurements of pH during the algal growth inhibition test with “PAC-B6-SF”

| Date | 2020-05-12 – Day 0 | 2020-05-15 – Day 3 |
|---|---|---|
| **Test concentration** | **pH** | **pH** |
| Control | 8.3 | 8.7 |
| 50 mL/L | 8.5 | 8.7 |
| 80 mL/L | 8.5 | 9.0 |
| 120 mL/L | 8.4 | 8.9 |
| 200 mL/L | 8.4 | 8.7 |
| 300 mL/L | 8.4 | 8.7 |
| 500 mL/L | 8.4 | 8.6 |
| 800 mL/L | 8.3 | 8.3 |

Table B. 3 Physical parameters – temperature monitoring from 2020-05-12 to 2020-05-15.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 22.6 | 0.1 | 22.1 | 22.7 |

## B.1.2 Statistical analysis – Determination of effect concentrations after exposure

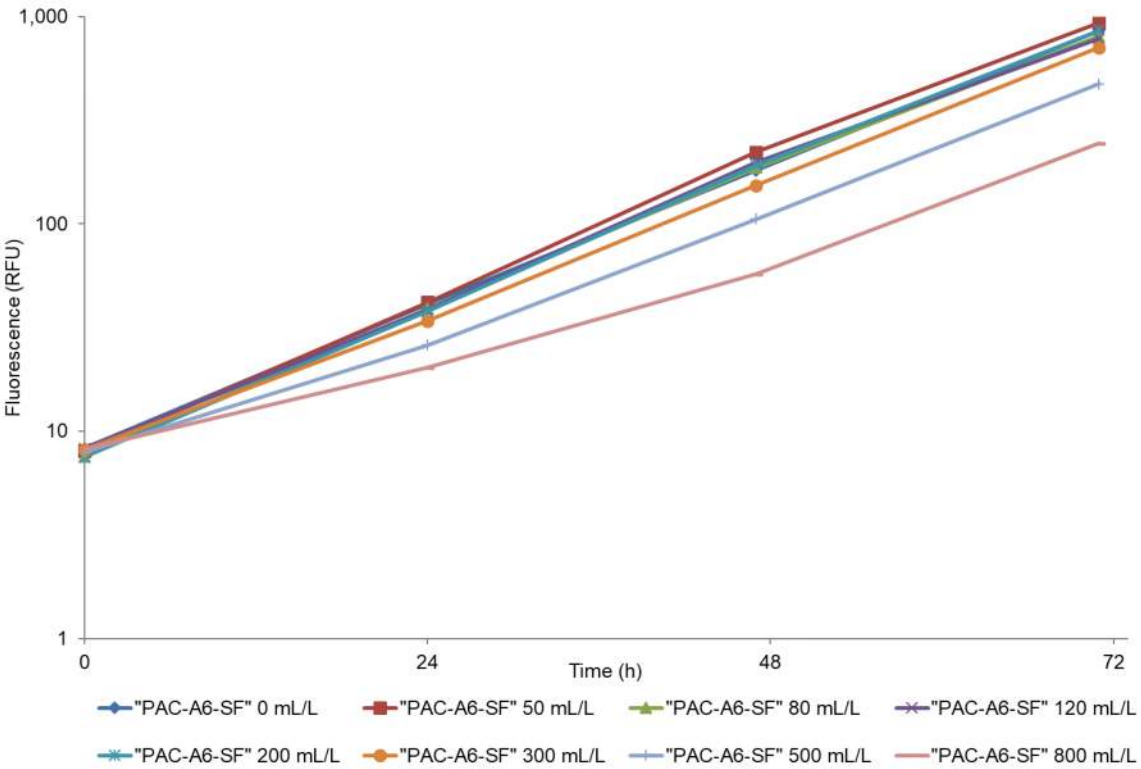


Figure B. 1 Fluorescence versus time in test with *Raphidocelis subcapitata* exposed to different concentrations of "PAC-A6-SF" (DHI ID No. 20-1245).

## B.1.3 Results of the statistical analysis of the growth rate

- Growth rate

Table B. 4 Experimental data of the growth rate ($h^{-1}$) in the tested concentrations.

| Replicate No. | Control | 50 mL/L | 80 mL/L | 120 mL/L | 200 mL/L | 300 mL/L | 500 mL/L | 800 mL/L |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.065 | 0.066 | 0.072 | 0.067 | 0.069 | 0.066 | 0.058 | 0.051 |
| 2 | 0.064 | 0.071 | 0.063 | 0.065 | 0.067 | 0.063 | 0.059 | 0.045 |
| 3 | 0.067 | 0.064 | 0.060 | 0.063 | 0.065 | 0.060 | 0.056 | 0.047 |
| 4 | 0.059 | - | - | - | - | - | - | - |
| 5 | 0.069 | - | - | - | - | - | - | - |
| 6 | 0.067 | - | - | - | - | - | - | - |
| Count | 6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| mean | 0.065 | 0.067 | 0.065 | 0.065 | 0.067 | 0.063 | 0.058 | 0.047 |
| Significance[1)] | - | | | | | | | *** |

1) Signif. codes: 0 '***' 0.001'**' 0.01 '*' 0.05 '.'0.1 ''1

- Normality

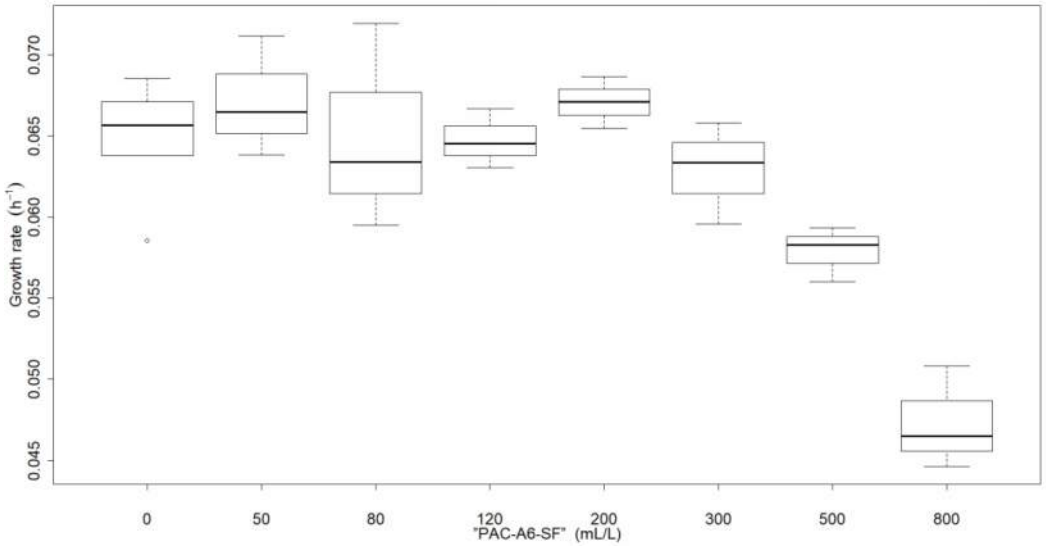


Figure B. 2 Boxplot of every test group for the growth rate.

The boxplot patterns show the data distribution (Figure B. 2). A normal distribution in each test group will be assumed in the following study.

### B.1.3.1 Results of the Probit analysis

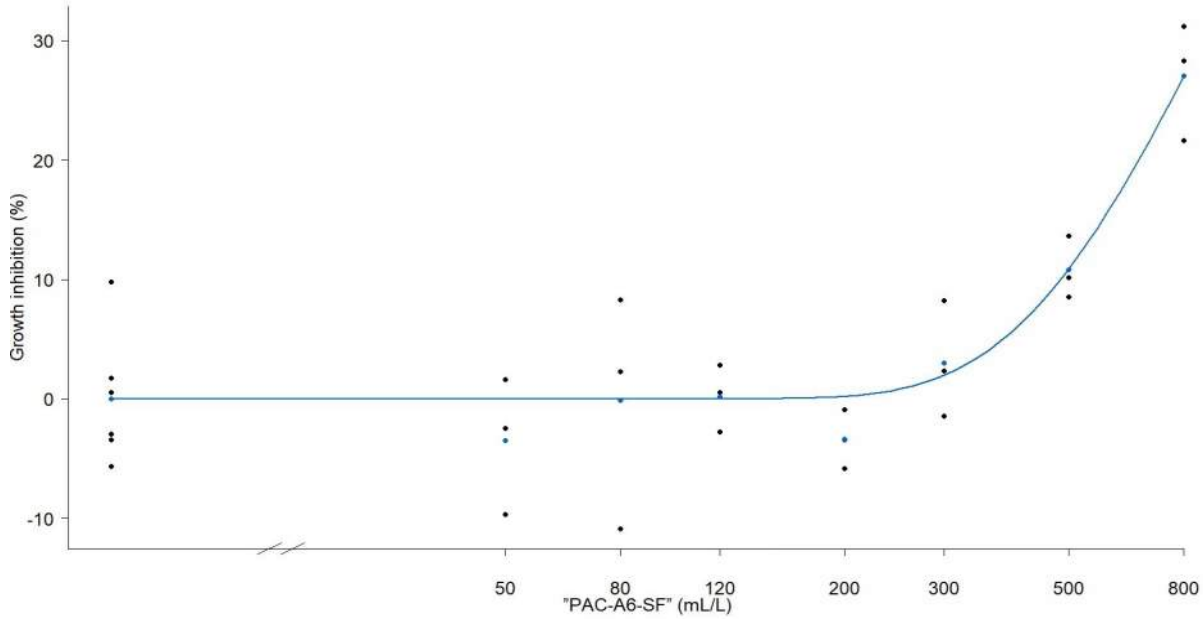


Figure B. 3 Effect of "PAC-A6-SF" on the growth rate after 3 days of exposure. In blue, the dose response curve established by use of the free software R. The blue points correspond to the average inhibition per concentrations. The black points correspond to the inhibition per replicate.

The test results can be seen in Table B. 5.

Table B. 5 Growth rate endpoint, estimations of NOEC, LOEC, EC10 and EC50.

| Endpoint | NOEC | LOEC | EC10 | EC50 | Unit |
|---|---|---|---|---|---|
| Growth rate | 500 | 800 | 483 (393-572) | >800 | mL/L |

## B.1.4 Calculation of the mean coefficient of variation for section-by-section specific growth rates

Table B. 6 Calculation of the mean coefficient of variation for section-by-section specific growth rates (between 0-1, 1-2 and 2-3 days) in the laboratory control cultures.

| Replicate | Growth rate per section (growth per hour) | | | Average growth | Variation coefficient |
|---|---|---|---|---|---|
| | 0-24 hours | 24-47 hours | 47-71 hours | | |
| Control 1 | 0.067 | 0.065 | 0.062 | 0.065 | 3% |
| Control 2 | 0.066 | 0.061 | 0.065 | 0.064 | 4% |
| Control 3 | 0.068 | 0.066 | 0.066 | 0.067 | 2% |
| Control 4 | 0.063 | 0.058 | 0.055 | 0.059 | 8% |
| Control 5 | 0.069 | 0.068 | 0.069 | 0.069 | 1% |
| Control 6 | 0.067 | 0.068 | 0.066 | 0.067 | 2% |
| Mean value | 0.067 | 0.064 | 0.064 | 0.065 | 3% |

## B.1.5 Validity criteria

Table B. 7 Validity criteria for the growth inhibition test with *Raphidocelis subcapitata* according to OECD 201 /1/.

| Criteria in the control | Target value | Fulfilled |
|---|---|---|
| Control pH increase during test | ≤ 1.5 (observed: 0.4) | yes |
| Control specific growth rate | ≥ 1.4 per day (observed: 1.6 per day) | yes |
| Control variation coefficient | ≤ 7.0% (observed: 5.5%) | yes |
| The mean coefficient of variation for section-by-section specific growth rates (0-1, 1-2 and 2-3 days) | ≤ 35% in the control (observed: 3%) | yes |

# B.2 *Daphnia magna* acute immobilisation test

## B.2.1 Primary data on the immobilisation test

Table B. 8 Daily observations of the total number mobile and immobile daphnids in the immobilisation test.

| **Date** | | **13 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **0** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

| **Date** | | **16 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **1** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 0 | 5 | 5 | 5 | 0 | 0 | 5[1)] | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

1) This result is considered an outlier and not included in the estimations.

| Date | | 19 March 2020 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accumulated days | | 2 | | | | | | | | | | | |
| Concentration | Initial number of daphnids | Number of mobile daphnids | | | | | | Number of immobile daphnids | | | | | |
| | | A | B | C | D | E | F | A | B | C | D | E | F |
| Control | 25 (30) | 5 | 5 | - | 5 | 5 | 5 | 0 | 0 | - | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

Table B. 9 Measurement of dissolved oxygen and pH during the immobilisation test - Day 0 and Day 2.

| Concentration | Dissolved oxygen (% sat) | | pH | |
|---|---|---|---|---|
| | Day 0 | Day 2 | Day 0 | Day 2 |
| Control | 98 | 97 | 8.0 | 8.1 |
| 56.3 mL/L | 99 | 97 | 8.0 | 8.1 |
| 113 mL/L | 99 | 97 | 8.0 | 8.1 |
| 225 mL/L | 99 | 97 | 8.0 | 8.1 |
| 450 mL/L | 98 | 97 | 8.0 | 8.1 |
| 900 mL/L | 96 | 97 | 7.9 | 8.2 |

Table B. 10 Physical parameters – temperature monitoring from 2020-05-13 to 2020-05-15.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 19.1 | 0.1 | 19.0 | 19.3 |

## B.2.2 Statistical analysis – Determination of effect concentrations after exposure

### B.2.2.1 Determination of the immobilisation ratio

Determination of the percentage immobilisation for each concentration in relation to the total number and estimation of the EC values.

Table B. 11 Experimental data of the immobilisation ratio (number of adults immobile per concentration)

| Concentration | No. of daphnids exposed | No. of immobile daphnids 24h | No. of immobile daphnids 48h | Immobilisation 24 h (%) | Immobilisation 48 h (%) |
|---|---|---|---|---|---|
| Control | 25[1)] | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 0 | 0 | 0 | 0 |
| 113 mL/L | 20 | 0 | 0 | 0 | 0 |
| 225 mL/L | 20 | 0 | 0 | 0 | 0 |
| 450 mL/L | 20 | 0 | 0 | 0 | 0 |
| 900 mL/L | 20 | 0 | 0 | 0 | 0 |

1) Control replicate C was considered an outlier and not included in the calculation.

### B.2.2.2 Results of the Probit analysis

As no negative effect was observed among the test groups, the data to estimate the ECX were not computed.

The test results can be seen in Table B. 12

Table B. 12 Immobilisation endpoint, estimations of EC10 and EC50.

| Endpoint | EC10 | EC50 | Unit |
|---|---|---|---|
| Immobilisation | >900 | >900 | mL/L |

## B.2.3 Validity criteria

Table B. 13 Validity criteria of the test according to the OECD No. 202 /2/ in the acute immobilisation test with *Daphnia magna.*

| Criteria | Target value | Fulfilled |
|---|---|---|
| Control immobilisation ratio | ≤ 10% (observed: 0%)[1)] | Yes |
| Dissolved oxygen | ≥70% (observed: ≥96%) | Yes |

1) 100% immobilisation seen in Control replicate C after 24 hours was considered an outlier.

# APPENDIX C

## Data from the test with “PAC-B6-SF”

# C Data from the test with “PAC-A6-SF”

## C.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)

### C.1.1 Primary measurements

Table C. 1 Raw data of the fluorescence (RFU) generated in the algal growth inhibition test with “PAC-B6-SF” (DHI ID No. 20-1246). The blanks were prepared exactly as the dilution series but did not contain algae.

| Test concentration | Replicate | 0 hour | 24 hours | 47 hours | 71 hours |
|---|---|---|---|---|---|
| Control | A | 8.3 | 44.2 | 188 | 857 |
| Control | B | 8.3 | 41.0 | 168 | 791 |
| Control | C | 8.3 | 44.2 | 201 | 1,003 |
| Control | D | 8.3 | 40.5 | 143 | 563 |
| Control | E | 8.3 | 42.1 | 221 | 1,150 |
| Control | F | 8.3 | 44.0 | 198 | 1,010 |
| Control blank | | 0 | 0 | 0 | 0 |
| 50 mL/L | A | 7.7 | 42.7 | 250 | 971 |
| 50 mL/L | B | 7.7 | 43.0 | 247 | 1,100 |
| 50 mL/L | C | 7.7 | 48.7 | 272 | 1,328 |
| 50 mL/L blank | | 0 | 0 | 0 | 0 |
| 80 mL/L | A | 8.0 | 47.3 | 298 | 1,534 |
| 80 mL/L | B | 8.0 | 45.3 | 232 | 719 |
| 80 mL/L | C | 8.0 | 46.3 | 243 | 825 |
| 80 mL/L blank | | 0 | 0 | 0 | 0 |
| 120 mL/L | A | 7.5 | 40.3 | 193 | 617 |
| 120 mL/L | B | 7.5 | 40.3 | 200 | 795 |
| 120 mL/L | C | 7.5 | 41.8 | 223 | 1,137 |
| 120 mL/L blank | | 0 | 0 | 0 | 0 |
| 200 mL/L | A | 8.1 | 43.1 | 205 | 866 |
| 200 mL/L | B | 8.1 | 37.3 | 180 | 709 |
| 200 mL/L | C | 8.1 | 44.5 | 210 | 678 |
| 200 mL/L blank | | 0 | 0 | 0 | 0 |
| 300 mL/L | A | 7.9 | 38.6 | 175 | 627 |
| 300 mL/L | B | 7.9 | 34.9 | 176 | 665 |
| 300 mL/L | C | 7.9 | 44.6 | 202 | 578 |
| 300 mL/L blank | | 0 | 0 | 0 | 0 |
| 500 mL/L | A | 8.5 | 33.4 | 154 | 433 |
| 500 mL/L | B | 8.5 | 30.4 | 143 | 541 |
| 500 mL/L | C | 8.5 | 40.4 | 228 | 853 |

| Test concentration | Replicate | 0 hour | 24 hours | 47 hours | 71 hours |
|---|---|---|---|---|---|
| 500 mL/L blank | | 0 | 0 | 0 | 0 |
| 800 mL/L | A | 7.3 | 26.4 | 101 | 251 |
| 800 mL/L | B | 7.3 | 31.7 | 128 | 293 |
| 800 mL/L | C | 7.3 | 28.4 | 123 | 292 |
| 800 mL/L blank | | 0 | 0 | 0 | 0 |

Table C. 2 Measurements of pH during the algal growth inhibition test with “PAC-B6-SF”

| Date | 2020-05-12 – Day 0 | 2020-05-15 – Day 3 |
|---|---|---|
| **Test concentration** | **pH** | **pH** |
| Control | 8.3 | 8.7 |
| 50 mL/L | 8.2 | 8.7 |
| 80 mL/L | 8.4 | 9.0 |
| 120 mL/L | 8.4 | 8.9 |
| 200 mL/L | 8.4 | 8.7 |
| 300 mL/L | 8.4 | 8.7 |
| 500 mL/L | 8.4 | 8.6 |
| 800 mL/L | 8.3 | 8.3 |

Table C. 3 Physical parameters – temperature monitoring from 2020-05-12 to 2020-05-15.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 22.6 | 0.1 | 22.1 | 22.7 |

## C.1.2 Statistical analysis – Determination of effect concentrations after exposure

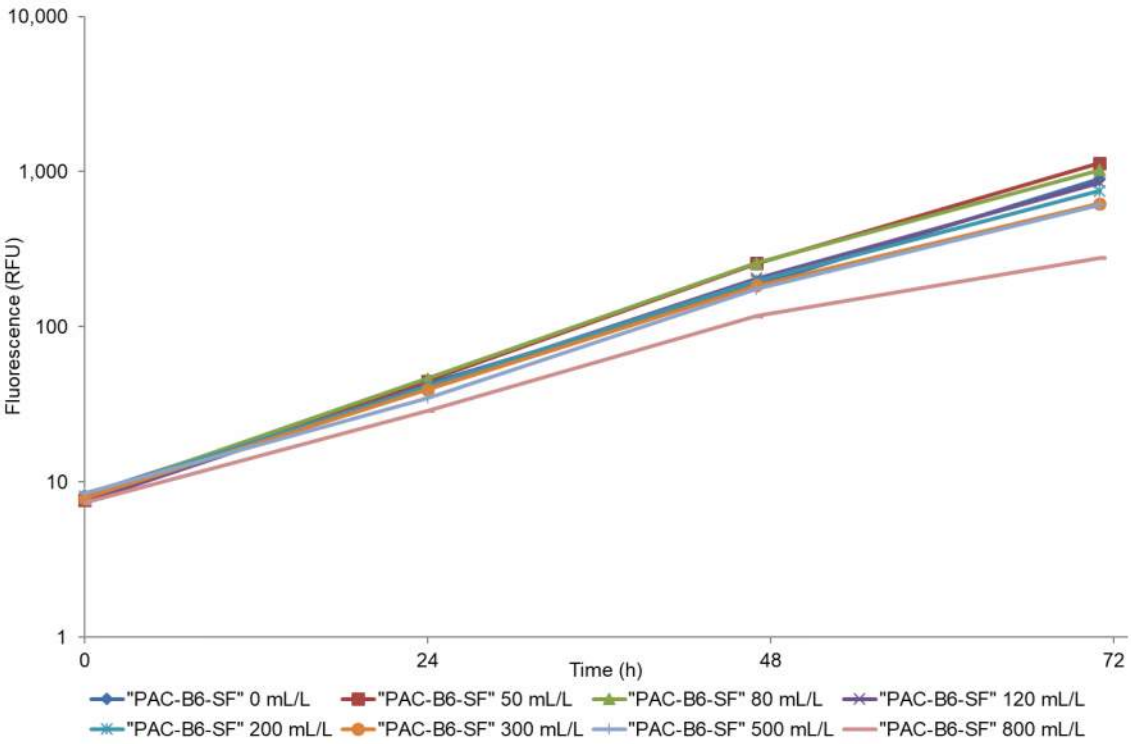


Figure C. 1 Fluorescence versus time in test with *Raphidocelis subcapitata* exposed to different concentrations of "PAC-B6-SF" (DHI ID No. 20-1246).

## C.1.3 Results of the statistical analysis of the growth rate

- Growth rate

Table C. 4 Experimental data of the growth rate ($h^{-1}$) in the tested concentrations.

| Replicate No. | Control | 50 mL/L | 80 mL/L | 120 mL/L | 200 mL/L | 300 mL/L | 500 mL/L | 800 mL/L |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.065 | 0.069 | 0.075 | 0.063 | 0.066 | 0.062 | 0.056 | 0.051 |
| 2 | 0.064 | 0.070 | 0.064 | 0.066 | 0.063 | 0.063 | 0.059 | 0.053 |
| 3 | 0.067 | 0.073 | 0.066 | 0.071 | 0.063 | 0.061 | 0.066 | 0.053 |
| 4 | 0.059 | - | - | - | - | - | - | - |
| 5 | 0.070 | - | - | - | - | - | - | - |
| 6 | 0.067 | - | - | - | - | - | - | - |
| Count | 6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| mean | 0.065 | 0.071 | 0.068 | 0.067 | 0.064 | 0.062 | 0.061 | 0.052 |
| Significance[1)] | - | | | | | | | *** |

1) Signif. codes: 0 '***' 0.001'**' 0.01 '*' 0.05 '.'0.1 ''1

- Normality

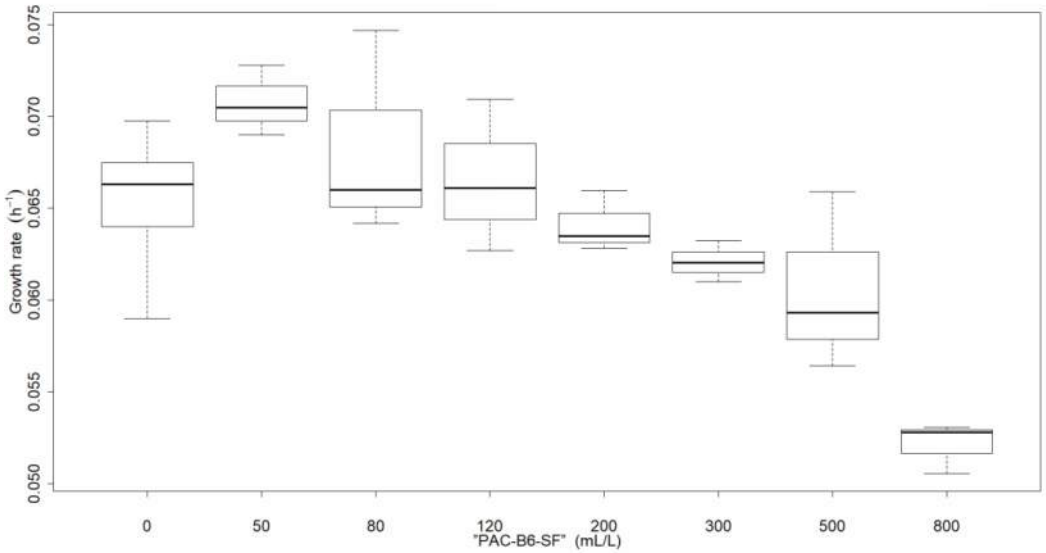


Figure C. 2 Boxplot of every test group for the growth rate.

The boxplot patterns show the data distribution (Figure C. 2). A normal distribution in each test group will be assumed in the following study.

### C.1.3.1 Results of the Probit analysis

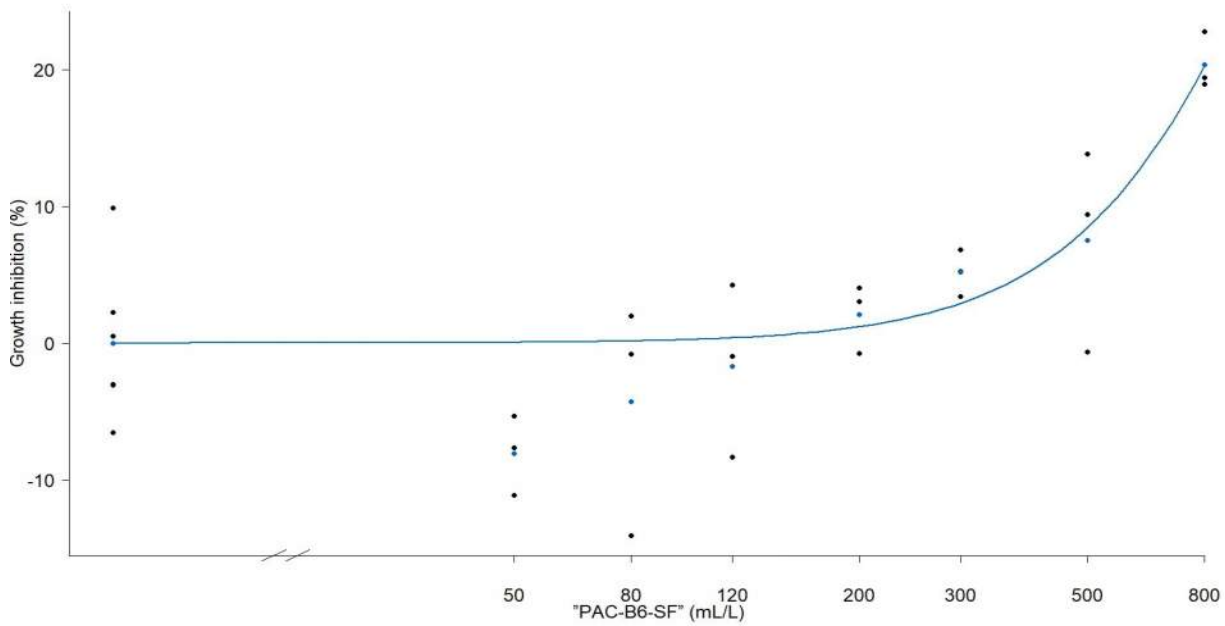


Figure C. 3 Effect of "PAC-B6-SF" on the growth rate after 3 days of exposure. In blue, the dose response curve established by use of the free software R. The blue points correspond to the average inhibition per concentrations. The black points correspond to the inhibition per replicate.

The test results can be seen in Table C. 5.

Table C. 5 Growth rate endpoint, estimations of NOEC, LOEC, EC10 and EC50.

| Endpoint | NOEC | LOEC | EC10 | EC50 | Unit |
|---|---|---|---|---|---|
| Growth rate | 500 | 800 | 544 (• - •)[1)] | >800 | mL/L |

1) Data did not allow statistical calculation of the 95% confidence interval

## C.1.4 Calculation of the mean coefficient of variation for section-by-section specific growth rates

Table C. 6 Calculation of the mean coefficient of variation for section-by-section specific growth rates (between 0-1, 1-2 and 2-3 days) in the laboratory control cultures.

| Replicate | Growth rate per section (growth per hour) | | | Average growth | Variation coefficient |
|---|---|---|---|---|---|
| | 0-24 hours | 24-47 hours | 47-71 hours | | |
| Control 1 | 0.070 | 0.063 | 0.063 | 0.065 | 6% |
| Control 2 | 0.067 | 0.061 | 0.064 | 0.064 | 4% |
| Control 3 | 0.070 | 0.066 | 0.067 | 0.068 | 3% |
| Control 4 | 0.066 | 0.055 | 0.057 | 0.059 | 10% |
| Control 5 | 0.068 | 0.072 | 0.069 | 0.070 | 3% |
| Control 6 | 0.070 | 0.065 | 0.068 | 0.068 | 3% |
| Mean value | 0.068 | 0.064 | 0.065 | 0.066 | 5% |

## C.1.5 Validity criteria

Table C. 7 Validity criteria for the growth inhibition test with *Raphidocelis subcapitata* according to OECD 201 /1/.

| Criteria in the control | Target value | Fulfilled |
|---|---|---|
| Control pH increase during test | ≤ 1.5 (observed: 0.4) | yes |
| Control specific growth rate | ≥ 1.4 per day (observed: 1.6 per day) | yes |
| Control variation coefficient | ≤ 7.0% (observed: 5.5%) | yes |
| The mean coefficient of variation for section-by-section specific growth rates (0-1, 1-2 and 2-3 days) | ≤ 35% in the control (observed: 5%) | yes |

# C.2 *Daphnia magna* acute immobilisation test

## C.2.1 Primary data on the immobilisation test

Table C. 8 Daily observations of the total number mobile and immobile daphnids in the immobilisation test.

| **Date** | | **26 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **0** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

| **Date** | | **27 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **1** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

| Date | | 28 May 2020 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accumulated days | | 2 | | | | | | | | | | | |
| Concentration | Initial number of daphnids | Number of mobile daphnids | | | | | | Number of immobile daphnids | | | | | |
| | | A | B | C | D | E | F | A | B | C | D | E | F |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

Table C. 9 Measurement of dissolved oxygen and pH during the immobilisation test - Day 0 and Day 2.

| Concentration | Dissolved oxygen (% sat) | | pH | |
|---|---|---|---|---|
| | Day 0 | Day 2 | Day 0 | Day 2 |
| Control | 100 | 97 | 8.0 | 8.1 |
| 56.3 mL/L | 100 | 97 | 8.0 | 8.1 |
| 113 mL/L | 100 | 97 | 8.0 | 8.0 |
| 225 mL/L | 100 | 97 | 8.0 | 8.1 |
| 450 mL/L | 100 | 98 | 8.0 | 8.1 |
| 900 mL/L | 100 | 98 | 7.9 | 8.2 |

Table C. 10 Physical parameters – temperature monitoring from 2020-05-26 to 2020-05-28.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 19.1 | 0.1 | 19.0 | 19.5 |

## C.2.2 Statistical analysis – Determination of effect concentrations after exposure

### C.2.2.1 Determination of the immobilisation ratio

Determination of the percentage immobilisation for each concentration in relation to the total number and estimation of the EC values.

Table C. 11 Experimental data of the immobilisation ratio (number of adults immobile per concentration)

| Concentration | No. of daphnids exposed | No. of immobile daphnids 24h | No. of immobile daphnids 48h | Immobilisation 24 h (%) | Immobilisation 48 h (%) |
|---|---|---|---|---|---|
| Control | 30 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 0 | 0 | 0 | 0 |
| 113 mL/L | 20 | 0 | 0 | 0 | 0 |
| 225 mL/L | 20 | 0 | 0 | 0 | 0 |
| 450 mL/L | 20 | 0 | 0 | 0 | 0 |
| 900 mL/L | 20 | 0 | 0 | 0 | 0 |

### C.2.2.2 Results of the Probit analysis

As no negative effect was observed among the test groups, the data to estimate the ECX were not computed.

The test results can be seen in Table C. 12.

Table C. 12 Immobilisation endpoint, estimations of EC10 and EC50.

| Endpoint | EC10 | EC50 | Unit |
|---|---|---|---|
| Immobilisation | >900 | >900 | mL/L |

## C.2.3 Validity criteria

Table C. 13 Validity criteria of the test according to the OECD No. 202 /2/ in the acute immobilisation test with *Daphnia magna.*

| Criteria | Target value | Fulfilled |
|---|---|---|
| Control immobilisation ratio | ≤ 10% (observed: 0%) | Yes |
| Dissolved oxygen | ≥70% (observed: ≥97%) | Yes |

# APPENDIX D

## Data from the test with “PAC-F-SF”

# D Data from the test with “PAC-F-SF”

## D.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)

### D.1.1 Primary measurements

Table D. 1 Raw data of the fluorescence (RFU) generated in the algal growth inhibition test with “PAC-F-SF” (DHI ID No. 20-1247). The blanks were prepared exactly as the dilution series but did not contain algae.

| Test concentration | Replicate | 0 hour | 24 hours | 47 hours | 70.5 hours |
|---|---|---|---|---|---|
| Control | A | 8.9 | 40.6 | 170 | 541 |
| Control | B | 8.9 | 43.5 | 191 | 656 |
| Control | C | 8.9 | 44.0 | 208 | 731 |
| Control | D | 8.9 | 40.1 | 174 | 547 |
| Control | E | 8.9 | 42.1 | 134 | 415 |
| Control | F | 8.9 | 40.8 | 157 | 493 |
| Control blank | | 0 | 0 | 0 | 0 |
| 50 mL/L | A | 8.9 | 45.9 | 202 | 641 |
| 50 mL/L | B | 8.9 | 44.0 | 186 | 561 |
| 50 mL/L | C | 8.9 | 37.9 | 161 | 545 |
| 50 mL/L blank | | 0 | 0 | 0 | 0 |
| 80 mL/L | A | 8.4 | 44.1 | 193 | 653 |
| 80 mL/L | B | 8.4 | 44.9 | 203 | 748 |
| 80 mL/L | C | 8.4 | 40.3 | 149 | 408 |
| 80 mL/L blank | | 0 | 0 | 0 | 0 |
| 120 mL/L | A | 8.9 | 43.7 | 161 | 442 |
| 120 mL/L | B | 8.9 | 41.9 | 179 | 612 |
| 120 mL/L | C | 8.9 | 41.2 | 180 | 611 |
| 120 mL/L blank | | 0 | 0 | 0 | 0 |
| 200 mL/L | A | 8.7 | 39.2 | 150 | 374 |
| 200 mL/L | B | 8.7 | 43.1 | 132 | 325 |
| 200 mL/L | C | 8.7 | 38.9 | 151 | 440 |
| 200 mL/L blank | | 0 | 0 | 0 | 0 |
| 300 mL/L | A | 8.8 | 37.0 | 124 | 259 |
| 300 mL/L | B | 8.8 | 44.6 | 142 | 273 |
| 300 mL/L | C | 8.8 | 40.4 | 154 | 373 |
| 300 mL/L blank | | 0 | 0 | 0 | 0 |
| 500 mL/L | A | 8.6 | 41.1 | 127 | 218 |
| 500 mL/L | B | 8.6 | 37.4 | 122 | 226 |
| 500 mL/L | C | 8.6 | 36.1 | 101 | 162 |

| Test concentration | Replicate | 0 hour | 24 hours | 47 hours | 70.5 hours |
|---|---|---|---|---|---|
| 500 mL/L blank | | 0 | 0 | 0 | 0 |
| 800 mL/L | A | 8.7 | 26.8 | 49.1 | 68.4 |
| 800 mL/L | B | 8.7 | 24.8 | 45.2 | 63.5 |
| 800 mL/L | C | 8.7 | 26.1 | 57.6 | 99.3 |
| 800 mL/L blank | | 0 | 0 | 0 | 0 |

Table D. 2 Measurements of pH during the algal growth inhibition test with “PAC-A6-SF”

| Date | 2020-05-12 – Day 0 | 2020-05-15 – Day 3 |
|---|---|---|
| **Test concentration** | **pH** | **pH** |
| Control | 8.3 | 8.3 |
| 50 mL/L | 8.4 | 8.4 |
| 80 mL/L | 8.5 | 8.4 |
| 120 mL/L | 8.4 | 8.3 |
| 200 mL/L | 8.4 | 8.3 |
| 300 mL/L | 8.3 | 8.3 |
| 500 mL/L | 8.3 | 8.3 |
| 800 mL/L | 8.2 | 8.4 |

Physical parameters – temperature monitoring from 2020-05-12 to 2020-05-15.

The temperature logger placed in water to monitor during the test period did not log data properly. Therefore, the data from the logger monitoring air temperature in the climate room was used. This showed a constant temperature in the test period.

## D.1.2 Statistical analysis – Determination of effect concentrations after exposure

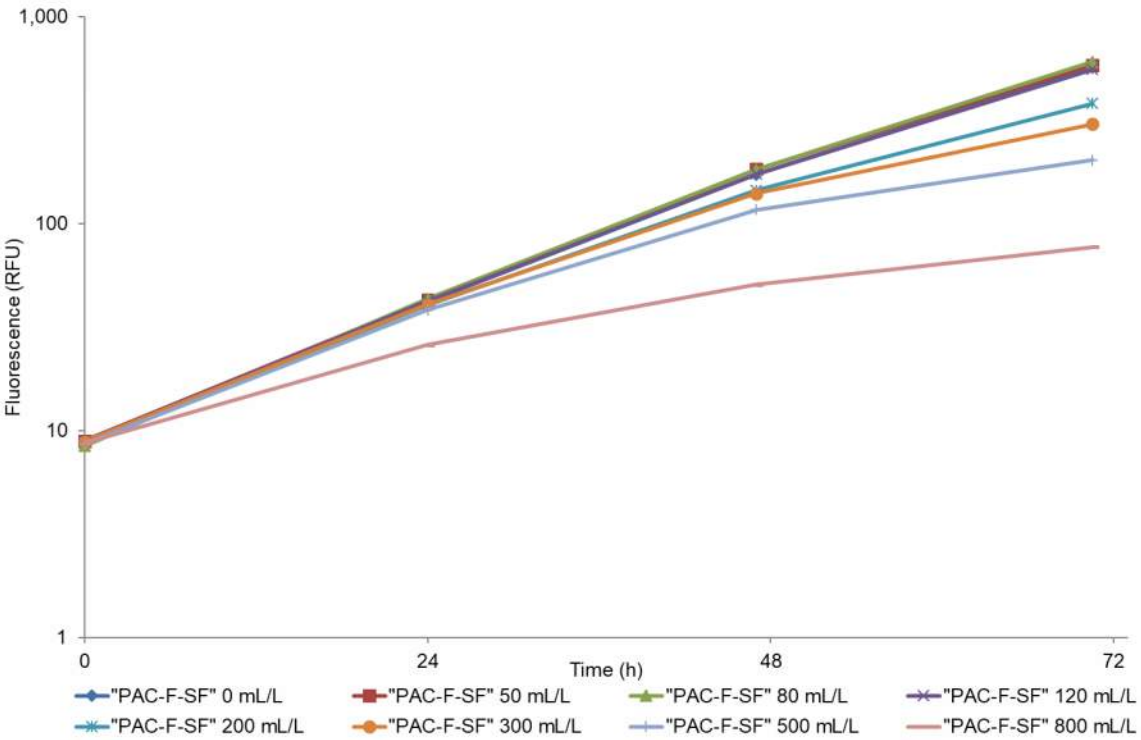


Figure D. 1 Fluorescence versus time in test with *Raphidocelis subcapitata* exposed to different concentrations of "PAC-F-SF" (DHI ID No. 20-1247).

## D.1.3 Results of the statistical analysis of the growth rate

- Growth rate

Table D. 3 Experimental data of the growth rate ($h^{-1}$) in the tested concentrations.

| Replicate No. | Control | 50 mL/L | 80 mL/L | 120 mL/L | 200 mL/L | 300 mL/L | 500 mL/L | 800 mL/L |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.059 | 0.061 | 0.062 | 0.056 | 0.054 | 0.048 | 0.046 | 0.029 |
| 2 | 0.061 | 0.059 | 0.064 | 0.060 | 0.051 | 0.049 | 0.047 | 0.028 |
| 3 | 0.063 | 0.059 | 0.055 | 0.060 | 0.056 | 0.054 | 0.042 | 0.035 |
| 4 | 0.059 | - | - | - | - | - | - | - |
| 5 | 0.054 | - | - | - | - | - | - | - |
| 6 | 0.057 | - | - | - | - | - | - | - |
| Count | 6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| mean | 0.059 | 0.060 | 0.060 | 0.059 | 0.054 | 0.050 | 0.045 | 0.030 |
| Significance[1)] | - | | | | | ** | *** | *** |

1) Signif. codes: 0 '***' 0.001'**' 0.01 '*' 0.05 '.'0.1 ''1

- Normality

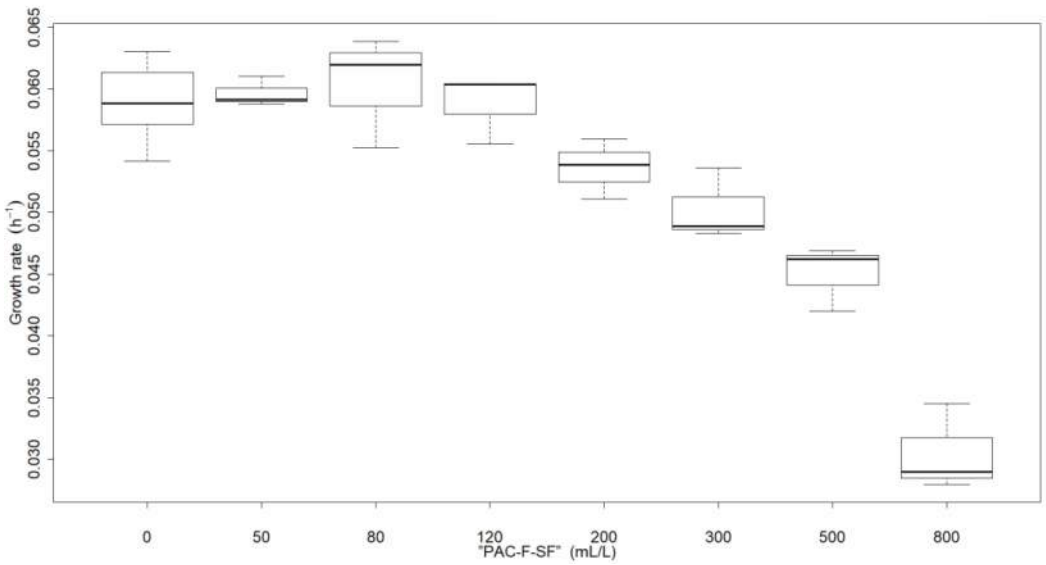


Figure D. 2 Boxplot of every test group for the growth rate.

The boxplot patterns show the data distribution (Figure D. 2). A normal distribution in each test group will be assumed in the following study.

### D.1.3.1 Results of the Probit analysis

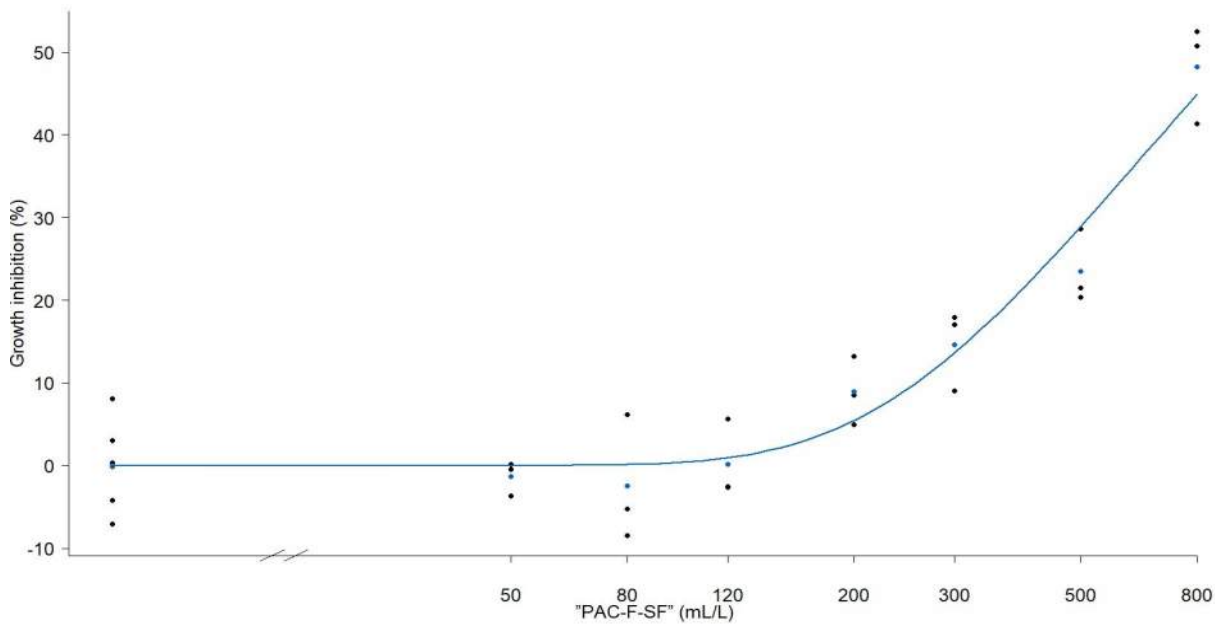


Figure D. 3 Effect of "PAC-F-SF" on the growth rate after 3 days of exposure. In blue, the dose response curve established by use of the free software R. The blue points correspond to the average inhibition per concentrations. The black points correspond to the inhibition per replicate.

The test results can be seen in Table D. 4.

Table D. 4 Growth rate endpoint, estimations of NOEC, LOEC, EC10 and EC50.

| Endpoint | NOEC | LOEC | EC10 | EC50 | Unit |
|---|---|---|---|---|---|
| Growth rate | 200 | 300 | 257 (204-310) | >800 | mL/L |

## D.1.4 Calculation of the mean coefficient of variation for section-by-section specific growth rates

Table D. 5 Calculation of the mean coefficient of variation for section-by-section specific growth rates (between 0-1, 1-2 and 2-3 days) in the laboratory control cultures.

| Replicate | Growth rate per section (growth per hour) | | | Average growth | Variation coefficient |
|---|---|---|---|---|---|
| | 0-24 hours | 24-47 hours | 47-70.5 hours | | |
| Control 1 | 0.063 | 0.062 | 0.049 | 0.058 | 13% |
| Control 2 | 0.066 | 0.064 | 0.052 | 0.061 | 12% |
| Control 3 | 0.067 | 0.068 | 0.053 | 0.063 | 13% |
| Control 4 | 0.063 | 0.064 | 0.049 | 0.058 | 14% |
| Control 5 | 0.065 | 0.050 | 0.048 | 0.054 | 17% |
| Control 6 | 0.063 | 0.059 | 0.049 | 0.057 | 13% |
| Mean value | 0.065 | 0.061 | 0.050 | 0.059 | 14% |

## D.1.5 Validity criteria

Table D. 6 Validity criteria for the growth inhibition test with *Raphidocelis subcapitata* according to OECD 201 /1/.

| Criteria in the control | Target value | Fulfilled |
|---|---|---|
| Control pH increase during test | ≤ 1.5 (observed: 0.0) | yes |
| Control specific growth rate | ≥ 1.4 per day (observed: 1.4 per day) | yes |
| Control variation coefficient | ≤ 7.0% (observed: 5.3%) | yes |
| The mean coefficient of variation for section-by-section specific growth rates (0-1, 1-2 and 2-3 days) | ≤ 35% in the control (observed: 14%) | yes |

## D.2 *Daphnia magna* acute immobilisation test

### D.2.1 Primary data on the immobilisation test

Table D. 7 Daily observations of the total number mobile and immobile daphnids in the immobilisation test.

| **Date** | | **28 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **0** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

| **Date** | | **29 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **1** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

| Date | | 30 May 2020 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accumulated days | | 2 | | | | | | | | | | | |
| Concentration | Initial number of daphnids | Number of mobile daphnids | | | | | | Number of immobile daphnids | | | | | |
| | | A | B | C | D | E | F | A | B | C | D | E | F |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

Table D. 8 Measurement of dissolved oxygen and pH during the immobilisation test - Day 0 and Day 2.

| Concentration | Dissolved oxygen (% sat) | | pH | |
|---|---|---|---|---|
| | Day 0 | Day 2 | Day 0 | Day 2 |
| Control | 100 | 98 | 7.9 | 8.0 |
| 56.3 mL/L | 100 | 98 | 8.0 | 8.0 |
| 113 mL/L | 100 | 98 | 8.0 | 8.0 |
| 225 mL/L | 100 | 99 | 8.2 | 8.1 |
| 450 mL/L | 100 | 99 | 8.4 | 8.2 |
| 900 mL/L | 100 | 99 | 8.4 | 8.4 |

Table D. 9 Physical parameters – temperature monitoring from 2020-05-28 to 2020-05-30.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 19.0 | 0.1 | 18.8 | 19.3 |

## D.2.2 Statistical analysis – Determination of effect concentrations after exposure

### D.2.2.1 Determination of the immobilisation ratio

Determination of the percentage immobilisation for each concentration in relation to the total number and estimation of the EC values.

Table D. 10 Experimental data of the immobilisation ratio (number of adults immobile per concentration)

| Concentration | No. of daphnids exposed | No. of immobile daphnids 24h | No. of immobile daphnids 48h | Immobilisation 24 h (%) | Immobilisation 48 h (%) |
|---|---|---|---|---|---|
| Control | 30 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 0 | 0 | 0 | 0 |
| 113 mL/L | 20 | 0 | 0 | 0 | 0 |
| 225 mL/L | 20 | 0 | 0 | 0 | 0 |
| 450 mL/L | 20 | 0 | 0 | 0 | 0 |
| 900 mL/L | 20 | 0 | 0 | 0 | 0 |

### D.2.2.2 Results of the Probit analysis

As no negative effect was observed among the test groups, the data to estimate the ECX were not computed.

The test results can be seen in Table D. 11.

Table D. 11 Immobilisation endpoint, estimations of EC10 and EC50.

| Endpoint | EC10 | EC50 | Unit |
|---|---|---|---|
| Immobilisation | >900 | >900 | mL/L |

## D.2.3 Validity criteria

Table D. 12 Validity criteria of the test according to the OECD No. 202 /2/ in the acute immobilisation test with *Daphnia magna.*

| Criteria | Target value | Fulfilled |
|---|---|---|
| Control immobilisation ratio | ≤ 10% (observed: 0%) | Yes |
| Dissolved oxygen | ≥70% (observed: ≥98%) | Yes |

# APPENDIX E

## Data from the test with “PAC-C6-SF”

# E Data from the test with “PAC-C6-SF”

## E.1 *Raphidocelis subcapitata* growth inhibition test (with pH-adjustment of the sample)

### E.1.1 Primary measurements

Table E. 1 Raw data of the fluorescence (RFU) generated in the algal growth inhibition test with “PAC-C6-SF” (DHI ID No. 20-1248). The blanks were prepared exactly as the dilution series but did not contain algae.

| Test concentration | Replicate | 0 hour | 23.5 hours | 46 hours | 70 hours |
|---|---|---|---|---|---|
| Control | A | 10.2 | 53.8 | 242 | 751 |
| Control | B | 10.2 | 43.7 | 204 | 573 |
| Control | C | 10.2 | 39.1 | 206 | 646 |
| Control | D | 10.2 | 38.3 | 197 | 547 |
| Control | E | 10.2 | 43.3 | 208 | 574 |
| Control | F | 10.2 | 43.9 | 198 | 549 |
| Control blank | | 0 | 0 | 0 | 0 |
| 50 mL/L | A | 10.5 | 48.6 | 190 | 471 |
| 50 mL/L | B | 10.5 | 43.8 | 171 | 428 |
| 50 mL/L | C | 10.5 | 45.7 | 211 | 608 |
| 50 mL/L blank | | 0 | 0 | 0 | 0 |
| 80 mL/L | A | 10.0 | 48.7 | 232 | 782 |
| 80 mL/L | B | 10.0 | 48.6 | 196 | 533 |
| 80 mL/L | C | 10.0 | 47.0 | 221 | 627 |
| 80 mL/L blank | | 0 | 0 | 0 | 0 |
| 120 mL/L | A | 10.4 | 41.1 | 151 | 380 |
| 120 mL/L | B | 10.4 | 51.7 | 198 | 490 |
| 120 mL/L | C | 10.4 | 47.4 | 211 | 590 |
| 120 mL/L blank | | 0 | 0 | 0 | 0 |
| 200 mL/L | A | 10.4 | 47.1 | 216 | 719 |
| 200 mL/L | B | 10.4 | 47.3 | 136 | 356 |
| 200 mL/L | C | 10.4 | 55.7 | 210 | 603 |
| 200 mL/L blank | | 0 | 0 | 0 | 0 |
| 300 mL/L | A | 10.8 | 47.8 | 170 | 520 |
| 300 mL/L | B | 10.8 | 58.0 | 163 | 433 |
| 300 mL/L | C | 10.8 | 50.2 | 136 | 468 |
| 300 mL/L blank | | 0 | 0 | 0 | 0 |
| 500 mL/L | A | 10.1 | 54.4 | 161 | 529 |
| 500 mL/L | B | 10.1 | 44.7 | 101 | 200 |
| 500 mL/L | C | 10.1 | 50.3 | 107 | 172 |

| Test concentration | Replicate | 0 hour | 23.5 hours | 46 hours | 70 hours |
|---|---|---|---|---|---|
| 500 mL/L blank | | 0 | 0 | 0 | 0 |
| 800 mL/L | A | 10.4 | 38.0 | 59.3 | 90.2 |
| 800 mL/L | B | 10.4 | 46.2 | 70.1 | 101 |
| 800 mL/L | C | 10.4 | 35.7 | 60.6 | 82.8 |
| 800 mL/L blank | | 0 | 0 | 0 | 0 |

Table E. 2 Measurements of pH during the algal growth inhibition test with “PAC-AC-SF”

| Date | 2020-05-19 – Day 0 | 2020-05-22 – Day 3 |
|---|---|---|
| **Test concentration** | **pH** | **pH** |
| Control | 8.5 | 8.4 |
| 50 mL/L | 8.5 | 8.2 |
| 80 mL/L | 8.5 | 8.3 |
| 120 mL/L | 8.4 | 8.1 |
| 200 mL/L | 8.4 | 8.3 |
| 300 mL/L | 8.4 | 8.1 |
| 500 mL/L | 8.3 | 8.3 |
| 800 mL/L | 8.3 | 8.4 |

Table E. 3 Physical parameters – temperature monitoring from 2020-05-12 to 2020-05-15.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 22.5 | 0.1 | 22.3 | 22.6 |

## E.1.2 Statistical analysis – Determination of effect concentrations after exposure

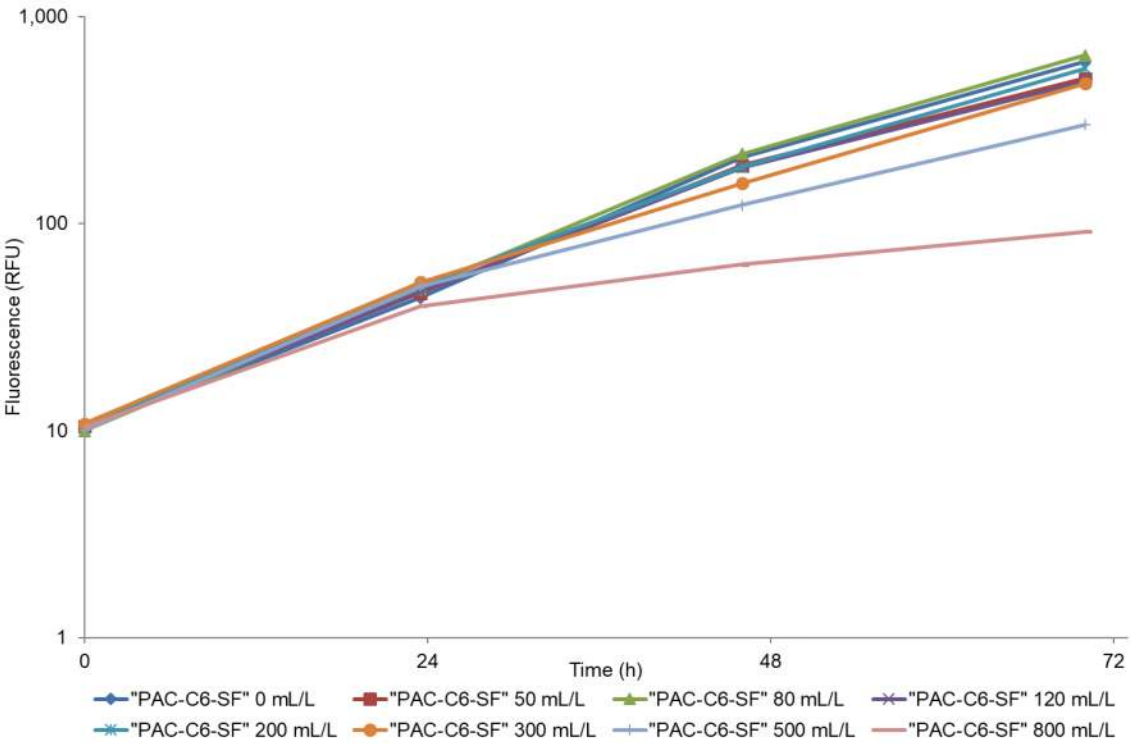


Figure E. 1 Fluorescence versus time in test with *Raphidocelis subcapitata* exposed to different concentrations of "PAC-C6-SF" (DHI ID No. 20-1248).

## E.1.3 Results of the statistical analysis of the growth rate

- Growth rate

Table E. 4 Experimental data of the growth rate ($h^{-1}$) in the tested concentrations.

| Replicate No. | Control | 50 mL/L | 80 mL/L | 120 mL/L | 200 mL/L | 300 mL/L | 500 mL/L | 800 mL/L |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.062 | 0.055 | 0.063 | 0.052 | 0.061 | 0.055 | 0.056 | 0.030 |
| 2 | 0.059 | 0.054 | 0.057 | 0.055 | 0.050 | 0.052 | 0.042 | 0.031 |
| 3 | 0.061 | 0.059 | 0.060 | 0.058 | 0.058 | 0.053 | 0.040 | 0.029 |
| 4 | 0.058 | - | - | - | - | - | - | - |
| 5 | 0.059 | - | - | - | - | - | - | - |
| 6 | 0.058 | - | - | - | - | - | - | - |
| Count | 6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| mean | 0.059 | 0.056 | 0.060 | 0.055 | 0.056 | 0.053 | 0.046 | 0.030 |
| Significance[1)] | - | | | | | | *** | *** |

1) Signif. codes: 0 '***' 0.001'**' 0.01 '*' 0.05 '.'0.1 ''1

- Normality

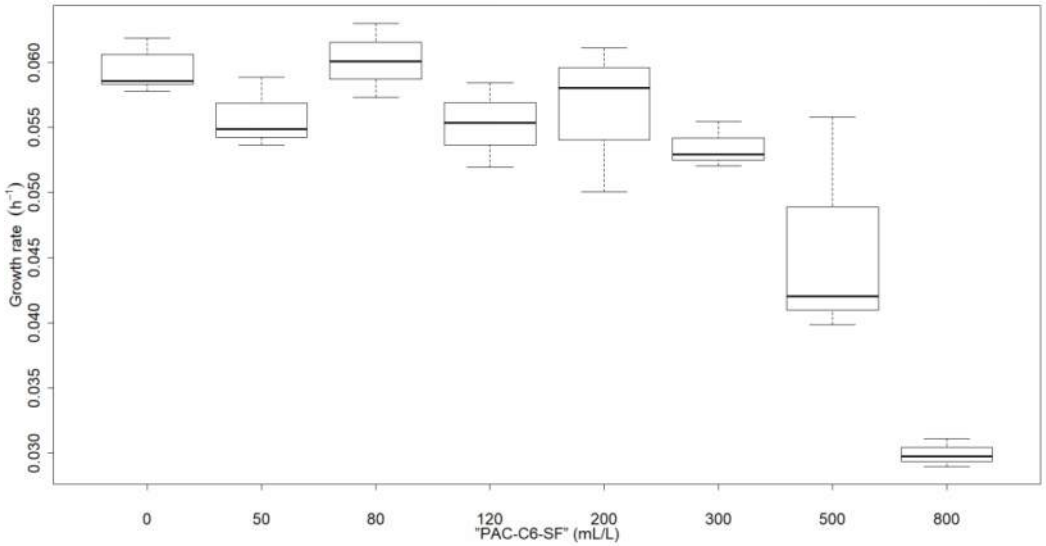


Figure E. 2 Boxplot of every test group for the growth rate.

The boxplot patterns show the data distribution (Figure E. 2). A normal distribution in each test group will be assumed in the following study.

### E.1.3.1 Results of the Probit analysis

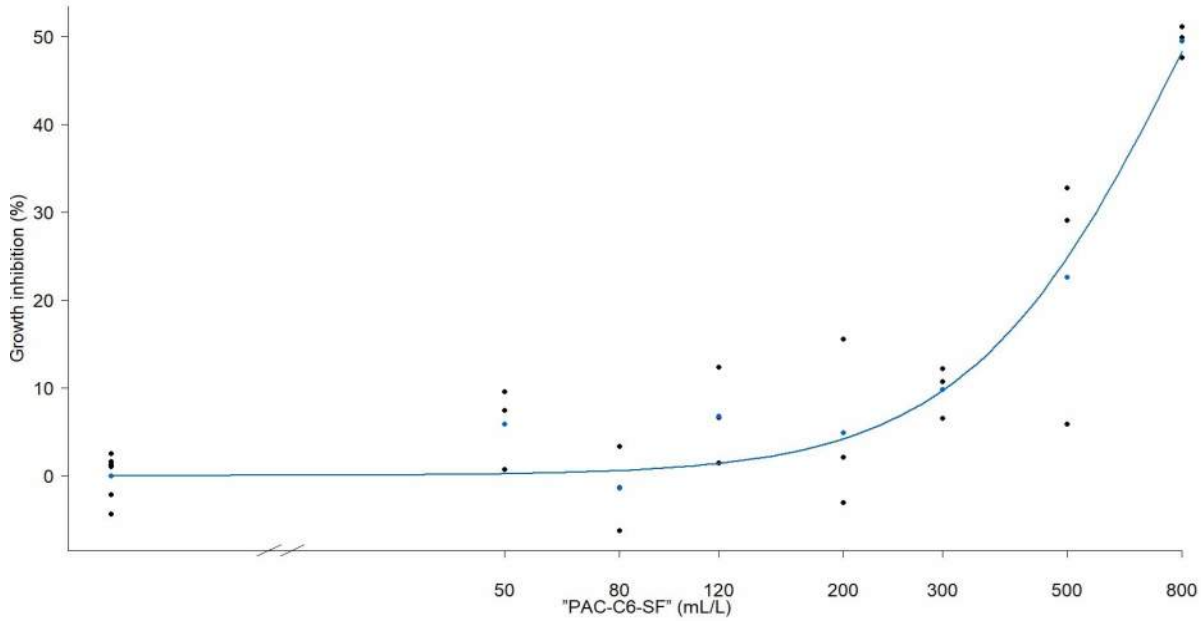


Figure E. 3 Effect of “PAC-C6-SF” on the growth rate after 3 days of exposure. In blue, the dose response curve established by use of the free software R. The blue points correspond to the average inhibition per concentrations. The black points correspond to the inhibition per replicate.

The test results can be seen in Table E. 5.

Table E. 5 Growth rate endpoint, estimations of NOEC, LOEC, EC10 and EC50.

| Endpoint | NOEC | LOEC | EC10 | EC50 | Unit |
|---|---|---|---|---|---|
| Growth rate | 300 | 500 | 305 (222-389) | >800 | mL/L |

## E.1.4 Calculation of the mean coefficient of variation for section-by-section specific growth rates

Table E. 6 Calculation of the mean coefficient of variation for section-by-section specific growth rates (between 0-1, 1-2 and 2-3 days) in the laboratory control cultures.

| Replicate | Growth rate per section (growth per hour) | | | Average growth | Variation coefficient |
|---|---|---|---|---|---|
| | 0-23.5 hours | 23.5-46 hours | 46-70 hours | | |
| Control 1 | 0.071 | 0.067 | 0.047 | 0.062 | 20% |
| Control 2 | 0.062 | 0.068 | 0.043 | 0.058 | 23% |
| Control 3 | 0.057 | 0.074 | 0.048 | 0.060 | 22% |
| Control 4 | 0.056 | 0.073 | 0.043 | 0.057 | 27% |
| Control 5 | 0.061 | 0.070 | 0.042 | 0.058 | 24% |
| Control 6 | 0.062 | 0.067 | 0.043 | 0.057 | 22% |
| Mean value | 0.062 | 0.070 | 0.044 | 0.058 | 23% |

## E.1.5 Validity criteria

Table E. 7 Validity criteria for the growth inhibition test with *Raphidocelis subcapitata* according to OECD 201 /1/.

| Criteria in the control | Target value | Fulfilled |
|---|---|---|
| Control pH increase during test | ≤ 1.5 (observed: -0.1) | yes |
| Control specific growth rate | ≥ 1.4 per day (observed: 1.4 per day) | yes |
| Control variation coefficient | ≤ 7.0% (observed: 2.7%) | yes |
| The mean coefficient of variation for section-by-section specific growth rates (0-1, 1-2 and 2-3 days) | ≤ 35% in the control (observed: 23%) | yes |

# E.2 *Daphnia magna* acute immobilisation test

## E.2.1 Primary data on the immobilisation test

Table E. 8 Daily observations of the total number mobile and immobile daphnids in the immobilisation test.

| **Date** | | **28 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **0** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 5 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

| **Date** | | **29 May 2020** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated day** | | **1** | | | | | | | | | | | |
| **Concentration** | **Initial number of daphnids** | **Number of mobile daphnids** | | | | | | **Number of immobile daphnids** | | | | | |
| | | **A** | **B** | **C** | **D** | **E** | **F** | **A** | **B** | **C** | **D** | **E** | **F** |
| Control | 30 | 0 | 5 | 5 | 5 | 5 | 5 | 5[1)] | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

1) This result is considered an outlier and not included in the estimations.

| Date | | 30 May 2020 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accumulated days | | 2 | | | | | | | | | | | |
| Concentration | Initial number of daphnids | Number of mobile daphnids | | | | | | Number of immobile daphnids | | | | | |
| | | A | B | C | D | E | F | A | B | C | D | E | F |
| Control | 25 (30) | - | 5 | 5 | 5 | 5 | 5 | - | 0 | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 113 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 225 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 450 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |
| 900 mL/L | 20 | 5 | 5 | 5 | 5 | - | - | 0 | 0 | 0 | 0 | - | - |

Table E. 9 Measurement of dissolved oxygen and pH during the immobilisation test - Day 0 and Day 2.

| Concentration | Dissolved oxygen (% sat) | | pH | |
|---|---|---|---|---|
| | Day 0 | Day 2 | Day 0 | Day 2 |
| Control | 100 | 98 | 7.9 | 8.1 |
| 56.3 mL/L | 100 | 98 | 7.9 | 8.1 |
| 113 mL/L | 100 | 98 | 7.9 | 8.1 |
| 225 mL/L | 100 | 98 | 7.8 | 8.1 |
| 450 mL/L | 100 | 98 | 7.7 | 8.1 |
| 900 mL/L | 100 | 98 | 7.6 | 8.1 |

Table E. 10 Physical parameters – temperature monitoring from 2020-05-28 to 2020-05-30.

| Mean (°C) | Standard deviation (°C) | Minimum (°C) | Maximum (°C) |
|---|---|---|---|
| 19.0 | 0.1 | 18.8 | 19.3 |

## E.2.2 Statistical analysis – Determination of effect concentrations after exposure

### E.2.2.1 Determination of the immobilisation ratio

Determination of the percentage immobilisation for each concentration in relation to the total number and estimation of the EC values.

Table E. 11 Experimental data of the immobilisation ratio (number of adults immobile per concentration)

| Concentration | No. of daphnids exposed | No. of immobile daphnids 24h | No. of immobile daphnids 48h | Immobilisation 24 h (%) | Immobilisation 48 h (%) |
|---|---|---|---|---|---|
| Control | 25[1)] | 0 | 0 | 0 | 0 |
| 56.3 mL/L | 20 | 0 | 0 | 0 | 0 |
| 113 mL/L | 20 | 0 | 0 | 0 | 0 |
| 225 mL/L | 20 | 0 | 0 | 0 | 0 |
| 450 mL/L | 20 | 0 | 0 | 0 | 0 |
| 900 mL/L | 20 | 0 | 0 | 0 | 0 |

1) Control replicate A was considered an outlier and not included in the calculation.

### E.2.2.2 Results of the Probit analysis

As no negative effect was observed among the test groups, the data to estimate the ECX were not computed.

The test results can be seen in Table E. 12.

Table E. 12 Immobilisation endpoint, estimations of EC10 and EC50.

| Endpoint | EC10 | EC50 | Unit |
|---|---|---|---|
| Immobilisation | >900 | >900 | mL/L |

## E.2.3 Validity criteria

Table E. 13 Validity criteria of the test according to the OECD No. 202 /2/ in the acute immobilisation test with *Daphnia magna.*

| Criteria | Target value | Fulfilled |
|---|---|---|
| Control immobilisation ratio | ≤ 10% (observed: 0%)[1)] | Yes |
| Dissolved oxygen | ≥70% (observed: ≥98%) | Yes |

1) 100% immobilisation seen in Control replicate A after 24 hours was considered an outlier.

# Bilag E Analyseskema

| | | | Ozonforsøg, Suez | | | Ozon + H2O2 | | | H2O2 + UV | | | H2O2 + faststof katalysator (Water IQ) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prøvenr. | | 52503 | 86564 | 86565 | 86566 | 95602 | 95603 | 95604 | 107104 | 107105 | 107106 | 62354 | 62355 | 62356 | 62357 | 88158 | 88159 |
| Prøvemrk. | | Baseline Grindsted | TA6-SF optimum | TA7-SF o-dosage | TA8-SF u-dosage | Test B 1 optimum | Test B 2 o-dosage | Test B 3 u-dosage | TC6-SF optimum | TC7-SF o-dosage | TC8-SF u-dosage | Run A WIQ | Run B High H2O2 | Run C WIQ | Run D WIQ | Run E, Optimum | Run F, Long time |
| Modtaget | | 11-03-2020 | 21-04-2020 | 21-04-2020 | 21-04-2020 | 28-04-2020 | 28-04-2020 | 28-04-2020 | 13-05-2020 | 13-05-2020 | 13-05-2020 | 24-03-2020 | 24-03-2020 | 24-03-2020 | 24-03-2020 | 22-04-2020 | 22-04-2020 |
| Ammonium+ammoniak, NH4+ | mg/l | 0,18 | 0,094 | <0,004 | 0,22 | 0,19 | 0,11 | 0,19 | 0,41 | 0,37 | 0,24 | 0,039 | 0,18 | 5,4 | 4,7 | 0,1 | 0,091 |
| Fluorid, F- | mg/l | - | - | - | - | - | - | - | <0,030 | <0,030 | 0,073 | - | - | - | - | - | - |
| Mangan, Mn | mg/l | 0,43 | 0,51 | 0,48 | 0,48 | 0,46 | 0,42 | 0,47 | 0,42 | 0,42 | 0,43 | 0,012 | 1,4 | 0,009 | 0,096 | 0,003 | 0,008 |
| Calcium, Ca++ | mg/l | 13 | 15 | 14 | 14 | 13 | 12 | 13 | 14 | 11 | 12 | 80 | 150 | 100 | 100 | 26 | 34 |
| Magnesium, Mg++ | mg/l | 5,9 | 6,4 | 5,9 | 5,9 | 5,5 | 5,2 | 5,5 | 6 | 4,9 | 5 | 12 | 18 | 4,3 | 7,6 | 0,45 | 0,51 |
| Kalium, K+ | mg/l | 1,1 | 1,3 | 1,1 | 1,1 | 1,1 | 1,3 | 1,1 | 1,1 | 0,9 | 1 | 14 | 30 | 130 | 110 | 240 | 220 |
| Natrium, Na+ | mg/l | 96 | 98 | 98 | 93 | 92 | 89 | 94 | 120 | 120 | 120 | 9,5 | 14 | 10 | 33 | 29 | 29 |
| Jern, Fe | mg/l | 5,4 | 2,9 | 3,3 | 3,3 | 1,4 | 2,8 | 1,8 | 2,6 | 0,51 | 0,84 | 0,33 | 42 | 5,3 | 44 | 0,6 | 0,76 |
| Nitrit, NO2- | mg/l | <0,001 | 0,0082 | 0,0094 | 0,0069 | <0,0010 | 0,016 | 0,003 | 0,0025 | 0,001 | 0,0033 | 0,013 | 0,001 | <0,001 | 0,001 | 0,01 | 0,003 |
| Nitrat, NO3- | mg/l | 0,06 | 0,24 | 0,75 | 0,37 | 0,12 | 0,41 | <0,10 | <0,10 | <0,10 | <0,10 | 0,74 | 0,66 | <0,030 | <0,030 | 3,8 | 17 |
| TOC | mg/l | 4,9 | | | | | | | | | | 4 | 5,5 | 5,1 | 4,2 | | |
| Total phosphor, P | mg/l | 0,014 | | | | | | | 0,13 | 0,003 | <0,003 | 0,027 | 0,036 | 0,16 | 0,32 | | |
| Hydrogencarbonat, HCO3 | mg/l | - | | | | | | | | | | | | | | | |
| COD iltforbrug m. dichromat | mg/l | 16 | | | | | | | | | | 17 | 33 | 750 | 990 | | |
| Total kvælstof, N | mg/l | 0,6 | | | | | | | | | | 0,4 | 0,52 | 0,5 | 1,2 | | |
| Chlorid, Cl- | mg/l | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 140 | 150 | 150 | 150 | 140 | 150 | 150 |
| Sulfat, SO4-- | mg/l | 32 | 32 | 40 | 34 | 39 | 36 | 39 | 89 | 100 | 94 | 31 | 320 | 160 | 310 | 34 | 38 |
| Hydrogencarbonat, HCO3- | mg/l | 71 | 49 | 47 | 51 | 48 | 46 | 50 | 51 | 48 | 52 | 52 | <3,0 | 150 | 82 | | |
| Aggressiv kuldioxid, CO2 | mg/l | 53 | | | | | | | | | | 48 | - | <5 | <2 | | |
| Inddampningsrest | mg/l | 350 | 350 | 370 | 380 | 380 | 370 | 370 | 420 | 460 | 430 | 550 | 810 | 880 | 1100 | | |
| NVOC | mg/l | 4,9 | 4,6 | 4,2 | 4,7 | 4 | 4,2 | 4,5 | 5,5 | 4,4 | 5,4 | 4 | 5,5 | 5,1 | 4,2 | | |
| Bromat | mg/l | <5,0 | 0,0091 | 0,065 | <0,0025 | <0,0025 | 0,019 | <0,0025 | | | | | | | | | |
| Arsen, As | µg/l | 3,8 | 2,2 | 1,9 | 2,3 | 0,97 | 2,1 | 0,98 | 0,62 | 0,42 | 0,44 | 1,2 | 1,4 | 0,4 | 1,4 | | |
| Bly, Pb | µg/l | 0,12 | 0,78 | | | | | | | | | 3 | 8,4 | 0,92 | 8,5 | | |
| Bor, B | µg/l | <10 | <10 | <10 | <10 | <10 | <10 | <10 | 10 | 10 | <10 | 10 | <10 | <10 | <10 | | |
| Cadmium, Cd | µg/l | 0,0086 | 0,019 | | | | | | | | | 0,045 | 0,084 | 0,012 | 0,083 | | |
| Barium, Ba | µg/l | 160 | 160 | 160 | 160 | 150 | 160 | 150 | 150 | 150 | 150 | 12 | 240 | 160 | 250 | | |
| Chrom, Cr | µg/l | 0,51 | 0,3 | | | | | | | | | 1,1 | 60 | 24 | 60 | | |
| Kobber, Cu | µg/l | 0,8 | 3,3 | | | | | | | | | 1,5 | 25 | 7,5 | 25 | | |
| Nikkel, Ni | µg/l | 4,7 | 4,3 | 4,4 | 4,7 | 4,5 | 4,4 | 4,3 | 4,5 | 4,3 | 4,4 | 4,6 | 9,1 | 6,3 | 9 | | |
| Zink, Zn | µg/l | 12 | 33 | | | | | | | | | 11 | 8,4 | 4 | 8,7 | | |
| **HS BTEXN** | - | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Benzen | µg/l | 520 | 120 | 20 | 170 | 71 | 39 | 170 | 1,1 | 5,2 | 53 | 300 | <0,020 | 18 | 1,3 | 0,037 | <0,020 |
| Toluen | µg/l | 5 | 0,56 | 0,043 | 0,79 | 0,31 | 0,15 | 0,84 | <0,020 | <0,020 | 0,084 | 4,1 | <0,020 | 0,12 | <0,020 | <0,020 | <0,020 |
| Ethylbenzen | µg/l | 0,64 | 0,047 | <0,020 | 0,07 | 0,026 | <0,020 | 0,077 | <0,020 | <0,020 | 0,023 | 0,68 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| m/p-xylen | µg/l | 1,1 | 0,021 | <0,020 | 0,061 | <0,020 | <0,020 | 0,057 | <0,020 | <0,020 | 0,021 | 2,2 | <0,020 | 0,036 | <0,020 | <0,020 | <0,020 |
| o-xylen | µg/l | 1,2 | 0,085 | <0,020 | 0,17 | 0,07 | <0,020 | 0,16 | <0,020 | <0,020 | 0,066 | 1,1 | 0,021 | 0,035 | <0,020 | <0,020 | <0,020 |
| Xylener (o,-m- og p-xylen) | µg/l | 2,3 | 0,11 | <0,040 | 0,23 | 0,07 | <0,040 | 0,22 | <0,040 | <0,040 | 0,087 | 3,3 | <0,040 | 0,071 | <0,040 | <0,040 | <0,040 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | µg/l | 2,9 | 0,15 | <0,060 | 0,3 | 0,096 | <0,060 | 0,29 | <0,060 | <0,060 | 0,11 | 4 | <0,060 | 0,071 | <0,060 | <0,060 | <0,060 |
| Naphtalen | µg/l | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| **Kulbrinter i vand, kulbrintefraktioner** | - | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Kulbrinter n-C6 - n-C10 | µg/l | 270 | 140 | 20 | 200 | <5,0 | <5,0 | 21 | <5,0 | <5,0 | <5,0 | 300 | <5,0 | 20 | <5,0 | <5,0 | <5,0 |
| Kulbrinter >n-C10 - n-C15 | µg/l | <5,0 | 13 | <5,0 | 14 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | 13 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| Kulbrinter >n-C15 - n-C20 | µg/l | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| Kulbrinter >n-C20 - n-C35 | µg/l | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| Total kulbrinter (C6-C35) | µg/l | 270 | 150 | 20 | 210 | <5,0 | <5,0 | 21 | <5,0 | <5,0 | <5,0 | 310 | <5,0 | 20 | <5,0 | <5,0 | <5,0 |
| **HS Chlor. og nedbr.** | - | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Trichlormethan (Chloroform) | µg/l | 0,3 | 0,15 | 0,16 | 0,15 | 0,23 | 0,21 | 0,21 | 0,14 | 0,18 | 0,22 | 0,13 | 0,037 | 0,089 | 0,1 | 0,024 | <0,020 |
| 1,1,1-trichlorethan | µg/l | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| Tetrachlormethan | µg/l | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| Trichlorethylen | µg/l | 22 | 2,8 | 0,33 | 3,9 | 3 | 1,6 | 5,6 | 0,3 | 0,14 | 3,2 | 8,4 | <0,020 | 1,2 | 0,18 | 1,1 | 0,59 |
| Tetrachlorethylen | µg/l | 48 | 4,1 | 2,3 | 4,3 | 4,2 | 3,4 | 5,9 | 0,28 | 0,12 | 2,3 | 15 | <0,020 | 3,9 | 1,1 | 0,37 | 0,022 |
| Chlorethan | µg/l | 35 | 12 | 10 | 11 | 14 | 13 | 15 | 8,6 | 7 | 17 | 26 | <0,10 | 18 | 11 | 3,8 | 0,54 |
| Vinylchlorid | µg/l | 7100 | 1,7 | <0,020 | 280 | 190 | 3 | 760 | 18 | 59 | 510 | 4700 | <0,020 | 3,2 | 3,1 | 9,6 | <0,020 |
| 1,1-dichlorethylen | µg/l | 2 | <0,020 | <0,020 | 0,25 | 0,089 | <0,020 | 0,19 | <0,020 | <0,020 | 0,15 | 1,5 | <0,020 | 0,073 | <0,020 | <0,020 | <0,020 |
| trans-1,2-dichlorethylen | µg/l | 41 | 0,14 | <0,020 | 5,1 | 7,1 | 0,1 | 18 | 2,5 | 0,9 | 37 | 43 | <0,020 | 0,31 | 0,14 | 0,11 | <0,020 |
| cis-1,2-dichlorethylen | µg/l | 1400 | 20 | <0,020 | 520 | 340 | 8,1 | 680 | 19 | 16 | 220 | 1100 | <0,020 | 140 | 17 | 0,94 | <0,020 |
| 1,2-dichlorethan | µg/l | <0,020 | <0,020 | 2,3 | 9,4 | 5,9 | 4,1 | 12 | 1,2 | 1,5 | 4,2 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| 1,1-dichlorethan | µg/l | 0,27 | 0,15 | 0,14 | 0,13 | 0,19 | 0,17 | 0,18 | 0,1 | 0,14 | 0,2 | 0,17 | <0,020 | 0,13 | 0,11 | 0,03 | <0,020 |
| Dichlormethan | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | 0,18 | 0,16 | 0,12 | <0,10 | <0,10 | 0,15 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Brom, Br Filt Felt | µg/l | 1460 | 1640 | 1660 | 1550 | 1630 | 1660 | 1630 | | | | | | | | | |
| **Grindstedpakke A - Vand** | - | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Acetylsulfaguanidin | µg/l | <0,10 | 0,21 | <0,10 | 0,21 | <0,10 | <0,10 | 0,12 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Acetylsulfanilsyre | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Aetallymal | µg/l | 2,5 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 0,33 | <0,10 | <0,10 | 1,2 | 2 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Allyl-n-butylbarbityrat | µg/l | 1,9 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 0,14 | <0,10 | 0,3 | 1,7 | <0,10 | 0,16 | 0,36 | <0,10 | <0,10 |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | µg/l | 9,2 | <0,10 | <0,10 | 0,2 | 0,17 | <0,10 | 0,57 | 0,32 | 0,22 | 3,6 | 8,8 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| 5-allyl-5-(methylbutyl)-barbitursyre | µg/l | 12 | <0,10 | <0,10 | 0,23 | 0,1 | <0,10 | 1,1 | <0,10 | <0,10 | 2,3 | 13 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Barbital | µg/l | 15 | 17 | 14 | 17 | 14 | 13 | 15 | 8,1 | 1,6 | 22 | 18 | <0,10 | 11 | 170 | 0,22 | <0,10 |
| Butobarbital (N-butylethylbarbitursyre) | µg/l | 23 | 15 | 6,2 | 16 | 6,5 | 5,5 | 12 | 0,67 | <0,10 | 6 | 19 | <0,10 | 3,3 | 52 | <0,10 | <0,10 |
| Butylbarbiturat | µg/l | 110 | 2,4 | 1,9 | 2,9 | 3,1 | 0,57 | 1,2 | <0,10 | <0,10 | <0,10 | 3,6 | <0,10 | <0,10 | 0,62 | <0,10 | <0,10 |
| 5,5-diallylbarbitursyre (Allobarbital) | µg/l | 230 | <0,10 | <0,10 | 2,7 | 0,77 | <0,10 | 16 | 0,45 | <0,10 | 41 | 120 | <0,10 | <0,10 | 0,48 | <0,10 | <0,10 |
| N-N-diethylnicotinamid | µg/l | 8,4 | 1,4 | 0,96 | 1,5 | 0,95 | 0,93 | 1,3 | 0,44 | <0,10 | 1,2 | 5,2 | <0,10 | 3,4 | 0,8 | <0,10 | <0,10 |
| Dipropenylamin | µg/l | 23 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| 5-ethyl-5-sec-butylbarbitursyre | µg/l | 19 | 16 | 9,6 | 15 | 9,5 | 8,9 | 14 | 2,7 | 0,16 | 11 | 15 | <0,10 | 4,8 | 59 | 0,21 | <0,10 |
| Ethylurethan | µg/l | 315 | 100 | 77 | 90 | 66 | 64 | 76 | 48 | 23 | 36 | 312 | <0,10 | 207 | 124 | 6,5 | 0,44 |
| Phtalylsulfathiazol | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 0,21 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Hexobarbital | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 0,11 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Isobutylbarbitursyre | µg/l | 150 | 3 | 2,5 | 3 | 3,1 | 0,53 | 0,99 | <0,10 | <0,10 | <0,10 | 4,3 | 0,15 | <0,10 | <0,10 | <0,10 | <0,10 |
| Isopropylbarbitursyre | µg/l | 86 | 1,3 | 1,9 | 2,2 | 2,2 | 0,53 | 0,7 | 0,13 | <0,10 | 0,44 | 3,9 | <0,10 | 0,13 | <0,10 | <0,10 | <0,10 |
| Meprobamat | µg/l | 61 | 160 | 75 | 190 | 84 | 78 | 160 | 11 | 0,14 | 49 | 62 | <0,10 | 39 | 5,8 | 0,88 | <0,10 |
| Methoxyproprionitril | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| N-methyldiethylbarbitursyre | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 0,17 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Monoethylbarbitursyre | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 27 | <0,10 | 190 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Pentobarbital | µg/l | 56 | 37 | 20 | 32 | 22 | 19 | 31 | 1,1 | <0,10 | 7,5 | 36 | <0,10 | 7,5 | 100 | 0,3 | <0,10 |
| Amobarbital | µg/l | 43 | 25 | 12 | 48 | 12 | 12 | 42 | 1,9 | <0,10 | 12 | 38 | <0,10 | 6,5 | 70 | 0,11 | <0,10 |
| Sulfanilamid | µg/l | 37 | <0,10 | <0,10 | 0,17 | <0,10 | <0,10 | 0,84 | <0,10 | <0,10 | <0,10 | 23 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfaguanidine | µg/l | 0,5 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | 0,19 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfamethazin (Sulfadimidin) | µg/l | 110 | <0,10 | <0,10 | 0,21 | <0,10 | <0,10 | 1,5 | <0,10 | <0,10 | 4,6 | 75 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfamethiazol | µg/l | 32 | <0,050 | <0,050 | 0,078 | <0,050 | <0,050 | 0,63 | <0,050 | <0,050 | 0,2 | 13 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfadiazin | µg/l | 1,8 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | 1,3 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfanilsyre | µg/l | 65 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 23 | <0,10 | <0,10 | <0,10 | 2,4 | 0,85 |
| Sulfacetamid | µg/l | 200 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 0,14 | <0,10 | <0,10 | <0,10 | 81 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfadoxin | µg/l | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfamerazin | µg/l | 9,1 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | 0,2 | 7,3 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfanilylurinstof | µg/l | 110 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | 61 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfapyridin | µg/l | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfathiazol | µg/l | 3,6 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | 2,1 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |

| | | Ozonforsøg, Suez | | | Ozon + H2O2 | | | H2O2 + UV | | | H2O2 + faststof kat. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PAC tests** | 104243 | 104244 | 104245 | 104246 | 104247 | 104248 | 104249 | 107107 | 107108 | 107109 | 104250 | 104251 | 104252 |
| Prøvemrk. | PAC raw water | PAC-A6-SF | PAC-A7-SF | PAC-A8-SF | PAC-B6-SF | PAC-B7-SF | PAC-B8-SF | PAC-C6-SF | PAC-C7-SF | PAC-C8-SF | PAC-B-SF | PAC-E-SF | PAC-F-SF |
| Modtaget | 07-05-2020 | 07-05-2020 | 07-05-2020 | 07-05-2020 | 07-05-2020 | 07-05-2020 | 07-05-2020 | 13-05-2020 | 13-05-2020 | 13-05-2020 | 07-05-2020 | 07-05-2020 | 07-05-2020 |
| TOC | | | | | | | | 2,3 | 1,9 | 2,2 | | | |
| **HS BTEXN** | : | : | : | : | : | : | : | : | : | : | | : | : |
| Benzen | 3,1 | 1,9 | 0,28 | 2,9 | 0,89 | 0,14 | 2,1 | 0,066 | 0,082 | 0,25 | <0,020 | <0,020 | <0,020 |
| Toluen | <0,020 | 0,045 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | 0,021 | 0,063 | 0,06 |
| Ethylbenzen | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| m/p-xylen | <0,020 | <0,020 | 0,033 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| o-xylen | 0,025 | <0,020 | 0,033 | 0,021 | 0,02 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | 0,022 | 0,03 | 0,031 |
| Xylener (o,-m- og p-xylen) | <0,040 | <0,040 | 0,066 | <0,040 | <0,040 | <0,040 | <0,040 | <0,040 | <0,040 | <0,040 | <0,040 | <0,040 | <0,040 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | <0,060 | <0,060 | 0,066 | <0,060 | <0,060 | <0,060 | <0,060 | <0,060 | <0,060 | <0,060 | <0,060 | <0,060 | <0,060 |
| Naphtalen | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| **Kulbrinter i vand, kulbrintefraktioner** | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Kulbrinter n-C6 - n-C10 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| Kulbrinter >n-C10 - n-C15 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| Kulbrinter >n-C15 - n-C20 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| Kulbrinter >n-C20 - n-C35 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| Total kulbrinter (C6-C35) | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 | <5,0 |
| **HS Chlor. og nedbr.** | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Trichlormethan (Chloroform) | 0,026 | 0,033 | <0,020 | <0,020 | 0,031 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| 1,1,1-trichlorethan | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| Tetrachlormethan | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| Trichlorethylen | 0,071 | 0,051 | <0,020 | 0,08 | 0,042 | <0,020 | 0,067 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| Tetrachlorethylen | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| Chlorethan | 1,1 | 1,5 | <0,10 | <0,10 | 1,4 | <0,10 | <0,10 | 2,6 | <0,10 | <0,10 | <0,10 | <0,10 | 0,12 |
| Vinylchlorid | 180 | 9,4 | 0,18 | 0,38 | 20 | 0,03 | 1,1 | 33 | 0,42 | 1,4 | <0,020 | 0,12 | <0,020 |
| 1,1-dichlorethylen | 0,038 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| trans-1,2-dichlorethylen | 1,1 | 0,11 | 0,031 | 0,12 | 0,45 | 0,028 | 0,25 | 0,25 | 0,055 | 0,47 | <0,020 | <0,020 | <0,020 |
| cis-1,2-dichlorethylen | 74 | 6,3 | 0,49 | 8 | 37 | 0,23 | 9 | 5,5 | 1,2 | 8,1 | <0,020 | 0,057 | <0,020 |
| 1,2-dichlorethan | 0,46 | 0,56 | 0,073 | 0,2 | 0,58 | 0,033 | 0,16 | 0,33 | <0,020 | 0,1 | <0,020 | <0,020 | <0,020 |
| 1,1-dichlorethan | <0,020 | 0,023 | <0,020 | <0,020 | 0,025 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 | <0,020 |
| Dichlormethan | 0,21 | <0,10 | 0,2 | 0,21 | 0,17 | <0,10 | 0,13 | <0,10 | 0,2 | <0,10 | 0,18 | 0,26 | 0,22 |
| **Grindstedpakke A - Vand** | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Acetylsulfaguanidin | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Acetylsulfanilsyre | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Aetallymal | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Allyl-n-butylbarbityrat | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| 5-allyl-5-(methylbutyl)-barbitursyre | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Barbital | 1,8 | 10 | 8,4 | 15 | 8 | 7,7 | 15 | 0,74 | 0,12 | 4,3 | <0,10 | <0,10 | <0,10 |
| Butobarbital (N-butylethylbarbitursyre) | 0,21 | 1,5 | 1,2 | 2,8 | 0,75 | 0,56 | 2,5 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Butylbarbiturat | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| 5,5-diallylbarbitursyre (Allobarbital) | 5,3 | <0,10 | <0,10 | 0,76 | 0,13 | <0,10 | 4,1 | <0,10 | <0,10 | 0,44 | <0,10 | <0,10 | <0,10 |
| N-N-diethylnicotinamid | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Dipropenylamin | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| 5-ethyl-5-sec-butylbarbitursyre | 0,11 | 0,79 | 0,64 | 1,2 | 0,45 | 0,36 | 1,1 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Ethylurethan | 200 | 150 | 140 | 150 | 130 | 110 | 130 | 37 | 9,7 | 39 | <0,10 | 1,9 | <0,10 |
| Phtalylsulfathiazol | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Hexobarbital | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Isobutylbarbitursyre | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Isopropylbarbitursyre | 0,43 | 0,2 | 0,3 | 0,32 | 0,31 | <0,10 | <0,10 | <0,10 | <0,10 | 0,14 | <0,10 | <0,10 | <0,10 |
| Meprobamat | 0,32 | 1,7 | 0,96 | 2,3 | 0,51 | 0,28 | 1,5 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Methoxyproprionitril | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| N-methyldiethylbarbitursyre | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Monoethylbarbitursyre | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Pentobarbital | 0,14 | 0,77 | 0,83 | 1,7 | 0,47 | 0,33 | 1,6 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Amobarbital | 0,13 | 0,51 | 0,47 | 1,6 | 0,42 | 0,25 | 1,1 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfanilamid | 0,35 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfaguanidine | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfamethazin (Sulfadimidin) | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfamethiazol | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfadiazin | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfanilsyre | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfacetamid | 0,23 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfadoxin | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfamerazin | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |
| Sulfanilylurinstof | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfapyridin | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 | <0,10 |
| Sulfathiazol | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 | <0,050 |

# Bilag F Analyserapporter ALS

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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 08-07-2020
**Version:** 2
**Modtaget:** 11-03-2020
**Analyseperiode:** 11-03-2020 - 08-04-2020
**Ordrenr.:** 563049

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** DGU 114.2567 BE6-2-2
**Udtaget:** 10.03.2020
**Prøvetype:** Råvand
**Prøvetager:** COWI/JAD
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

| **Prøvenr.:** | 52503/20 | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Resultat** | **Enhed** | **DL** | **Urel (%)** | **Metode Navn** |
| Ammonium+ammoniak, NH4+ | 0.18 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.43 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 13 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 5.9 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 1.1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 96 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 5.4 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | <0.001 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | 0.060 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| TOC | 4.9 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.014 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 16 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.60 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Sulfat, SO4-- | 32 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | 71 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | 53 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 350 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.9 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat *1 | <5.0 | µg/l | 5 | 30 | CZ SOP D06 02 098 |
| Arsen, As | 3.8 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 0.12 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.0086 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 0.51 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 0.80 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 4.7 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 12 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | DS/EN ISO 10301:2000 |
| Benzen | 520 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | 5.0 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | 0.64 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | 1.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | 1.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | 2.3 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 2.9 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | - | | | AK61 - GC/FID/pentan |



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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 52503/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 270 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 270 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.30 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 22 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 48 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 35 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 7100 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | 2.0 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 41 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 1400 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.27 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| Brom, Br Filt Felt | *1 | 1460 | µg/l | 3 | 20 | ICP/MS ISO 17294-2 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | 2.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 1.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 9.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 23 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 110 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 230 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 8.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 19 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 315 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 150 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 86 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 61 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 56 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 43 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 37 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | 0.50 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 110 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 32 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | 1.8 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 65 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | 200 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | 9.1 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | 110 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | 3.6 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Laboratoriet vurderer: Prøvens totalkulbrinter har sin oprindelse i autobenzin.

## Underleverandør

*1 ALS Czech Republic s.r.o, CAI L1163

Jens Rasmussen



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run A
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62354/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 0.039 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.012 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 80 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 12 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 14 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 9.5 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 0.33 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.013 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | 0.74 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 4.0 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.027 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 17 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.40 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 31 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | 52 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | 48 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 550 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.0 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.2 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 3.0 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | 10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.045 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 12 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 1.1 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 1.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 4.6 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 11 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | 300 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | 4.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | 0.68 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | 2.2 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | 1.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | 3.3 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 4.0 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 62354/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 300 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | 13 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 310 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.13 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 8.4 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 15 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 26 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 4700 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | 1.5 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 43 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 1100 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.17 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | 2.0 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 1.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 8.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 18 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 19 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 3.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 120 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 5.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 312 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | 0.11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 4.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 3.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 38 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | 0.19 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 75 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 13 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | 1.3 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | 81 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | 7.3 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | 61 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | 2.1 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run B
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62355/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 0.18 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 1.4 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 150 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 18 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 30 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 14 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 42 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.001 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | 0.66 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 5.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.036 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 33 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.52 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 320 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | <3.0 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | - | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 810 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 5.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 8.4 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.084 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 240 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 60 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 25 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 9.1 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 8.4 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | 0.021 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 62355/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.037 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 0.15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

**Kommentar**

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run C
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62356/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 5.4 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.009 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 100 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 4.3 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 130 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 10 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 5.3 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | <0.001 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | <0.030 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 5.1 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.16 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 750 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.50 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 160 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | 150 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | <5 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 880 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 5.1 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 0.40 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 0.92 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.012 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 24 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 7.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 6.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 4.0 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | 18 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | 0.12 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | 0.036 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | 0.035 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | 0.071 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 0.071 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 62356/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.089 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 1.2 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 3.9 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 18 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 3.2 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | 0.073 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.31 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 140 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.13 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.16 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 3.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 3.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 4.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 207 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 7.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 6.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run D
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62357/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 4.7 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.096 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 100 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 7.6 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 110 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 33 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 44 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.001 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | <0.030 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.32 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 990 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 1.2 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 140 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 310 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | 82 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | <2 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 1100 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 8.5 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.083 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 250 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 60 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 25 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 9.0 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 8.7 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | 1.3 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 62357/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.10 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 0.18 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 1.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 11 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 3.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.14 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 17 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.11 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 170 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 52 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 0.62 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.48 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 0.80 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 59 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 124 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 5.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 100 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 70 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

**Kommentar**

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 22-05-2020 |
| **Version:** | 1 |
| **Modtaget:** | 22-04-2020 |
| **Analyseperiode:** | 22-04-2020 - 22-05-2020 |
| **Ordrenr.:** | 569983 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | E |
| **Udtaget:** | 20.04.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Water IQ |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 88158/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.10 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.003 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 26 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 0.45 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 240 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 29 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 0.60 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.01 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 3.8 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.047 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 150 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 34 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 270 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 810 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 3.6 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | | 1.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 38 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 0.51 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 0.037 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.024 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 88158/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 1.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 0.37 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 3.8 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 9.6 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.11 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 0.94 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.030 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 0.22 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.21 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 6.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 0.88 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 0.30 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 0.11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 2.4 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 22-05-2020 |
| **Version:** | 1 |
| **Modtaget:** | 22-04-2020 |
| **Analyseperiode:** | 22-04-2020 - 22-05-2020 |
| **Ordrenr.:** | 569983 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | F |
| **Udtaget:** | 20.04.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Water IQ |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 88159/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.091 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.008 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 34 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 0.51 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 220 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 29 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 0.76 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.003 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 17 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.026 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 150 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 38 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 230 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 800 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 2.8 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | | 1.2 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 52 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 0.20 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 88159/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 0.59 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 0.022 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 0.54 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 0.44 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 0.85 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.



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**ANALYSERAPPORT**

Majken Maria Løyche

Majken Løyche



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# Bilag D Rapport fra DHI

# Bilag E Analyseskema

# Bilag F Analyserapporter ALS

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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 08-07-2020
**Version:** 2
**Modtaget:** 11-03-2020
**Analyseperiode:** 11-03-2020 - 08-04-2020
**Ordrenr.:** 563049

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** DGU 114.2567 BE6-2-2
**Udtaget:** 10.03.2020
**Prøvetype:** Råvand
**Prøvetager:** COWI/JAD
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

| **Prøvenr.:** | 52503/20 | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Resultat** | **Enhed** | **DL** | **Urel (%)** | **Metode Navn** |
| Ammonium+ammoniak, NH4+ | 0.18 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.43 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 13 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 5.9 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 1.1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 96 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 5.4 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | <0.001 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | 0.060 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| TOC | 4.9 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.014 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 16 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.60 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Sulfat, SO4-- | 32 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | 71 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | 53 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 350 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.9 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat *1 | <5.0 | µg/l | 5 | 30 | CZ SOP D06 02 098 |
| Arsen, As | 3.8 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 0.12 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.0086 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 0.51 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 0.80 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 4.7 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 12 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | DS/EN ISO 10301:2000 |
| Benzen | 520 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | 5.0 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | 0.64 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | 1.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | 1.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | 2.3 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 2.9 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | - | | | AK61 - GC/FID/pentan |



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## ANALYSERAPPORT

**Prøvenr.:** 52503/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 270 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 270 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.30 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 22 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 48 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 35 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 7100 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | 2.0 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 41 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 1400 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.27 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| Brom, Br Filt Felt | *1 | 1460 | µg/l | 3 | 20 | ICP/MS ISO 17294-2 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | 2.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 1.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 9.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 23 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 110 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 230 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 8.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 19 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 315 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 150 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 86 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 61 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 56 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 43 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 37 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | 0.50 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 110 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 32 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | 1.8 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 65 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | 200 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | 9.1 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | 110 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | 3.6 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Laboratoriet vurderer: Prøvens totalkulbrinter har sin oprindelse i autobenzin.

## Underleverandør

*1 ALS Czech Republic s.r.o, CAI L1163

Jens Rasmussen



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 08-07-2020 |
| **Version:** | 2 |
| **Modtaget:** | 24-03-2020 |
| **Analyseperiode:** | 24-03-2020 - 25-04-2020 |
| **Ordrenr.:** | 564730 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | Run A |
| **Udtaget:** | 20.03.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Water IQ |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 62354/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 0.039 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.012 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 80 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 12 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 14 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 9.5 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 0.33 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.013 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | 0.74 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| TOC | 4.0 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.027 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 17 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.40 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 31 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | 52 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | 48 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 550 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.0 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.2 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 3.0 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | 10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.045 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 12 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 1.1 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 1.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 4.6 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 11 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | DS/EN ISO 10301:2000 |
| Benzen | 300 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | 4.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | 0.68 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | 2.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | 1.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | 3.3 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 4.0 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |



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## ANALYSERAPPORT

**Prøvenr.:** 62354/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 300 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | 13 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 310 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.13 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 8.4 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 15 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 26 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 4700 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | 1.5 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 43 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 1100 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.17 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | 2.0 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 1.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 8.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 18 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 19 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 3.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 120 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 5.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 312 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | 0.11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 4.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 3.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 62 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 38 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | 0.19 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 75 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 13 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | 1.3 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | 81 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | 7.3 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | 61 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | 2.1 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Jens Rasmussen



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 08-07-2020
**Version:** 2
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run B
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62355/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 0.18 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 1.4 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 150 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 18 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 30 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 14 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 42 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.001 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | 0.66 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| TOC | 5.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.036 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 33 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.52 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 320 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | <3.0 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | - | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 810 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 5.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 8.4 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.084 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 240 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 60 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 25 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 9.1 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 8.4 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | DS/EN ISO 10301:2000 |
| Benzen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | 0.021 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |



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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 62355/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.037 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 0.15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

**Kommentar**

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Jens Rasmussen



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 08-07-2020
**Version:** 2
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run C
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62356/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 5.4 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.009 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 100 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 4.3 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 130 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 10 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 5.3 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | <0.001 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | <0.030 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| TOC | 5.1 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.16 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 750 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.50 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 160 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | 150 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | <5 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 880 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 5.1 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 0.40 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 0.92 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.012 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 24 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 7.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 6.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 4.0 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | DS/EN ISO 10301:2000 |
| Benzen | 18 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | 0.12 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | 0.036 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | 0.035 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | 0.071 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 0.071 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |



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## ANALYSERAPPORT

**Prøvenr.:** 62356/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.089 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 1.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 3.9 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 18 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 3.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | 0.073 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.31 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 140 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.13 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.16 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 3.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 3.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 4.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 207 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 39 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 7.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 6.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Jens Rasmussen



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 08-07-2020 |
| **Version:** | 2 |
| **Modtaget:** | 24-03-2020 |
| **Analyseperiode:** | 24-03-2020 - 25-04-2020 |
| **Ordrenr.:** | 564730 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | Run D |
| **Udtaget:** | 20.03.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Water IQ |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 62357/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 4.7 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.096 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 100 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 7.6 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 110 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 33 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 44 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.001 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | <0.030 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| TOC | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.32 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 990 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 1.2 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 310 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | 82 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | <2 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 1100 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 8.5 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.083 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 250 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 60 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 25 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 9.0 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 8.7 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | DS/EN ISO 10301:2000 |
| Benzen | 1.3 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |



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## ANALYSERAPPORT

**Prøvenr.:** 62357/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.10 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.18 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 1.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 11 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 3.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.14 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 17 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.11 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 170 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 52 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 0.62 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.48 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 0.80 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 59 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 124 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 5.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 100 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 70 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

**Kommentar**

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Jens Rasmussen



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run A
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62354/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 0.039 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.012 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 80 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 12 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 14 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 9.5 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 0.33 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.013 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | 0.74 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 4.0 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.027 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 17 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.40 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 31 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | 52 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | 48 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 550 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.0 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.2 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 3.0 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | 10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.045 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 12 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 1.1 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 1.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 4.6 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 11 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | 300 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | 4.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | 0.68 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | 2.2 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | 1.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | 3.3 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 4.0 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 62354/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 300 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | 13 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 310 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.13 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 8.4 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 15 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 26 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 4700 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | 1.5 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 43 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 1100 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.17 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | 2.0 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 1.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 8.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 18 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 19 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 3.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 120 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 5.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 312 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | 0.11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 4.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 3.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 38 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | 0.19 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 75 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 13 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | 1.3 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | 81 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | 7.3 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | 61 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | 2.1 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run B
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62355/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 0.18 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 1.4 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 150 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 18 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 30 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 14 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 42 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.001 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | 0.66 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 5.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.036 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 33 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.52 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 320 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | <3.0 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | - | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 810 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 5.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 8.4 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.084 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 240 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 60 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 25 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 9.1 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 8.4 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | 0.021 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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**Prøvenr.:** 62355/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.037 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 0.15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**Kommentar**

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run C
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62356/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 5.4 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.009 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 100 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 4.3 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 130 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 10 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 5.3 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | <0.001 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | <0.030 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 5.1 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.16 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 750 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 0.50 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 150 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 160 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | 150 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | <5 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 880 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 5.1 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 0.40 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 0.92 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.012 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 24 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 7.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 6.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 4.0 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | 18 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | 0.12 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | 0.036 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | 0.035 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | 0.071 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | 0.071 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 62356/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.089 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 1.2 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 3.9 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 18 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 3.2 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | 0.073 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.31 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 140 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.13 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.16 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 3.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 3.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 4.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 207 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 7.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 6.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

## Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 25-04-2020
**Version:** 1
**Modtaget:** 24-03-2020
**Analyseperiode:** 24-03-2020 - 25-04-2020
**Ordrenr.:** 564730

**Sagsnavn** A121940-002
**Lokalitet:** 535-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Run D
**Udtaget:** 20.03.2020
**Prøvetype:** Vand
**Prøvetager:** Water IQ
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 62357/20

| Parameter | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | 4.7 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | 0.096 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | 100 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | 7.6 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | 110 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | 33 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | 44 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | 0.001 | mg/l | 0.001 | 15 | DS/ISO 15923:2013 |
| Nitrat, NO3- | <0.030 | mg/l | 0.1 | 15 | DS/ISO 15923:2013 + beregning |
| TOC | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Total phosphor, P | 0.32 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | - | mg/l | 0.3 | 15 | Granplot |
| COD iltforbrug m. dichromat | 990 | mg/l | 5 | 10 | DS/ISO 15705:2006 |
| Total kvælstof, N | 1.2 | mg/l | 0.02 | 15 | DS/EN ISO 11905-1:1998 |
| Chlorid, Cl- | 140 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Fluorid, F- | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | 310 | mg/l | 0.5 | 15 | DS/ISO 15923:2013 |
| Hydrogencarbonat, HCO3- | 82 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Aggressiv kuldioxid, CO2 | <2 | mg/l | 2 | 15 | DS 236:1977 |
| Inddampningsrest | 1100 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | 1.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | 8.5 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | 0.083 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | 250 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | 60 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | 25 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | 9.0 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | 8.7 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | - | | | AK210 - HS GC/MS |
| Benzen | 1.3 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 62357/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.10 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 0.18 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 1.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 11 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 3.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.14 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 17 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.11 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 170 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 52 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 0.62 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.48 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 0.80 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 59 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 124 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 5.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 100 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 70 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

**Kommentar**

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 22-05-2020
**Version:** 1
**Modtaget:** 21-04-2020
**Analyseperiode:** 21-04-2020 - 22-05-2020
**Ordrenr.:** 569726

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** TA6-SF
**Udtaget:** 20.04.2020
**Prøvetype:** Vand - Lab forsøg
**Prøvetager:** SUEZ, Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 86564/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.094 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.51 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 15 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 6.4 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1.3 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 98 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 2.9 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.0082 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 0.24 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | <0.003 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 32 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 49 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 350 | mg/l | 10 | 10 | DS 204:1980 |
| Methan, CH4 | | 0.059 | mg/l | 0.01 | 20 | AK129 - HS GC/FID |
| NVOC | | 4.6 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat | *2 | 0.0091 | mg/l | 0.0025 | 16 | DIN EN ISO 15061:2001-12 |
| Arsen, As | | 2.2 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bly, Pb | | 0.78 | µg/l | 0.025 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Cadmium, Cd | | 0.019 | µg/l | 0.003 | 10 | DS/EN ISO 17294-2:2016 |
| Barium, Ba | | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Chrom, Cr | | 0.30 | µg/l | 0.01 | 10 | DS/EN ISO 17294-2:2016 |
| Kobber, Cu | | 3.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Zink, Zn | | 33 | µg/l | 0.3 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 120 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | 0.56 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | 0.047 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | 0.021 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | 0.085 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | 0.11 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | 0.15 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |



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## ANALYSERAPPORT

**Prøvenr.:** 86564/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Kulbrinter n-C6 - n-C10 | # | 140 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | 13 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 150 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.15 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 2.8 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 4.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 12 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 1.7 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.14 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 20 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.15 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| Bromid, Br | *1 | 1640 | µg/l | 10 | | ICP/SFMS SS EN ISO 17294-2: 2016 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | 0.21 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 17 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 2.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 1.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 16 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 100 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 3.0 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 1.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 160 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 37 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 25 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

## Kommentar

De påviste kulbrinter svarer ikke til et normalt kulbrinteprodukt. De påviste stoffer kan komme ved udvaskning af enten delvist nedbrudt benzin eller diesel/fyringsgasolie.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.

## Underleverandør

*1 # ALS Scandinavia AB, SWEDAC 2030

*2 GBA Gesellschaft für Bioanalytik mbH, DAkkS D-PL-14170-01-00

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 22-05-2020
**Version:** 1
**Modtaget:** 21-04-2020
**Analyseperiode:** 21-04-2020 - 22-05-2020
**Ordrenr.:** 569726

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** TA7-SF
**Udtaget:** 20.04.2020
**Prøvetype:** Vand - Lab forsøg
**Prøvetager:** SUEZ, Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 86565/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | <0.004 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.48 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 14 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 5.9 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1.1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 98 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 3.3 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.0094 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 0.75 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.052 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 40 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 47 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 370 | mg/l | 10 | 10 | DS 204:1980 |
| Methan, CH4 | | 0.018 | mg/l | 0.01 | 20 | AK129 - HS GC/FID |
| NVOC | | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat | *2 | 0.065 | mg/l | 0.0025 | 16 | DIN EN ISO 15061:2001-12 |
| Arsen, As | | 1.9 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 20 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | 0.043 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 20 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |



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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 86565/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.16 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 0.33 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 2.3 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 10 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | 2.3 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.14 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| Bromid, Br | *1 | 1660 | µg/l | 10 | | ICP/SFMS SS EN ISO 17294-2: 2016 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 14 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 6.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 1.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 0.96 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 9.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 77 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 2.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 1.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 75 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 20 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



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**ANALYSERAPPORT**

## Kommentar

De påviste kulbrinter svarer til benzen.

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS218:1975, MOD til DS/EN ISO 10304-1:2009.

## Underleverandør

*1 # ALS Scandinavia AB, SWEDAC 2030
*2 GBA Gesellschaft für Bioanalytik mbH, DAkkS D-PL-14170-01-00

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 22-05-2020
**Version:** 1
**Modtaget:** 21-04-2020
**Analyseperiode:** 21-04-2020 - 22-05-2020
**Ordrenr.:** 569726

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** TA8-SF
**Udtaget:** 20.04.2020
**Prøvetype:** Vand - Lab forsøg
**Prøvetager:** SUEZ, Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 86566/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.22 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.48 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 14 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 5.9 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1.1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 93 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 3.3 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.0069 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 0.37 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.004 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 34 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 51 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 380 | mg/l | 10 | 10 | DS 204:1980 |
| Methan, CH4 | | 0.093 | mg/l | 0.01 | 20 | AK129 - HS GC/FID |
| NVOC | | 4.7 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat | *2 | <0.0025 | mg/l | 0.0025 | 16 | DIN EN ISO 15061:2001-12 |
| Arsen, As | | 2.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.7 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 170 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | 0.79 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | 0.070 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | 0.061 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | 0.17 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | 0.23 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | 0.30 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 200 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | 14 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 210 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |



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## ANALYSERAPPORT

**Prøvenr.:** 86566/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.15 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 3.9 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 4.3 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 11 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 280 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | 0.25 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 5.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 520 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | 9.4 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.13 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| Bromid, Br | *1 | 1550 | µg/l | 10 | | ICP/SFMS SS EN ISO 17294-2: 2016 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | 0.21 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 0.20 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 0.23 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 17 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 16 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 2.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 2.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 1.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 90 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 3.0 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 2.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 190 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 32 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 48 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 0.17 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 0.21 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 0.078 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

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**ANALYSERAPPORT**

## Kommentar

De påviste kulbrinter svarer ikke til et normalt kulbrinteprodukt. De påviste stoffer kan komme ved udvaskning af enten delvist nedbrudt benzin eller diesel/fyringsgasolie.

De påviste chlorerede opløsningsmidler er kvantiseret ved GC/MS, og er således ikke medtaget ved beregning af totalkulbrinter.

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.

## Underleverandør

*1 # ALS Scandinavia AB, SWEDAC 2030

*2 GBA Gesellschaft für Bioanalytik mbH, DAkkS D-PL-14170-01-00

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 22-05-2020 |
| **Version:** | 1 |
| **Modtaget:** | 22-04-2020 |
| **Analyseperiode:** | 22-04-2020 - 22-05-2020 |
| **Ordrenr.:** | 569983 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | E |
| **Udtaget:** | 20.04.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Water IQ |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 88158/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.10 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.003 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 26 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 0.45 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 240 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 29 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 0.60 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.01 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 3.8 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.047 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 150 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 34 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 270 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 810 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 3.6 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | | 1.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 38 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 0.51 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 0.037 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | 0.024 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



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Telefon: +45 4925 0770
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## ANALYSERAPPORT

**Prøvenr.:** 88158/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 1.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 0.37 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 3.8 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 9.6 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.11 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 0.94 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.030 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 0.22 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.21 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 6.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 0.88 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 0.30 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 0.11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 2.4 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 22-05-2020 |
| **Version:** | 1 |
| **Modtaget:** | 22-04-2020 |
| **Analyseperiode:** | 22-04-2020 - 22-05-2020 |
| **Ordrenr.:** | 569983 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | F |
| **Udtaget:** | 20.04.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Water IQ |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 88159/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.091 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.008 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 34 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 0.51 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 220 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 29 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 0.76 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.003 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 17 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.026 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 150 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 38 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 230 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 800 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 2.8 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | | 1.2 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 52 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 0.20 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

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RIGHT SOLUTIONS | RIGHT PARTNER

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DK-3050 Humlebæk
Telefon: +45 4925 0770
www.alsglobal.dk

TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 88159/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 0.59 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 0.022 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 0.54 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 0.44 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | 0.85 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 28-05-2020 |
| **Version:** | 1 |
| **Modtaget:** | 28-04-2020 |
| **Analyseperiode:** | 28-04-2020 - 28-05-2020 |
| **Ordrenr.:** | 570975 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | Test 1 |
| **Udtaget:** | 27.04.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Rekv/SUEZ, Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 95602/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.19 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.46 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 13 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 5.5 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1.1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 92 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 1.4 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | <0.0010 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 0.12 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | <0.003 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 39 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 48 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 380 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 4.0 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat | *2 | <0.0025 | mg/l | 0.0025 | 16 | DIN EN ISO 15061:2001-12 |
| Arsen, As | | 0.97 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 150 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 71 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | 0.31 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | 0.026 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | 0.070 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | 0.070 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | 0.096 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |



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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 95602/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Trichlormethan (Chloroform) | | 0.23 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 3.0 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 4.2 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 14 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 190 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | 0.089 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 7.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 340 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | 5.9 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.19 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | 0.18 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| Bromid, Br | *1 | 1630 | µg/l | 10 | | ICP/SFMS SS EN ISO 17294-2: 2016 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 0.17 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 14 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 6.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 3.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.77 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 0.95 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 9.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 66 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 3.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 2.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 84 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 22 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.

### Underleverandør

*1 # ALS Scandinavia AB, SWEDAC 2030



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

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**ANALYSERAPPORT**

*2 GBA Gesellschaft für Bioanalytik mbH, DAkkS D-PL-14170-01-00

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 28-05-2020
**Version:** 1
**Modtaget:** 28-04-2020
**Analyseperiode:** 28-04-2020 - 28-05-2020
**Ordrenr.:** 570975

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** Test 2
**Udtaget:** 27.04.2020
**Prøvetype:** Vand
**Prøvetager:** Rekv/SUEZ, Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

| **Prøvenr.:** | | 95603/20 | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | | **Resultat** | **Enhed** | **DL** | **Urel (%)** | **Metode Navn** |
| Ammonium+ammoniak, NH4+ | | 0.11 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.42 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 12 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 5.2 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1.3 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 89 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 2.8 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.016 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | 0.41 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | <0.003 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | -- | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 36 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 46 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 370 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 4.2 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat | *2 | 0.019 | mg/l | 0.0025 | 16 | DIN EN ISO 15061:2001-12 |
| Arsen, As | | 2.1 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 160 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 39 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | 0.15 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

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DK-3050 Humlebæk
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## ANALYSERAPPORT

**Prøvenr.:** 95603/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Trichlormethan (Chloroform) | | 0.21 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 1.6 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 3.4 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 13 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 3.0 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 0.10 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 8.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | 4.1 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.17 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | 0.16 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| Bromid, Br | *1 | 1660 | µg/l | 10 | | ICP/SFMS SS EN ISO 17294-2: 2016 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 5.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 0.57 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 0.93 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 8.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 64 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 0.53 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.53 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 78 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 19 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.

### Underleverandør

*1 # ALS Scandinavia AB, SWEDAC 2030



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

*2 GBA Gesellschaft für Bioanalytik mbH, DAkkS D-PL-14170-01-00

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 28-05-2020 |
| **Version:** | 1 |
| **Modtaget:** | 28-04-2020 |
| **Analyseperiode:** | 28-04-2020 - 28-05-2020 |
| **Ordrenr.:** | 570975 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | Test 3 |
| **Udtaget:** | 27.04.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | Rekv/SUEZ, Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 95604/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.19 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | - | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.47 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 13 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 5.5 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1.1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 94 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 1.8 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.0030 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | <0.10 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | <0.003 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS 218:1975,MOD |
| Sulfat, SO4-- | | 39 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 50 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 370 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 4.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Bromat | *2 | <0.0025 | mg/l | 0.0025 | 16 | DIN EN ISO 15061:2001-12 |
| Arsen, As | | 0.98 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 150 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | AK210 - HS GC/MS |
| Benzen | | 170 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Toluen | | 0.84 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Ethylbenzen | | 0.077 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| m/p-xylen | | 0.057 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| o-xylen | | 0.16 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m- og p-xylen) | | 0.22 | µg/l | 0.04 | 20 | AK210 - HS GC/MS |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | 0.29 | µg/l | 0.06 | 20 | AK210 - HS GC/MS |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | 21 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | 21 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | AK210 - HS GC/MS |



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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 95604/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Trichlormethan (Chloroform) | | 0.21 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Trichlorethylen | | 5.6 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Tetrachlorethylen | | 5.9 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Chlorethan | | 15 | µg/l | 0.10 | 20 | AK210 - HS GC/MS |
| Vinylchlorid | | 760 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethylen | | 0.19 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| trans-1,2-dichlorethylen | | 18 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| cis-1,2-dichlorethylen | | 680 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,2-dichlorethan | | 12 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| 1,1-dichlorethan | | 0.18 | µg/l | 0.020 | 20 | AK210 - HS GC/MS |
| Dichlormethan | | 0.12 | µg/l | 0.1 | 20 | AK210 - HS GC/MS |
| Bromid, Br | *1 | 1630 | µg/l | 10 | | ICP/SFMS SS EN ISO 17294-2: 2016 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | 0.12 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | 0.33 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 0.57 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 1.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | 1.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 16 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 1.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 14 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 76 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | 0.99 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.70 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 160 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 31 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 42 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 0.84 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 1.5 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 0.63 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | 0.14 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Grundet nedbrud på apparatet har laboratoriet været nødt til at skifte analysemetode for fluorid fra DS/EN ISO 10304-1:2009 til DS218:1975, MOD.
Prøven har et indhold af kulbrinter, der ikke umiddelbart kan sammenlignes med et kendt olie- eller tjæreprodukt. Kogepunktsintervallet for de påviste kulbrinter ligger på ca. 100 - 150 °C.



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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Telefon: +45 4925 0770
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**ANALYSERAPPORT**

**Underleverandør**

*1 # ALS Scandinavia AB, SWEDAC 2030
*2 GBA Gesellschaft für Bioanalytik mbH, DAkkS D-PL-14170-01-00

Ditte T. E. Strecker

Ditte Therese Ekman Strecker



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC raw water |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104243/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 3.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.025 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.026 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.071 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 1.1 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 180 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | 0.038 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 1.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 74 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.46 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.21 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 1.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 0.21 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 104243/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | 5.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 200 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.43 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 0.32 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 0.14 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 0.13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | 0.35 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | 0.23 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-A6-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104244/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 1.9 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | 0.045 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.033 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.051 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 1.5 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 9.4 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.11 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 6.3 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.56 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.023 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 1.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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DK-3050 Humlebæk
Telefon: +45 4925 0770
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## ANALYSERAPPORT

**Prøvenr.:** 104244/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.79 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 150 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.20 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 1.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 0.77 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 0.51 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



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# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-A7-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104245/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 0.28 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | 0.033 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.033 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | 0.066 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | 0.066 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 0.18 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.031 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 0.49 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.073 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.20 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 8.4 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 1.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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DK-3050 Humlebæk
Telefon: +45 4925 0770
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## ANALYSERAPPORT

**Prøvenr.:** 104245/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.64 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 140 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.30 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 0.96 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 0.83 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 0.47 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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DK-3050 Humlebæk
Telefon: +45 4925 0770
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-A8-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104246/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 2.9 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.021 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.080 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 0.38 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.12 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 8.0 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.20 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.21 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 2.8 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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DK-3050 Humlebæk
Telefon: +45 4925 0770
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TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 104246/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.76 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 1.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 150 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.32 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 2.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 1.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 1.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



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Telefon: +45 4925 0770
www.alsglobal.dk

TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-B6-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104247/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 0.89 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.031 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.042 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 1.4 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 20 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.45 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 37 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.58 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.025 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.17 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 8.0 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 0.75 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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DK-3050 Humlebæk
Telefon: +45 4925 0770
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## ANALYSERAPPORT

**Prøvenr.:** 104247/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.45 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 130 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.31 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 0.51 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 0.47 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 0.42 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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Telefon: +45 4925 0770
www.alsglobal.dk

TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-B7-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104248/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 0.14 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 0.030 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.028 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 0.23 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.033 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 7.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 0.56 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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Telefon: +45 4925 0770
www.alsglobal.dk

## ANALYSERAPPORT

**Prøvenr.:** 104248/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 110 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 0.28 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 0.33 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 0.25 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-B8-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104249/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 2.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.067 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 1.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.25 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 9.0 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.16 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.13 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 15 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 2.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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DK-3050 Humlebæk
Telefon: +45 4925 0770
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## ANALYSERAPPORT

**Prøvenr.:** 104249/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | 4.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 1.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 130 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 1.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 1.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 1.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-B-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104250/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | 0.021 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.022 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.18 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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## ANALYSERAPPORT

**Prøvenr.:** 104250/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

Tegnforklaring:
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<: mindre end >: Større end

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ALS Denmark A/S
Bakkegårdsvej 406 A
DK-3050 Humlebæk
Telefon: +45 4925 0770
www.alsglobal.dk

TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-E-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104251/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | 0.063 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.030 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 0.12 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 0.057 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.26 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

Tegnforklaring:
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DK-3050 Humlebæk
Telefon: +45 4925 0770
www.alsglobal.dk

## ANALYSERAPPORT

**Prøvenr.:** 104251/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 1.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



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DK-3050 Humlebæk
Telefon: +45 4925 0770
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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 09-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 07-05-2020 |
| **Analyseperiode:** | 07-05-2020 - 09-06-2020 |
| **Ordrenr.:** | 572951 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-F-SF |
| **Udtaget:** | 05.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 104252/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | 0.060 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.031 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 0.12 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.22 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

Tegnforklaring:
#: Ikke akkrediteret i.p.: Ikke påvist
<: mindre end >: Større end

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DK-3050 Humlebæk
Telefon: +45 4925 0770
www.alsglobal.dk

## ANALYSERAPPORT

**Prøvenr.:** 104252/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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DK-3050 Humlebæk
Telefon: +45 4925 0770
www.alsglobal.dk

TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 12-06-2020
**Version:** 1
**Modtaget:** 13-05-2020
**Analyseperiode:** 13-05-2020 - 12-06-2020
**Ordrenr.:** 573656

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** TC6-SF
**Udtaget:** 11.05.2020
**Prøvetype:** Vand
**Prøvetager:** SUEZ/Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 107104/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.41 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.42 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 14 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 6.0 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1.1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 120 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 2.6 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.0025 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | <0.10 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.13 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Sulfat, SO4-- | | 89 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 51 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 420 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 5.5 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | | 0.62 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | 10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 150 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.5 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 1.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.14 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |



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## ANALYSERAPPORT

**Prøvenr.:** 107104/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.30 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 0.28 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 8.6 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 18 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 2.5 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 19 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 1.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.10 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.14 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 0.32 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 8.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 0.67 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.45 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 0.44 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 2.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 48 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.13 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | 27 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 1.1 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 1.9 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

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**ANALYSERAPPORT**

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 12-06-2020
**Version:** 1
**Modtaget:** 13-05-2020
**Analyseperiode:** 13-05-2020 - 12-06-2020
**Ordrenr.:** 573656

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** TC7-SF
**Udtaget:** 11.05.2020
**Prøvetype:** Vand
**Prøvetager:** SUEZ/Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 107105/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.37 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | <0.030 | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.42 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 11 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 4.9 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 0.9 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 120 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 0.51 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.0010 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | <0.10 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | 0.003 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Sulfat, SO4-- | | 100 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 48 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 460 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 4.4 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | | 0.42 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | 10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 150 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.3 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 5.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.18 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |



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## ANALYSERAPPORT

**Prøvenr.:** 107105/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 0.14 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 0.12 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 7.0 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 59 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.90 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 16 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 1.5 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.14 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 0.22 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 1.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 0.16 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 23 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 0.14 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar



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**ANALYSERAPPORT**

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 12-06-2020
**Version:** 1
**Modtaget:** 13-05-2020
**Analyseperiode:** 13-05-2020 - 12-06-2020
**Ordrenr.:** 573656

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** TC8-SF
**Udtaget:** 11.05.2020
**Prøvetype:** Vand
**Prøvetager:** SUEZ/Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 107106/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Ammonium+ammoniak, NH4+ | | 0.24 | mg/l | 0.004 | 15 | SM 17udg. 4500-NH3 |
| Fluorid, F- | | 0.073 | mg/l | 0.03 | 15 | DS/EN ISO 10304-1:2009 |
| Mangan, Mn | | 0.43 | mg/l | 0.001 | 10 | DS/EN ISO 11885:2009 |
| Calcium, Ca++ | | 12 | mg/l | 0.5 | 10 | DS/EN ISO 11885:2009 |
| Magnesium, Mg++ | | 5.0 | mg/l | 0.3 | 10 | DS/EN ISO 11885:2009 |
| Kalium, K+ | | 1 | mg/l | 0.05 | 10 | DS/EN ISO 11885:2009 |
| Natrium, Na+ | | 120 | mg/l | 0.1 | 10 | DS/EN ISO 11885:2009 |
| Jern, Fe | | 0.84 | mg/l | 0.01 | 10 | DS/EN ISO 11885:2009 |
| Nitrit, NO2- | | 0.0033 | mg/l | 0.001 | 15 | DS/ISO 15923-1:2013 |
| Nitrat, NO3- | | <0.10 | mg/l | 0.1 | 15 | DS/ISO 15923-1:2013 + beregning |
| Total phosphor, P | | <0.003 | mg/l | 0.003 | 15 | DS/EN ISO 6878:2004 Del 7 |
| Hydrogencarbonat, HCO3 | | - | mg/l | 0.3 | 15 | Granplot |
| Chlorid, Cl- | | 140 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Sulfat, SO4-- | | 94 | mg/l | 0.5 | 15 | DS/ISO 15923-1:2013 |
| Hydrogencarbonat, HCO3- | | 52 | mg/l | 3 | 15 | DS/EN ISO 9963-1:1996 |
| Inddampningsrest | | 430 | mg/l | 10 | 10 | DS 204:1980 |
| NVOC | | 5.4 | mg/l | 0.1 | 15 | DS/EN 1484:1997+SM 5310B:2014 |
| Arsen, As | | 0.44 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Bor, B | | <10 | µg/l | 10 | 20 | DS/EN ISO 11885:2009 |
| Barium, Ba | | 150 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| Nikkel, Ni | | 4.4 | µg/l | 0.03 | 10 | DS/EN ISO 17294-2:2016 |
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 53 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | 0.084 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | 0.023 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | 0.021 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | 0.066 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | 0.087 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | 0.11 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | 0.22 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |



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Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
Oplysninger om måleusikkerhed findes på www.alsglobal.dk

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<: mindre end >: Større end

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DK-3050 Humlebæk
Telefon: +45 4925 0770
www.alsglobal.dk

TEST Reg.nr. 361

## ANALYSERAPPORT

**Prøvenr.:** 107106/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | 3.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | 2.3 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 17 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 510 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | 0.15 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 37 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 220 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 4.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | 0.20 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.15 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | 1.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | 0.30 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | 3.6 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | 2.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 22 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | 6.0 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5,5-diallylbarbitursyre (Allobarbital) | # | 41 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | 1.2 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | 11 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 36 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | 0.21 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.44 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | 49 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | 0.17 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | 190 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | 7.5 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | 12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | 4.6 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | 0.20 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | 0.20 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
Analyserapporten må kun gengives i sin helhed, medmindre skriftlig godkendelse forligger
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**ANALYSERAPPORT**

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 12-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 13-05-2020 |
| **Analyseperiode:** | 13-05-2020 - 12-06-2020 |
| **Ordrenr.:** | 573656 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-C6-SF |
| **Udtaget:** | 11.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 107107/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 0.066 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | 2.6 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 33 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.25 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 5.5 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.33 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 0.74 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 107107/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 37 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



Laboratoriet er akkrediteret af DANAK. Analyseresultaterne gælder kun for de(n) analyserede prøve(r).
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www.alsglobal.dk

TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

**Udskrevet:** 12-06-2020
**Version:** 1
**Modtaget:** 13-05-2020
**Analyseperiode:** 13-05-2020 - 12-06-2020
**Ordrenr.:** 573656

**Sagsnavn** A121940-002
**Lokalitet:** 565-32009, Svinget 12, Grindsted
**Prøvested:** Lab forsøg
**Prøve ID:** PAC-C7-SF
**Udtaget:** 11.05.2020
**Prøvetype:** Vand
**Prøvetager:** SUEZ/Zürich
**Kunde:** Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk

**Prøvenr.:** 107108/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 0.082 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 0.42 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.055 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 1.2 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | 0.20 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 0.12 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 107108/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 9.7 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



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TEST Reg.nr. 361

# ANALYSERAPPORT

COWI
Parallelvej 2
2800 Lyngby
Att.: Jarl Dall-Jepsen

| | |
|---|---|
| **Udskrevet:** | 12-06-2020 |
| **Version:** | 1 |
| **Modtaget:** | 13-05-2020 |
| **Analyseperiode:** | 13-05-2020 - 12-06-2020 |
| **Ordrenr.:** | 573656 |

| | |
|---|---|
| **Sagsnavn** | A121940-002 |
| **Lokalitet:** | 565-32009, Svinget 12, Grindsted |
| **Prøvested:** | Lab forsøg |
| **Prøve ID:** | PAC-C8-SF |
| **Udtaget:** | 11.05.2020 |
| **Prøvetype:** | Vand |
| **Prøvetager:** | SUEZ/Zürich |
| **Kunde:** | Region Syddanmark, Damhaven 12, 7100 Vejle, Att. Hanne Nielsen, PersonRef. hni@rsyd.dk |

**Prøvenr.:** 107109/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| **HS BTEXN** | | | - | | | DS/EN ISO 10301:2000 |
| Benzen | | 0.25 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Toluen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Ethylbenzen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| m/p-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| o-xylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m- og p-xylen) | | <0.040 | µg/l | 0.04 | 20 | DS/EN ISO 10301:2000 |
| Xylener (o,-m-, p-xylen og ethylbenzen) | # | <0.060 | µg/l | 0.06 | 20 | DS/EN ISO 10301:2000 |
| Naphtalen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| **Kulbrinter i vand** | | | - | | | AK61 - GC/FID/pentan |
| **Kulbrintefraktioner** | | | - | | | AK61 - GC/FID/pentan |
| Kulbrinter n-C6 - n-C10 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C10 - n-C15 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C15 - n-C20 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Kulbrinter >n-C20 - n-C35 | # | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| Total kulbrinter (C6-C35) | | <5.0 | µg/l | 5 | 30 | AK61 - GC/FID/pentan |
| **HS Chlor. og nedbr.** | | | - | | | DS/EN ISO 10301:2000 |
| Trichlormethan (Chloroform) | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1,1-trichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlormethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Trichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Tetrachlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Chlorethan | | <0.10 | µg/l | 0.10 | 20 | DS/EN ISO 10301:2000 |
| Vinylchlorid | | 1.4 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethylen | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| trans-1,2-dichlorethylen | | 0.47 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| cis-1,2-dichlorethylen | | 8.1 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,2-dichlorethan | | 0.10 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| 1,1-dichlorethan | | <0.020 | µg/l | 0.020 | 20 | DS/EN ISO 10301:2000 |
| Dichlormethan | | <0.10 | µg/l | 0.1 | 20 | DS/EN ISO 10301:2000 |
| **Grindstedpakke A - Vand** | | | - | | | AK186 - LC-GC/MS/MS |
| Acetylsulfaguanidin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Acetylsulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Aetallymal | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Allyl-n-butylbarbityrat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-isobutyl-barbitursyre (Butalbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| 5-allyl-5-(methylbutyl)-barbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Barbital | # | 4.3 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butobarbital (N-butylethylbarbitursyre) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Butylbarbiturat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |



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## ANALYSERAPPORT

**Prøvenr.:** 107109/20

| Parameter | | Resultat | Enhed | DL | Urel (%) | Metode Navn |
|---|---|---|---|---|---|---|
| 5,5-diallylbarbitursyre (Allobarbital) | # | 0.44 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-N-diethylnicotinamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Dipropenylamin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| 5-ethyl-5-sec-butylbarbitursyre (Butabarbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Ethylurethan | # | 39 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Phtalylsulfathiazol | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Hexobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isobutylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Isopropylbarbitursyre | # | 0.14 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Meprobamat | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Methoxyproprionitril | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| N-methyldiethylbarbitursyre (Metharbital) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Monoethylbarbitursyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Pentobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Amobarbital | # | <0.10 | µg/l | 0.1 | 30 | AK186 - GC/MS |
| Sulfanilamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfaguanidine | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamethazin (Sulfadimidin) | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfamethiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfadiazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilsyre | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfacetamid | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfadoxin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfamerazin | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |
| Sulfanilylurinstof | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfapyridin | # | <0.10 | µg/l | 0.1 | 30 | AK186 - LC/MS/MS |
| Sulfathiazol | # | <0.050 | µg/l | 0.05 | 30 | AK186 - LC/MS/MS |

### Kommentar

Ingen kommentar

Majken Maria Løyche

Majken Løyche



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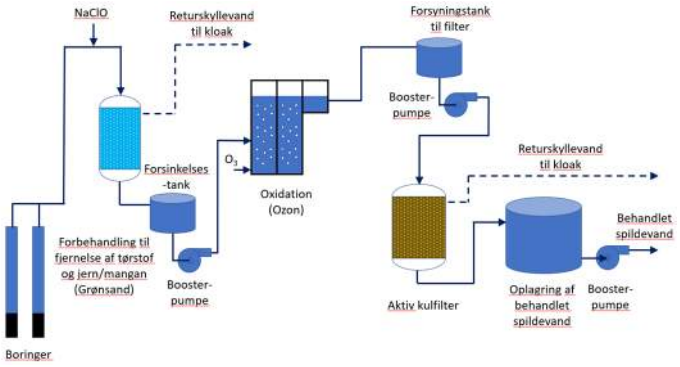
# Bilag G Detaljeret analyse af AOP afværgemetoder

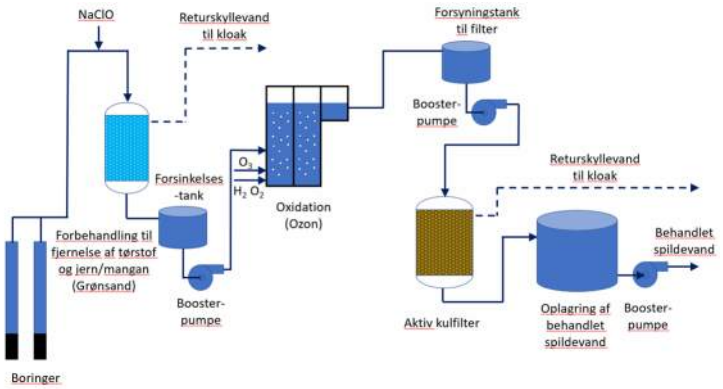
| LØSNING A | SANDFILTER + OZON + GAC |
|---|---|
| Kort metodebeskrivelse | Denne løsning omfatter følgende procestrin:<br>1 Oppumpning af forurenet grundvand og drænvand. Vand ledes gennem rørføring til vandbehandlingsanlæg.<br>2 Forrensning gennem sandfilter for jern og mangan. Der anvendes Greensand filter.<br>AOP-behandling med ozon til nedbrydning af organiske miljøfremmede stoffer. Processen finder sted i en reaktor, hvor ozon udnyttes optimalt. Ozon er et meget kraftigt iltningsmiddel, der også kan danne hydroxylradikaler. Ozon kan ilte de flest organiske stoffer, hvis ozonkoncentrationen er passende høj og reaktionstiden er lang nok.<br>4 Efterfiltrering gennem kulfilter til fjernelse af evt. rester af ozon og ikke nedbrudte organiske miljøfremmede stoffer.<br>5 Bortskaffelse af renset vand enten til recipient, grundvandszonen eller spildevandssystemet.<br>Proces 1 og 5 er tidligere beskrevet i /2/. Proces 2 og 4 er beskrevet udførligt i bilag I og J – og beskrives kun overordnet i dette bilag - idet disse processer stort set er de samme for alle de fire rensemetoder. Dette notat giver en mere detaljeret beskrivelse af selve AOP-processen og de erfaringer, der er opnået ved de udførte laboratorieforsøg med forurenet grundvand fra Grindstedværket.<br>Principdiagram fremgår af nedenstående figur.<br>  <br><br>Ozonbehandlingssystemer bruger ozon til at nedbryde organiske forureninger i vand. Ozonen genereres på stedet ud fra luft eller ren ilt med elektricitet i en ozongenerator. Den mest effektive metode er at anvende flydende ilt (LOX = liquid oxygen), der kan leveres med tankbil. Den resulterende ozongas injiceres derefter i vandet i en "lukket" reaktor. Reaktoren skal være dimensioneret til at give en tilstrækkelig opholdstid for ozon til at reagere med forureningerne. Brugen af ren ilt giver mulighed for en højere koncentration af ozon, hvilket muliggør en mere effektiv drift af AOP-reaktoren.<br>Ozon reagerer også med evt. tilstedeværende bromid i vandet ved at danne det giftige bromat, hvilket er kræftfremkaldende (I USA er bromat EPA-reguleret desinfektionsbiprodukt med en MCL på 10 µg/l). Reaktionsligningen for denne reaktion er: |

| LØSNING A | SANDFILTER + OZON + GAC | |
|---|---|---|
| | $$Br^- + O_3 \rightarrow BrO_3^-$$<br>Grundvand med bromid under 35 µg/l betragtes som lavt bromid. Grundvandet fra Grindstedværket indeholder ca. 1400 µg/l bromid, og ved laboratorieforsøgene kunne man holde dannelsen af bromat på et acceptabelt lavt niveau, såfremt ozondoseringen ikke oversteg 13 mg/l.<br>Resterende ozon i reaktoren kan adskilles fra vandet og destrueres ved anvendelse af et katalytisk filter. Ozongeneratoren producerer en betydelig mængde spildvarme, der skal håndteres via enten luft eller vandkøling. Det er vores indledende vurdering, at luftkøling vil være tilstrækkelig. Den endelig vurdering skal laves i detailprojektet.<br>Ved laboratorieforsøgene blev ca. halvdelen af de flygtige komponenter (vinylchlorid og cis-DCE) strippet af væsken sammen med den ozonholdige gas, der blev tilsat. Det er usikkert, om man kan designe et fuldskala-anlæg, hvor der ikke afstrippes flygtige komponenter til atmosfæren. Rensning af afgangsgassen fra ozonreaktoren i aktivt kul er ikke nogen god metode, da aktivt kul har lav kapacitet for vinylchlorid og cis-DCE.<br>Reaktoren er et lukket system, så principielt ikke kan slippe ozon ud, før vandet kommer ud af reaktoren. Der leveres en ozon-rumdetektor, der placeres i det rum, hvor ozonanlægget er placeret. Overskrides den gældende ozonkoncentration i luften, slukker ozongeneratoren automatisk.<br>Ozon vil efterhånden nedbrydes, og nedbrydningshastigheden afhænger af vandets pH og sammensætning. I almindeligt postevand vil ozonkoncentrationen normalt halveres på 15 minutter. Ved nedbrydningen dannes ilt. | |
| Billede af ozonreaktor | <br>HortiZone anlæg fra Holland med en kapacitet på 0,7 eller 1,2 m³/h. PLC-Styreskab i forgrunden og reaktionstank i baggrunden. | <br>Ozonanlæg fra Oxidationtech.com<br>Kapacitet: 1,5-9 m³/h |

| LØSNING A | SANDFILTER + OZON + GAC |
|---|---|
| | |
| Udviklingsstadium | Ozonbehandling af spildevand har været anvendt i Danmark og mange andre lande i mange år. Ozonbehandling anvendes også som supplerende metode ved biologisk behandling af spildevand med svært nedbrydelige stoffer. I Danmark anvendes det således som supplement i forbindelse med rensning af hospitalsspildevand med svært nedbrydelige medicinrester.<br><br>Ozonbehandling af den særlige forurening i grundvandet i Grindsted er dog ikke tidligere belyst. |
| Kommercielt tilgængelig | En komplet ozonløsning med kulfilter kan leveres som færdig pakkeløsning af f.eks. Suez Water Danmark A/S. Flere danske firmaer kan også levere ozonanlæg til spildevandsrensning, og de kan formentlig let tilpasse anlæggene, så de kan anvendes til rensning af grundvandet fra Grindsted.<br><br>I USA leveres ozonanlæg bl.a. af Xylem/Wedeco og Mazzei:<br><br>https://www.xylem.com/en-us/brands/wedeco/<br><br>https://mazzei.net/ |
| Renseeffekt | Renseeffekten afhænger af reaktionstiden og ozondoseringen. Jo længere reaktionstid og jo højere ozonkoncentration, jo mere organisk forurening vil der blive nedbrudt. Ikke alle organiske stoffer nedbrydes lige let. Laboratorieforsøgene har vist, at alle stofgrupper i grundvandet (BTEX, total kulbrinter, chlorerede opløsningsmidler og Grindsted stoffer) kan nedbrydes mere end 90%, hvis blot der doseres nok ozon. I praksis kan man dog kun dosere ca. 13 mg/l, hvis man skal undgå en kritisk bromatdannelsen, og med den dosering er rensningen for mange stoffer < 90%. Den bedste renseeffekt opnås for chlorerede opløsningsmidler. |
| Kapacitet ($m^3/h$) | Ozonanlæg leveres i mange forskellige størrelser – og vil kunne behandle den forventede mængde på mellem 5 og 10 $m^3/h$. |
| Energiforbrug | Ud fra laboratorieforsøgene og COWIs beregninger ligger energiforbruget på ca. 1 $kWh/m^3$ ved et flow på 10 $m^3$/time. Hvis der skal doseres mere ozon end ved det optimale laboratorieforsøg, vil energiforbruget være større. |
| Ozonforbrug | Ud fra erfaringerne ved laboratorieforsøgene bør ozondoseringen holdes < 13 mg/l for at undgå dannelsen af bromat.<br><br>Kemikalieforbrug ved et flow på 10 $m^3$/time:<br><br>› ozon = 0,13 kg/time (ca. 1150 kg/år) |
| Forventet holdbarhed af udstyr | Ozon system: De primære vedligeholdelseskomponenter til ozonsystemet er ozongeneratoren og ozonreduktionsfilteret. Disse komponenter skal have en levetid svarende til andet udstyr i systemet (dvs. i størrelsesordenen 10-20 år). |

| LØSNING A | SANDFILTER + OZON + GAC |
|---|---|
| Overskydende materiale som skal bortskaffes | Ozonanlæg: Der er ikke nogen restprodukter der skal bortskaffes. |
| Metodens tekniske begrænsninger | Laboratorieforsøgene har vist, at man ikke kan nedbryde de forurenende stoffer i grundvandet fra Grindstedværket tilstrækkelig effektivt med en dosering af ozon på 13 mg/l. Det er usikkert, hvor meget nedbrydningen kan forbedres med en væsentlig højere ozondosering, da det kun har været undersøgt med en lille ekstra dosering. |
| Behov for supplerende oplysninger/tests | De gennemførte laboratorieforsøg har afdækket metodens muligheder og begrænsninger i den aktuelle sag. |
| Fordele | › Almindelig anvendt i spildevandsbehandling<br>› I AOP-processen nedbrydes de organiske urenheder til vand og kuldioxid, og der dannes der ingen affaldsprodukter.<br>› Simpelt i opbygning. Tidsforbrug til pasning og vedligeholdelse er formentlig mindre end for de andre løsninger med AOP.<br>› Ved denne metode anvendes ingen kemikalier – kun elektricitet og ilt. Dog anvendes kemikalier til returskyl/regenerering af sandfilter.<br>› Laboratorieforsøgene har vist, at metoden kan nedbryde de fleste af de organiske forureninger i grundvandet fra Grindstedværket. Dog er der enkelte stoffer, som ikke kan nedbrydes. |
| Ulemper | › Der er risiko for, at der ved nedbrydning af den organiske forurening kan dannes toksiske nedbrydningsprodukter, som ikke fjernes ved renseprocessen.<br>› Flygtige organiske komponenter afstrippes delvis, hvilket er uønsket<br>› Der skal tages forholdsregler, så der ikke afgives for store mængder ozon til luften i det lokale, hvor anlægget er placeret. Derfor skal der være en ozonmåler i rummet, så anlægget automatisk stopper i tilfælde af for høj ozonkoncentration.<br>› Laboratorieforsøgene har vist, at dannelse af det giftige bromat er en stor risiko, fordi grundvandets bromidkoncentration er meget høj (ca. 1400 µg/l). Det sætter en øvre grænse for, hvor meget ozon, der kan doseres, og det sætter igen en grænse for, hvilken renseeffektivitet, der kan opnås. |
| Referencer | Amerikanske leverandører:<br>**Xylem/Wedeco**<br>https://www.xylem.com/en-us/brands/wedeco/<br>**Mazzei**<br>https://mazzei.net/ |

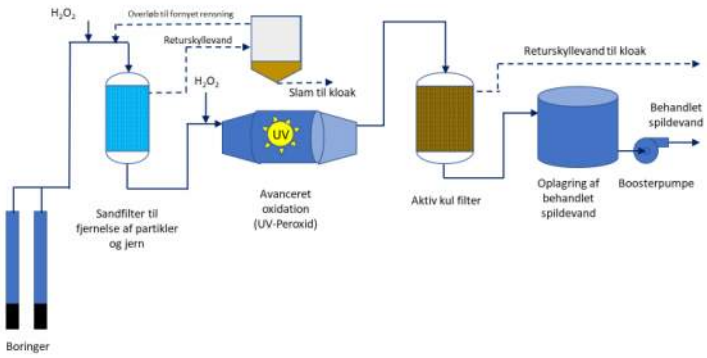
| LØSNING A | SANDFILTER + OZON + GAC |
|---|---|
| | Der er én hollandsk leverandører af udstyr, som er godkendt til nedbrydning af pesticider i drænvand fra gartnerier. Disse anlæg er leveret til flere hollandske gartnerier:<br><br>**AgroZone IE BV**, http://www.agrozone.nl/<br><br>E-mail: info@agrozone.nl<br><br>Udvalgte danske leverandører af ozonanlæg:<br><br>**O3 Nordic**, Telefon: 31458118, E-mail: na@O3nordic.com<br><br>O3 Nordic har leveret flere ozonanlæg i Danmark til rensning af forurenet grundvand.<br><br>**Suez Water A/S:** Telefon 69156600. https://www.suez.com/en Kontakt i Danmark: Per Krøyer Kristensen, per.kroyer.kristensen@degremont.com<br><br>Suez har internationalt leveret mange ozonanlæg suppleret med aktivt kul til rensning af mange typer spildevand med miljøfremmede stoffer – bl.a. hospitalsspildeand. Den danske afdeling har deltaget i flere ozonprojekter og har bådelaboratorieanlæg og pilotanlæg til rådighed. |

| LØSNING B | SANDFILTER + OZON + H2O2 + GAC |
|---|---|
| Kort metodebeskrivelse | Denne løsning omfatter følgende procestrin:<br>1 Oppumpning af forurenet grundvand og drænvand. Vand ledes gennem rørføring til vandbehandlingsanlæg.<br>2 Forrensning gennem sandfilter for jern og mangan. Der anvendes Greensand filter.<br>3 AOP-behandling med ozon + $H_2O_2$ til nedbrydning af organiske miljøfremmede stoffer. Processen finder sted i en reaktor, hvor $H_2O_2$ kommer i kontakt med ozon. Herved dannes hydroxylradikaler som kan nedbryde den organiske forurening. Hydroxylradikaler (•OH), har et standard oxidationspotential på 2,8 V. Til sammenligning har ozon et standard oxidationspotentiale på 2,1 V. Jo større standard oxidationspotentiale, jo flere stoffer kan oxideres.<br>4 Efterfiltrering gennem kulfilter til fjernelse af evt. rester af brintperoxid og ozon samt ikke nedbrudte miljøfremmede stoffer.<br>5 Bortskaffelse af renset vand enten til recipient, grundvandszonen eller spildevandssystemet<br><br>Proces 1 og 5 er tidligere beskrevet i /2/. Proces 2 og 4 er beskrevet udførligt i bilag I og J – og beskrives kun overordnet i dette bilag. Dette notat giver en mere detaljeret beskrivelse af selve AOP-processen.<br><br>Principdiagram fremgår af nedenstående figur.<br>  <br><br><br>Beskrivelse af AOP-anlæg:<br><br>Ozon / hydrogenperoxid AOP-systemer bruger ozon til at oxidere hydrogenperoxid til hydroxylradikaler (OH *). Ligningen for denne reaktion er:<br><br>$$2O_3 + H_2O_2 \rightarrow 2OH^* + 3O_2$$<br><br>Dette opnås ved tilsætning af brintperoxid til vandet efterfulgt af tilsætning af ozon i en AOP-reaktor. Der vil typisk være overskud af brintperoxid og ozon, som kan nedbrydes efterfølgende i kulfilteret. Rester af ozon i reaktoren kan evt. adskilles fra vandet og destrueres ved anvendelse af et katalytisk filter<br><br>Ozon/brintperoxid processen kan hæmmes af høj pH.<br><br>Ozon reagerer også med evt. tilstedeværelse af bromid i vandet ved at danne det giftige bromat, hvilket er kræftfremkaldende (I USA er |

| LØSNING B | SANDFILTER + OZON + H2O2 + GAC |
|---|---|
| | bromat EPA-reguleret desinfektionsbiprodukt med en MCL på 10 µg/l). Reaktionsligningen for denne reaktion er: $$Br^- + O_3 \rightarrow BrO_3^-$$ Grundvand med bromid under 35 µg/l betragtes som lavt bromid. Bromatdannelse kan styres ved at forøge forholdet mellem hydrogenperoxid og ozon og adskille ozoninjektionen over reaktoren.<br><br>Doserne af ozon og peroxid samt forholdet mellem de to kemikalier skal optimeres for den aktuelle vandtype, da disse parametre er stærkt afhængige af vandkemi.<br><br>Ozongeneratoren producerer en betydelig mængde spildvarme, der skal håndteres via enten luft eller vandkøling. Det er vores foreløbige vurdering, at luftkøling vil være tilstrækkelig. Den endelig vurdering skal laves i detailprojektet.<br><br>Reaktoren er helt lukket, så der ikke kan slippe ozon ud, før vandet kommer ud af reaktoren. Der leveres en ozon-rumdetektor, der placeres i det rum, hvor ozonanlægget er placeret. Overskrides den gældende ozonkoncentration i luften, slukker ozongeneratoren automatisk.<br><br>Ozon vil efterhånden nedbrydes, og nedbrydningshastigheden afhænger af vandets pH og sammensætning. I almindeligt postevand vil ozonkoncentrationen normalt halveres på 15 minutter. Ved nedbrydningen dannes ilt. |
| Billede af ozon + H2O2 reaktor | <br>Foto af APT HiPOX System |
| Udviklingsstadium | Avanceret oxidation med ozon og brintperoxid er efter vores viden ikke tidligere anvendt i fuldskala til behandling af forurenet grundvand i Danmark. Derimod er metoden betragtet som en moden metode i USA i forbindelse med rensning af svært nedbrydelige organisk forurening. |

| LØSNING B | SANDFILTER + OZON + H2O2 + GAC |
|---|---|
| Kommercielt tilgængelig | APTwater LLC<br>1921Arena Blvd<br>Sacramento, CA 95834<br>USA<br>T: +1 916-779-7651<br>www.aptwater.com |
| Renseeffekt | Renseeffekten afhænger af reaktionstiden og doseringen af ozon og $H_2O_2$. Jo længere reaktionstid og jo højere koncentration af ozon og $H_2O_2$, jo mere organisk forurening vil der blive nedbrudt. Laboratorieforsøgene har vist, at alle stofgrupper i grundvandet (BTEX, total kulbrinter, chlorerede opløsningsmidler og Grindsted-stoffer) kan nedbrydes mere end 90%, hvis blot der doseres nok ozon og brintperoxid. I praksis kan man dog kun dosere ca. 13 g/l ozon, hvis man skal undgå bromatdannelsen, og med den dosering er rensningen for mange stoffer < 90%. Den bedste renseeffekt opnås for chlorerede opløsningsmidler.Laboratorieforsøgene har vist, at ozon + brintperoxid kan destruere kulbrinterne mere effektivt end ozon alene. For de øvrige stoffer er der ikke den store forskel i renseeffekt mellem ozon og ozon+$H_2O_2$.<br><br>Ikke nedbrudt organisk forurening eller nedbrydningsprodukter vil i vid udstrækning fjernes ved efterrensning i i kulfilteret, men ikke alle stoffer fjernes i kulfilteret. Kulfilteret vil ligeledes fjerne rester af ozon og brintperoxid. |
| Kapacitet ($m^3/h$) | Ozonanlæg af denne type leveres i mange forskellige størrelser – og vil kunne behandle den forventede mængde på ca.10 $m^3/h$. |
| Energiforbrug | Ca. 1 kWh/$m^3$ ved 10 $m^3$/time |
| Kemikalieforbrug | Ved det optimale laboratorieforsøg blev der doser 12 mg/l ozon og 2 mg/l brinperoxid.<br>› Kemikalieforbrug ved et flow på 10 $m^3$/time:<br>› ozon = 0,12 eller 1.050 kg/år<br>› $H_2O_2$ = 0,02 kg/time = ca. 500/år 35% $H_2O_2$. |
| Forventet holdbarhed af udstyr | Ozon system: De primære vedligeholdelseskomponenter til ozonsystemet er ozongeneratoren og ozonreduktionsfilteret. Disse komponenter skal have en levetid svarende til andet udstyr i systemet (dvs. i størrelsesordenen 10-20 år).<br><br>AOP - systemet bruger flere indsprøjtningspunkter for ozon i rørreaktoren. Ozonstrømmen til hvert indsprøjtningspunkt styres med en manifold af ventiler. I lignende applikationer har operatører bemærket, at det har været nødvendig med hyppig udskiftning af disse ventiler. |
| Overskydende materiale som skal bortskaffes | AOP-anlæg: Der er ikke nogen restprodukter der skal bortskaffes |
| Metodens tekniske begrænsninger | AOP-systemet: Metoden er følsom over for stoffer, der giver en "scavenger" effekt. En scavenger i AOP-processer er et stof, der |

| LØSNING B | SANDFILTER + OZON + H2O2 + GAC |
|---|---|
| | absorberer hydroxylradikaler. Bicarbonat er kendt som en af de mest almindelige scavengers. Metoden er også følsom over for forholdet mellem ozon og brintperoxid, som derfor skal kontrolleres præcist. Hvis bromatkontrol er påkrævet, kan dette i sidste ende begrænse mængden af ozon, der kan anvendes, og det begrænser behandlingseffektiviteten. |
| Behov for supplerende oplysninger/tests | Der er lavet laboratorieforsøg, som belyser renseeffekten og kemikalieforbruget. Der er umiddelbart ikke behov for yderligere tests. |
| Fordele | › Laboratorieforsøgene har vist, at metoden kan nedbryde de fleste af de organiske forureninger i grundvandet fra Grindstedværket. Dog er der enkelte stoffer, som ikke kan nedbrydes.I AOP-processen nedbrydes de organiske urenheder til vand og kuldioxid dannes der ingen affaldsprodukter. |
| Ulemper | › AOP-systemet er lidt mere kompliceret at drive end løsning A – hvor der kun anvendes ozon.<br>› Flygtige organiske komponenter afstrippes delvis, hvilket er uønsket.<br>› Der skal tages forholdsregler, så der ikke afgives for store mængder ozon til luften i det lokale, hvor anlægget er placeret. Derfor skal der være en ozonmåler i rummet, så anlægget automatisk stopper i tilfælde af for høj ozonkoncentration. Brintperoxid kræver særlig omhu ved installeringen, da det sønderdeles naturligt og kan opbygge stort tryk, hvis stoffet kan reagere med organisk stof i rør eller beholdere.<br>› Laboratorieforsøgene har vist, at dannelse af det giftige bromat er en stor risiko, fordi grundvandets bromidkoncentration er meget høj (ca. 1400 µg/l). Det sætter en øvre grænse for, hvor meget ozon, der kan doseres, og det sætter igen en grænse for, hvilken renseeffektivitet, der kan opnås. |
| Referencer | USA:<br>APTwater LLC<br>1921Arena Blvd<br>Sacramento, CA 95834<br>USA<br>T: +1 916-779-7651<br>www.aptwater.com<br><br>Europa:<br>APT Istallation in Muttenz, Switzerland<br>**Peter Hartmann**<br>Head of Water Treatment Switzerland<br><br>**address:** WABAG Water Technology Ltd, Bürglistrasse 31, P.O. Box, CH-8401 Winterthur<br>**office:** +41 52 218 14 20<br>**mobile:** +41 79 349 61 62<br>**skype:** hartmann.wabag<br>**web:** www.wabag.net |

| LØSNING C | SANDFILTER + H2O2/UV + GAC |
|---|---|
| Kort metodebeskrivelse | Denne løsning omfatter følgende procestrin:<br>1 Oppumpning af forurenet grundvand og drænvand. Vand ledes gennem rørføring til vandbehandlingsanlæg.<br>2 Forrensning gennem sandfilter, hvor der doseres $H_2O_2$. Herved iltes $Fe^{+2}$ til $Fe^{+3}$, der udfældes som brunt slam, $Fe(OH)_3$, der filtreres fra i sandfilteret. Ved denne metode fjernes ikke mangan, men analyser af grundvandet viser, at mangankoncentrationen er ret lav (ca. 0,4 mg/l).<br>3 AOP behandling med $H_2O_2$ + UV til nedbrydning af organiske miljøfremmede stoffer. Processen finder sted i en reaktor, hvor der tilsættes en passende mængde brintperoxid og belyses derefter med UV-lys. Herved katalyseres dannelsen af hydroxylradikaler, som kan nedbryde den organiske forurening.<br>4 Efterfiltrering gennem kulfilter til fjernelse af evt. rester af brintperoxid samt ikke nedbrudte miljøfremmede stoffer.<br>5 Bortskaffelse af renset vand enten til recipient, grundvandszonen eller spildevandssystem<br>Proces 1 og 5 er tidligere beskrevet i /2/. Proces 2 og 4 er beskrevet udførligt i bilag I og J – og beskrives kun overordnet i dette bilag. Dette notat giver en mere detaljeret beskrivelse af selve AOP-processen.<br>Principdiagram fremgår af nedenstående figur.<br>  <br><br>Beskrivelse af AOP-anlæg:<br>AOPsystemer med UV/brintperoxid anvender UV til fremstilling af hydroxylradikaler fra brintperoxid. Ligningen for denne reaktion er:<br>$$UV\ lys + H_2O_2 \rightarrow OH^* + 3O_2$$<br>Dette opnås ved tilsætning af brintperoxid til vandet, efterfulgt af bestråling af vandet via UV-lamper i en AOP-reaktor, som er designet til at give den korrekte kontakttid og opblanding til vandbehandlingen. UV- og brintperoxid-doserne skal optimeres for den specifikke vandkvalitet, der skal behandles. |

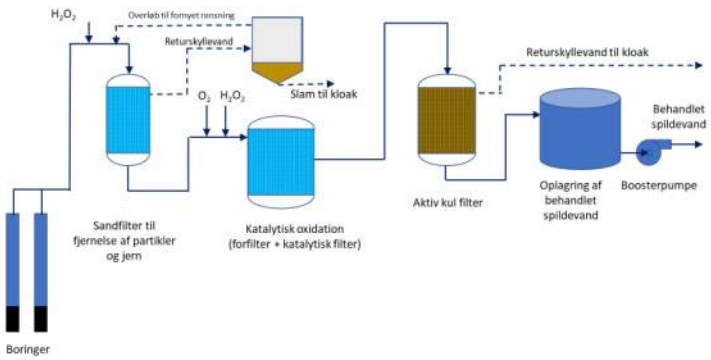
| LØSNING C | SANDFILTER + H2O2/UV + GAC |
|---|---|
| | Energieffektiviteten af et UV/peroxid anlæg måles som el-forbruget ved en 10-faktor reduktion af forureningen. Den relative dosis af brintperoxid og UV kan optimeres og reducere de totale omkostninger."<br><br>Det betyder, at det kan være mere økonomisk at nøjes med en lavere rensegrad ved UV-peroxid og i stedet fjerne en lidt større rest af organisk forurening i kulfilteret.<br><br>Denne proces resulterer evt. i overskud at brintperoxid, som nedbrydes i den efterfølgende filtrering i kulfilteret.<br><br>UV/peroxidprocesser er stærkt afhængige af UV-transmittansen (UVT) af det vand, der behandles. Hvis UVT er lav, trænger der for lidt UV-lys gennem vandet og metoden vil ikke være så effektiv. UVT påvirkes negativt af uklarhed i vandet og ved tilstedeværelsen af organiske forbindelser og nogle metaller. Det vurderes dog, at klarhed af det oppumpede grundvand vil være stor og det organiske indhold vil være lille.<br><br>Laboratorieforsøgene viste, at der var meget lav UVT i det oppumpede grundvand. UVT blev dog forøget meget under renseprocessen i takt med, at de organiske stoffer blev nedbrudt.<br><br>UV-lamper skal rengøres regelmæssigt for at forhindre belægninger, der reducerer UV-intensiteten. Rengøring kan foregå automatisk eller manuelt efter ønske.<br><br>UV/Peroxid bruger lavtryks kviksølv (LP UV) eller mediumtryks kviksølv (MP UV) lamper. LP UV-systemer har tendens til at være større, men mere energieffektive end MP UV-systemer, så de bruges ofte i drikkevandsbehandlingsapplikationer med høje strømningshastigheder.<br><br>Energiforbruget fra MP UV-systemer er højere, men bølgelængden er over et bredere spektrum, således at dets reaktion med peroxid er mindre effektiv. MP UV-enheder udsender lys i bølgelængder, som kan deltage i sidereaktioner med andre bestanddele i vandet (fx produktion af nitrit fra nitrat). |
| Billede af UV + H2O2 reaktor | <br>Billede af det hollandske Apollo Plus anlæg. |

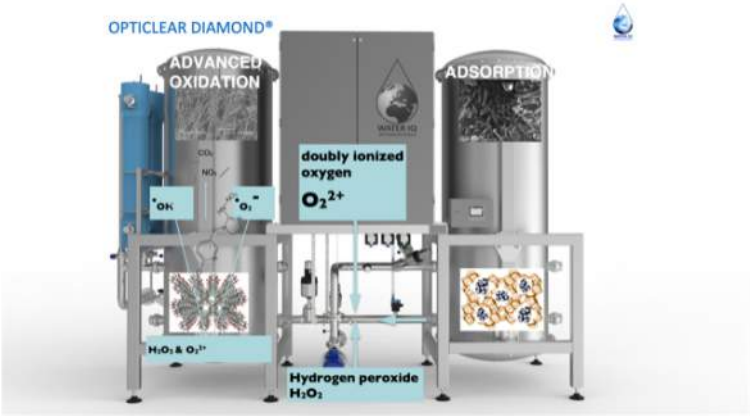
| LØSNING C | SANDFILTER + H2O2/UV + GAC |
|---|---|
| | <br>Foto af et dansk UV-anlæg fra UltraAqua (øverst)<br>Foto of Trojan UVSwift Medium Pressure UV System (nederst)<br> <br>Foto af Trojan UV Phox Low-Pressure UV System |
| Udviklingsstadium | Metoden, der også kaldes fotokemisk oxidation, har været anvendt i mange år til rensning af grundvand med miljøfremmede organiske stoffer. Det første anlæg i Danmark blev etableret i 1992 til rensning af grundvand forurenet med trichlorethylen (TCE). I Holland har man godkendt 4 forskellige anlæg af denne type til rensning af drænvand fra gartnerier for pesticider, se under referencer. Disse anlæg forventes også at kunne anvendes til den særlige Grindsted forurening. |
| Kommercielt tilgængelig | Kan leveres som færdig pakkeløsning fra fire forskellige hollandske firmaer, se under referencer. Kan leveres fra danske firmaer, der |

| LØSNING C | SANDFILTER + H2O2/UV + GAC |
|---|---|
| | sælger kommercielle UV-anlæg og tilpasser dem til opgaven med et forfilter, brintperoxiddosering samt kulfilter til efterfiltrering.<br><br>I USA leveres færdige anlæg fx. af Trojan UVSwift, se under referencer. |
| Renseeffekt | Renseeffekten afhænger af, hvor hurtigt man pumper vandet igennem anlægget. Jo større opholdstid vandet har med UV-belysning, jo mere organisk stof vil der blive nedbrudt. Den største renseeffekt opnås, når UVT er høj og vandet er tæt på UV-lyskilden.<br><br>Laboratorieforsøgene gav en bedre rensning end ozonprocesserne for alle organiske komponenter. Total kulbrinter blev fjernet fuldstændigt. Chlorerede forbindelser blev fjernet > 99%, og mange Grindstedstoffer blev også fjernet ret effektivt – men ikke alle. Efterfølgende beregninger tyder på, at der kan opnås betydelig bedre rensning ved at øge UV-doseringen i forhold til, hvad der blev anvendt ved laboratorieforsøgene.<br><br>Uorganiske stoffer fjernes ikke. |
| Kapacitet (m³/h) | Denne type anlæg kan leveres i mange forskellige størrelser – og vil kunne behandle den forventede mængde på ca. 10 m³/h. |
| Energiforbrug | Energiforbruget vil afhænge af vandtype og forureningsgraden. COWI har på baggrund af laboratorieforsøgene beregnet det forventede energiforbrug til denne løsning på ca. 2,5 kWh/m³, forudsat 10 m³/time. Disse beregninger er baseret på anvendelse af LP-lamper og udstyr fra dansk producent. Anvendes MP-lamper, vil energiforbruget være betydeligt større. |
| Kemikalieforbrug | Ved laboratorieforsøgene er anvendt en dosering i AOP-reaktoren på ca. 20 mg/l $H_2O_2$ svarende til et forbrug af 35% $H_2O_2$ på ca. 5000 kg/år. Ved et flow på 10 m³/h skal formentlig anvendes 4 serieforbundne anlæg, der hver indeholder 12 LP-lamper á 350 W svarende til et samlet effektforbrug til UV-processen på 16,8 kW. |
| Forventet holdbarhed af udstyr | Minimums levetiden for UV-lamper angives normalt af producenten. UltraAqua angiver levetiden for deres LP UV-lamper til ca. 2 år. Andre leverandører angiver typisk 1½ års levetid. |
| Overskydende materiale som skal bortskaffes | AOP anlæg: Der er ikke nogen restprodukter, der skal bortskaffes. Kun jernholdigt returskyllevand fra forfilteret. |
| Metodens tekniske begrænsninger | Varierende UV-transmittans i vandet samt vandets indhold af stoffer, der modvirker dannelsen af hydroxylradikaler (stoffer med såkaldt "scavenger" effekt) vil influere på renseeffekten.<br><br>Belægning på UV-lamper kan begrænse UV-doseringen og derved renseeffektiviteten |
| Behov for supplerende oplysninger/tests | Laboratorieforsøgene har demonstreret, hvilken renseeffekt, der opnås ved forskellige UV-doser og forskellige koncentrationer af $H_2O_2$. Ved forsøgene er der dog ikke anvendt så stor UV-dosering, at man har kunnet påvise den maksimale reseeffekt, der kan opnås |

| LØSNING C | SANDFILTER + H2O2/UV + GAC |
|---|---|
| | med denne metode for alle aktuelle organiske forureninger. Derfor ville et pilotforsøg kunne være nyttigt til at fremskaffe disse oplysninger, ligesom man ved et pilotforsøg vil kunne påvise metodens stabilitet og eventuelle uforudsete problemer. |
| Fordele | › Anlægget fylder ikke ret meget, og det er relativt simpelt i opbygning. Tidsforbrug til pasning og vedligeholdelse er mindre end ved anvendelse af ozon.<br>› Det er simplere og mere sikkert at håndtere brintperoxid end f.eks. ozon.<br>› Mange urenheder nedbrydes til vand og kuldioxid, så der dannes der ingen faste affaldsprodukter. |
| Ulemper | › Der er en risiko for, at der ved nedbrydning af de organiske stoffer kan dannes toksiske nedbrydningsprodukter, som ikke fjernes ved renseprocessen.<br>› Vandet skal være transparent, så UV-lyset ikke svækkes for meget ved gennemlysning.<br>› Der kan dannes belægninger på lampeglasset, som svækker lysgennemgangen. Derfor bør anlægget være forsynet med et afrensningssystem for lampeglassene. Afrensningen kan foretages automatisk eller manuelt efter ønske. Ved afrensningen kan anvendes mekaniske skrabere eller en syreskylning.<br>› Lampernes lysstyrke reduceres med alderen. Derfor bør anlægget være forsynet med en UV-lysstyrkemåler, så der automatisk kan kompenseres for faldende intensitet ved at øge tilsvarende for lamperne lysstyrke, så lysintensiteten holdes konstant. |
| Referencer | 4 hollandske leverandører, der sælger anlæg som i Holland er godkendt til nedbrydning af pesticider i drænvand fra gartnerier:<br>Enthoven Techniek BV, http://www.enthoventechniek.nl/<br>e-mail: info@patronagrisystems.nl<br>HortiMax BV, www.hortimax.com , e-mail: sales@hortimax.com<br>WaterQ BV, www.waterq.com , e-mail: info@waterq.com<br>Priva BV, www.priva.com e-mail: contact.priva@priva.nl<br><br>I Danmark er der flere leverandører, der sælger UV-anlæg til desinfektion af vand. UltraAqua har tilsyneladende erfaring og stor ekspertise for denne rensemetode.<br>Kontakt: Morten Møller Klausen,<br>Office +45 7023 1020<br>Mobile +45 2750 9430<br>Email mmk@ultraaqua.com<br>Web www.ultraaqua.com |

| LØSNING C | SANDFILTER + H2O2/UV + GAC |
|---|---|
| | I USA leveres samlede anlæg fx. af Trojan UVSwift (Medium Pressure)<br>https://www.trojanuv.com/products/drinkingwater/trojanuvswift;<br>Kontakt: Keep, Terry <tkeep@trojanuv.com><br>Calgon RayOx (Medium Pressure)<br>https://www.calgoncarbon.com/products/rayox/ |

| LØSNING D | SANDFILTER + H2O2/katalysator + GAC |
|---|---|
| Kort metodebeskrivelse | Denne løsning omfatter følgende procestrin:<br>1 Oppumpning af forurenet grundvand og drænvand. Vand ledes gennem rørføring til vandbehandlingsanlæg.<br>2 Vandet forrenses i et sandfilter, hvor der tilsættes brintperoxid. Herved iltes jern, der udfældes som ferrihydroxid, som tilbageholdes i sandfilteret. Egentlig skulle det indbyggede filter i det katalytiske anlæg kunne fjerne både jern og mangan, men vi har valgt at indsætte et sandfilter for at være sikre på at de store jernmængder kan fjernes uden at give problemer i det katalytiske anlæg.<br>3 AOP-anlægget består af to filtre. Det første filter er en slags mekanisk filter, der er coated, så det kan fjerne både partikler ladede kolloider. Det andet filter er et keramisk filter, hvor filtermaterialet er coated med en katalysator. Når brintperoxid kommer i kontakt med katalysatoren dannes hydroxylradikaler. Der doseres også lidt ioniseret ilt for at øge oxidationen. Der er endvidere mulighed for tilsætning af en katalysatoropløsning for at opnå endnu bedre nedbrydning af de organiske stoffer.<br>4 Efterfiltrering gennem kulfilter til fjernelse af evt. rester af brintperoxid samt ikke nedbrudte miljøfremmede stoffer.<br>5 Bortskaffelse af renset vand enten til recipient, grundvandszonen eller spildevandssystem.<br>Proces 1 og 5 er tidligere beskrevet i /2/. Proces 2 og 4 er beskrevet udførligt i bilag I og J – og beskrives kun overordnet i dette bilag. Dette notat giver en mere detaljeret beskrivelse af selve AOP-processen.<br>Principdiagram fremgår af nedenstående figur.<br>  <br><br>Beskrivelse af AOP-system "Opticlear Diamond" fra Water IQ:<br>Som reaktorer anvendes to filtre i serie. Det første filter er et keramisk filter, der er coated med en negativ belægning. I dette filter kan man fjerne både mekaniske urenheder og positive komponenter som $Fe^{+2}$ og $Mn^{+2}$. Vandet fra dette filter går ind i en andet keramisk filter, hvor filtermaterialet er coated med en katalysator, der er i stand til at aktivere brintperoxid. Før filteret doseres brintperoxid og ioniseret ilt til vandet, og ved kontakt med katalysatoren aktiveres brintperoxid under dannelsen af hydroxylradikaler. Hydroxylradikaler sørger for en hurtig nedbrydning af den organiske forurening. Alt i alt giver denne |

| LØSNING D | SANDFILTER + H2O2/katalysator + GAC |
|---|---|
| | kombination af filtre ifølge de hollandske leverandører en meget effektiv fjernelse af alle mulige organiske stoffer.<br><br>Det første adsorptionsfilter vil langsomt stoppes til. Returskylning er kun nødvendigt, hvis der er mange mekaniske urenheder i vandet. Ellers renses filteret typisk 2-4 gange årligt i forbindelse med reaktivering af det katalytiske filter. Katalysatoren forbruges/inaktiveres langsomt, og derfor skal den katalytiske coatning i begge filtre fornyes 2-4 gange årligt. Spildevandet fra reaktivering kan måske ikke udledes direkte til kloak, men det skal bortskaffes, hvis det indeholder skadelige stoffer. Det må undersøges nærmere ved detailprojektering.<br><br>Man kan eventuelt også tilsætte nogle kemikalier til vandet, så den oxiderende effekt bliver endnu kraftigere, men ofte er renseeffekten tilfredsstillende uden tilsætning af flydende katalysator. |
| Billede af anlæg med katalytisk filter | <br>  <br><br>To billeder af et rammemonteret anlæg "Opticlear Diamond" fra Water IQ i Holland. Model M1, som vil kunne rense 10 m³/h. |

| LØSNING D | SANDFILTER + H2O2/katalysator + GAC |
|---|---|
| | <br>Mobilt anlæg af typen "Opticlear Diamond". Anlægget i traileren har en kapacitet på 10 m³/h |
| Udviklingsstadium | Metoden er forholdsvis ny, og der er ingen anlæg af denne type i drift i Danmark. Metoden minder om løsning B og C, da disse tre metoder alle danner hydroxylradikaler ud fra brintperoxid. I Holland har firmaet Water IQ fået godkendt denne anlægstype til rensning af pesticidholdigt drænvand fra gartnerier. |
| Kommercielt tilgængelig | Kan leveres som en rammemonteret udgave eller som et mobilt anlæg installeret i en container/truck. De to modeller er vist på ovenstående billeder. Begge løsninger vil indeholde et lille forfilter (grovsi) samt diverse hjælpeudstyr og PLC-styring. Det betyder, at det meget let kan kobles til sandfilter og kulfilter på stedet. Containeren vil kunne købes, lejes eller leases efter nærmere aftale med Water IQ. Så vidt vides findes ingen danske leverandører af denne type renseudstyr. |
| Renseeffekt | Renseeffekten afhænger af, hvor hurtigt man pumper vandet igennem anlægget. Jo længere opholdstid vandet har i det katalytiske filter, jo mere organisk stof vil der blive nedbrudt, forudsat at der er brintperoxid til stede.<br><br>Ved laboratorieforsøgene blev det påvist, at stort set alle stoffer kunne destrueres i anlægget til meget lave restkoncentrationer (under detektionsgrænsen for de fleste stoffer), såfremt opholdstiden var passende lang, og der blev doseret nok brintperoxid. Metoden var den bedste af de fire undersøgte AOP-metoder til at destruere Grindsted-stofferne.<br><br>Uorganiske stoffer blev som ventet ikke fjernet ved rensningen. |
| Kapacitet (m³/h) | De hollandske anlæg kan leveres i mange forskellige størrelser – typisk fra 0,48 m³/h til 60 m³/h. |
| Energiforbrug | Ud fra forsøgene har Water IQ kalkuleret det samlede energiforbrug for rensemetoden til 0,63 kWh/m³ |
| Kemikalieforbrug | Ved det optimale forsøg blev der anvendt en dosering af brintperoxid på 100 mg/l. Det forventes dog, at man kan optimere forbruget og komme noget længere ned på et fuldskala-anlæg. Med et flow på 10 m³/h og en dosering på 100 mg/l $H_2O_2$ bliver forbruget af 35% brintperoxid ca. 25 tons/år. |

| LØSNING D | SANDFILTER + H2O2/katalysator + GAC |
|---|---|
| Forventet holdbarhed af udstyr | Anlægget vil jf. drøftelse med producenten kunne holde i mindst 10 år. Det gælder både de keramiske filtre og filterkolonnerne, der er lavet i rustfri stål. |
| Overskydende materiale som skal bortskaffes | Når anlægget anvendes til rensning af drænvand fra gartnerier, skal forfilteret hyppigt returskylles, fordi det stopper til med partikler. Det forventes ikke, at filteret skal returskylles, hvis det anvendes til rensning af forurenet Grundvand i Grindsted, fordi der kun er få mekaniske urenheder i vandet. Tilbageholdte metalioner og ladede partikler vil fjernes i forbindelse med reaktivering (fornyet coatning) af filteret.<br><br>Ved reaktivering af filteret dannes lidt spildevand. Det drejer sig om 2,4 $m^3$ spildevand med rester af reaktiveringskemikalier og stoffer fra filteret. Vi kender ikke disse kemikalier, men vi har fået oplyst, at man i Holland kan udlede dette vand til offentligt spildevandsanlæg. |
| Metodens tekniske begrænsninger | Det er vigtigt, at spildevandet er filtreret effektivt før reaktoren, men ellers er der ingen umiddelbare begrænsninger for metoden. Dog er metoden ikke særlig anvendelig til rensning af industrispildevand med stort indhold af organisk stof. Laboratorieforsøgene har vist, at metoden er særdeles effektiv til destruktion af de organiske forureninger i grundvandet fra Grindstedværket. |
| Behov for supplerende oplysninger/tests | De gennemførte laboratorieforsøg har demonstreret metodens effektivitet. Water IQ anfører i forsøgsrapporten, at der bør laves tests i pilot plant på lokaliteten for at kunne optimere metoden med hensyn til reaktionstid og dosering af brintperoxid og ilt. Det vil endvidere give erfaringer med drift af forfilteret, reaktivering af katalysatoren samt afdække uforudsete problemer. |
| Fordele | › Det er simplere og mere sikkert at håndtere brintperoxid end f.eks. ozon.<br>› Da mange urenheder nedbrydes til vand og kuldioxid, dannes der ingen væsentlige rest affaldsprodukter bort set fra slam, der fremkommer ved returskylning af forfilter.<br>› Den katalytiske proces kræver ikke løbende kemikalietilsætning ud over brintperoxid, og den forbruger ingen strøm. Elforbruget skyldes, at vandet skal pumpes gennem filtrene.<br>› Metoden virker uanset om vandet er transparent eller ej.<br>› Metoden er relativt billig i drift ift. de øvrige AOP-metoder |
| Ulemper | › Der er en risiko for, at der ved nedbrydning af de organiske stoffer kan dannes toksiske nedbrydningsprodukter, som ikke fjernes ved renseprocessen.<br>› Katalysatoren forbruges og skal fornyes ca. én gang halvårligt.<br>› Der dannes små mængder spildevand ved CIP-rensning og der skal ske reaktivering af filtrene. |
| Referencer | 2 hollandske leverandører af udstyr, der er godkendt til behandling af pesticidholdigt drænvand fra gartnerier. Alt udstyr fremstilles dog hos Water IQ, mens Waterson foretager rensning på kontraktbasis |

| LØSNING D | SANDFILTER + H2O2/katalysator + GAC |
|---|---|
| | med mobile anlæg. Anlægget kan evt. leases i en given periode som en "Containerløsning".<br><br>Fast installation: Water IQ International BV, https://www.wateriq.nl/<br>E-mail: mail@wateriq.nl<br><br>Mobilt anlæg: Waterson B.V., www.waterson.nl<br><br>E-mail: info@waterson.nl |

# Bilag H Beskrivelse af forfiltrering

# Bilag H: Forfiltrering

De fire undersøgte AOP-metoder kræver alle en forfiltrering før AOP for at fjerne mekaniske urenheder samt jern og mangan. Det kan gøres på forskellig vis, men i dette projekt ønsker man ikke at anvende et beluftet sandfilter, som ellers er den mest almindelige metode på vandværkerne. Det skyldes, at man ved beluftning vil strippe en stor mængde flygtige forbindelser fra vandet ud i atmosfæren, og det kan ikke accepteres i dette projekt. Her er forskellige muligheder.

**Grøndsandfiltrering**

Greensand Filtration – grønsandsfiltrering - er i Nordamerika en udbredt teknologi til fjernelse af jern og mangan fra grundvand. Størst udbredelse af denne teknologi finder sted i behandling af drikkevand, hvor jern og mangan fjernes for at overholde miljømyndighedernes (USEPA) sekundære æstetiske drikkevandskvalitetskrav. Grønsandsfiltreringsprocessen fungerer i store træk som tryksat filtrering gennem et multimedie, hvor vand presses gennem et lag af filtermediegranulat i en lukket beholder under tryk. I lighed med andre typer af tryksat multimediefiltrering, bliver filtermaterialet renset ved tilbageskylning, hvor de akkumulerede materialer på mediet skylles bort, og der sikres et lavt trykfald hen over filteret.

I modsætning til andre typer af tryksat multimediefiltrering, er mediet i et grønsandsfilter bestående af glaukonikgranulat belagt med et lag af manganoxid. Laget af manganoxid på oversiden af grønsandet oxiderer indholdet af jern og mangan i det vand der strømmer gennem filtermaterialet. De dannede jern- og manganoxider tilbageholdes inde i filtermaterialet, og bliver fjernet ved tilbageskylningsprocessen som før beskrevet. Under oxidationsprocessen bliver belægningen af manganoxid delvist reduceret, og såfremt der ikke tilføres en regenerende oxidant gennem en længere periode, bliver belægningen nedbrudt, hvilket nødvendiggør udskiftning af grønsandsmediet. Regenerering af manganoxidbelægningen gennemføres ved en af følgende metoder, eller ved kombination deraf:

- Løbende regenerering ved tilsætning af hypoklorit (klor), kaliumpermanganat, eller begge, til indløbsvandet til grønssandsfilteret (typisk benyttet når der ønskes jernfjernelse), og

- Periodisk regenerering ved at tage trykbeholderen ud af drift, og lade en kaliumpermanganatopløsning gennemvæde filtermaterialet (typisk benyttet når der alene ønskes manganfjernelse).

I anvendelser hvor klor benyttes til regenerering, tilsættes det i lave koncentrationer (5-7 mg/l, typisk for drikkevand i USA), og udløbet fra grønsandsfilteret indeholder residual klor. Hvis udledningen fra grønsandsfilteret kræver yderligere behandling, kan den tilbageværende klor blive fjernet ved hjælp af omvendt osmose, avancerede oxidationsprocesser der benytter brintperoxid, natriumbisulfit, eller gennem aktivt kul. Hvis udløbsvandet skal indgå som drikkevandsforsyning, skal der i USA evt. tilsættes klor for at opnå den rette koncentration af residual klor i distributionssystemet. Bemærk, at det

overskydende chlor vil forbruge brintperoxid, hvis vandet renses ved metode B eller C.

Grønsandsfiltreringsudstyr er kommercielt tilgængeligt via forskellige leverandører. Nedenstående link viser et datablad for udstyr leveret af Nalco (Ecolab).

https://www.reskem.com/wp-uploads/2015/04/reskem-unitech-greensandfilter.pdf

### Sandfilter med brintperoxid

Ved dosering af brintperoxid til grunvandet kan man hurtigt ilte $Fe^{+2}$ til $Fe^{+3}$, som herefter udfælder som brune slampartikler, $Fe(OH)_3$. Metoden er hurtig og effektiv, og der sker ingen stripning af flygtige organisek forbindelser til atmosfæren. Ulempen er, at man ikke kan oxidere mangan ved denne metode.

Kemiske analyser af grundvandet fra grindstedværket tyder på, at jernkoncentrationen typisk ligger mellem 3 og 10 mg/l, så det er derfor vigtig at få fjernet jern før AOP og kulfiltrering. Analyserne tyder imidlertid også på, at der kun er små koncentrationer af mangan (ca. 0,5 mg/l). Derfor er det ikke så vigtigt at få fjernet mangan i et forfilter, og derfor kan man anvende dosering af brintperoxid.

Til iltning af 1 mg $Fe^{+2}$ forbruges teoretisk 0,3 mg $H_2O_2$, så det er kun ganske lidt brintperoxid, der skal tilsættes. Efter forfiltrering går vandet til AOP, og her vil et lille overskud af brintperoxid ikke genere. Dog kan dette overskud måske gøre det vanskeligt at opnå det rette blandingsforhold mellem ozon og brintperoxid, hvis man anvender den metode (metode B). Derimod vil det ikke genere alvorligt ved UV-processen (metode C), hvor man alligevel skal dosere brintperoxid. Her vil lidt større koncentration af brintperoxid typisk give en lidt bedre renseeffekt.

Hvis man i stedet for brintperoxid doserer lidt natriumhypochlorit, vil man både opnå en iltning af jern og mangan. Metoden vil da svarer til den metode, der anvendes i et Grønsandsfilter. Overskud af chlor i det forrensede vand, vil fjernes, når der doseres brintperoxid til vandet (metode B og C), hvilket vil medfører et lidt større forbrug af brintperoxid.

### Keramisk coated filter med negativ belægning

Det er en meget speciel filtertype, der anvendes i det katalytiske anlæg fra Water IQ (Metode D). Filteret kan fjerne mekaniske urenheder, og det er sælig effektiv til at fjerne små positive kolloider. Derfor anvendes der ikke noget sandfilter som forfilter – kun en grovsi på 500µ. Finfiltreringen foregår i det keramiske filter, hvori man også opfanger jern, der udskilles ved iltningen.

Laboratorieforsøgene tyder også på, at man opfanger nogle af de opløste organiske Grindsted-stoffer i forfilteret. Da forfilteret skal returskylles ca. 1 gang dagligt, dannes der 3 $m^3$ returskyllevand pr. døgn. Dette returskyllevand skal sedimenteres, så slammet kan opkoncentrers, før det bortskaffes. Da vandfasen kan indeholde Grindsted-stoffer, anbefales det, at vandfasen renses på ny i AOP-anlægget.

# Bilag I Beskrivelse af efterfiltrering med kulfilter

| Metode | Aktivt kul |
|---|---|
| Kort metodebeskrivelse | Efter rensning i AOP reaktor sker der filtrering gennem kulfilter inden slutafleding af det rensede grundvand.<br><br>I kullene bindes evt. rester af organisk forureningen, mens brintperoxid og ozon nedbrydes.<br><br>I et kulfilter anvendes normalt kulgranulat med en kornstørrelse på 0,5-1,0 mm og en rumvægt på ca. 0,5 kg/liter. Kullene kan typisk optage en organisk stof-mængde på 20-30 % af egen vægt. Jo mere kulkolonnen mættes med organisk stof, desto dårligere bliver renseeffektiviteten. Hvis et kulfilter overbelastes, kan man risikere at nogle stoffer med dårligere affinitet til kullene afgives igen fra kulfilteret, fordi de bliver udstødt af stoffer med stor affinitet til kullene. Af-hængig af, hvilke stoffer der skal fjernes, vil man typisk skulle have en opholds-tid i kulfilteret på 10-15 minutter for at opnå en god rensning.<br><br>Vi foreslår at anlægget vil blive udført med to kulfiltre i serie. På den måde kan man få optaget maksimal mængde organisk stof, uden at det går ud over renseeffektiviteten, fordi vandet til sidst løber igennem en næsten rent kulfilter. Når det første filter er helt mættet, skal det udskiftes, hvorefter man bytter om på rækkefølgen, så det helt nye filter bliver placeret til sidst.<br><br>Et kulfilter kan laves som en fast installation, hvor beholderen tømmes og fyldes med kul på stedet. Det kan også være en fleksibel installation, hvor hele beholderen udskiftes og erstattes med en ny.<br><br>Procesforløb: Forfiltrering – AOP reaktor – efterfiltrering med aktivt kul-filter |
| Skitse/billede | <br><br><br>Billede af to 1-gangs kulfiltre fra Chemviron. Den lille beholder indeholder 75 kg kul og kan typisk køre med et max. flow på 2 m³/h. Den store beholder rummer 450 kg kul og kan køre med et max- flow på 6 m³/h. |

| Metode | Aktivt kul |
|---|---|
| | <br>To små 1-gangs filtre (75 kg) installeret i et container renseanlæg. |
| Udviklingsstadium | Metoden har været kendt længe og er veldokumenteret, og den anvendes i hele verden til fjernelse af organisk stof i vand. Aktivt kul har i mange år været anvendt herhjemme til rensning af forurenet grundvand med organisk stof. |
| Kommercielt tilgængelig | Filtre med aktivt kul kan leveres fra mange danske firmaer enten som fast installation eller som mobile beholdere, hvor hele beholderen udskiftes, når kullene er mættede. Beholderen kan enten sendes til regenerering, eller hele beholderen med indhold kan sendes til destruktion på forbrændingsanlæg. |
| Renseeffekt | Det afgørende for om et stof kan adsorberes er stoffets kemiske sammensætning. Nogle stoffer har en meget stor affinitet til aktivt kul, mens andre stoffer har dårligere affinitet eller meget lille affinitet. Generelt kan det siges, at upolære stoffer adsorberes godt, mens polære stoffer adsorberes dårligt.<br><br>Ved laboratorieforsøgene har man både afprøvet kulrensning direkte på råvand og som efterrensning efter AOP. Kulforsøgene er ikke optimeret, da formålet i første omgang blot var at se, om man kunne fjerne stofresterne fra AOP-forsøgene med aktivt kul. Ved forsøgene er anvendt pulveriseret aktivt kul (PAC), da det er bedst egnet til batchforsøg. I praksis vil man normalt anvende granuleret aktivt kul (GAC) i kolonner,<br><br>Forsøgene viste, at man som ventet kunne fjerne kulbrinter ganske effektivt samt til en vis grad også BTEX. Fjernelsen af chlorerede opløsningsmidler gik også nogenlunde, når der var nok kul til stede. Fjernelsen af vinylchlorid og cis-DCE var ikke helt komplet, hvilket stemmer udmærket overens med erfaringer fra tidligere sager, hvor man har set, at kullenes affinitet til disse to stoffer ikke er særlig god.<br><br>Kullene havde stor renseeffekt over for de fleste Grindsted-stoffer, men effekten over for ethylurethan var dog ikke særlig god. Effekten var heller ikke helt i top for 5,5-diallylbarbitursyre, barbital og pentobarbital.<br><br>Renseeffekten i et aktivt kulfilter afhænger af, hvor hurtigt man pumper vandet igennem anlægget. Jo større opholdstid vandet har i kontakt med aktivt kul, jo bedre vil renseeffekten blive. |
| Kapacitet ($m^3/h$) | Filtre med aktivt kul kan leveres i næsten alle størrelse. Kontakttiden skal typisk være 10-15 minutter for at opnå optimal tilbageholdelse af pesticider. |

| Metode | Aktivt kul |
|---|---|
| Indkøb af kulfiltre | Det forventes 2 kulfiltre i serie med hver ca. 1.000 kg kul. Opholdstiden i dette anlæg vil være ca. 12 minutter ved max. flow (10 $m^3/h$). |
| Kulforbrug | Kulforbruget er vanskeligt præcist at forudsige. Det hænger bl.a. sammen med, hvor meget organisk stof, der nedbrydes ved AOP samt ved destruktion af ozon og H2O2. Jo mere stof, der fjernes ved AOP, jo mindre kul vil der forbruges til efterrensning. Som udgangspunkt forventes et forbrug i størrelsesorden 4500 kg/år. Vi skal regne med, at det koster ca. 35 kr/kg at skifte kul (købe nye kul og destruere gamle kul). Hvis kulforbruget er 4500 kg/år svarer det til ca. 160.000 kr/år. Et kulforbrug på 4500 kg/år er dog nok i overkanten. 4500 kg kul kan optage ca. 900 kg organisk stof, men da der også bruges kul til destruktion af brintperoxid og/eller ozon er det forkert at kalkulere alene ud fra den mængde organiske stof, der skal fjernes. Derfor må ovenstående estimering af kulforbruget tages med forbehold.<br><br>Man kan også leje et kulfilter hos Chemviron Carbon. Når filteret er mættet, udskiftes hele filteret. Investeringen er meget mindre, men driftsudgiften er til gengæld noget større. Det er dog bekvemt med udskiftning af hele filteret, men det skal ses i forhold til, hvor mange gange der skal skiftes kul pr. år. |
| Fordele | › Kan både fjerne rester af organisk forurening samt rester af ozon og brintperoxid<br>› Anlægget fylder ikke ret meget, og det er simpelt i opbygning. Tidsforbrug til pasning og vedligeholdelse er minimal.<br>› Der anvendes ingen kemikalier.<br>› Metoden virker uanset om vandet er transparent eller ej. |
| Ulemper | › Aktivt kul kan ikke fjerne alle de organiske stoffer.<br>› Når kullene er mættede skal de udskiftes og sendes til regenerering eller destruktion.<br>› Vandet skal være fri for partikler, som vil tilbageholdes i kulefilteret, som efterhånden stopper til. |
| Referencer | Udvalgte danske leverandører af kulfiltre:<br><br>Chemviron Carbon: http://www.chemviron.eu/<br><br>e-mail: sgroenbjerg@calgoncarbon.com<br><br>Aage Christensen A/S, https://www.aagechristensen.dk/aktivt-kulfilter.aspx ,<br><br>E-mail: info@aagechristensen.dk<br><br>Kemic Vandrens A/S, http://www.kemic.dk/<br><br>E-mail: kemic@kemic.dk<br><br>Silhorko A/S, https://www.silhorko.dk/<br><br>E-maill: info.dk@silhorko.dk<br><br>BWT Water, http://www.bwt.dk/da/Sider/default.aspx<br><br>Email: bwt@bwt.dk |

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