

Ultrasound combined with Ozone technology

Feasibility study '19-'20 & Pilot '21-'22
Innovation program micropollutant removal from
wastewater

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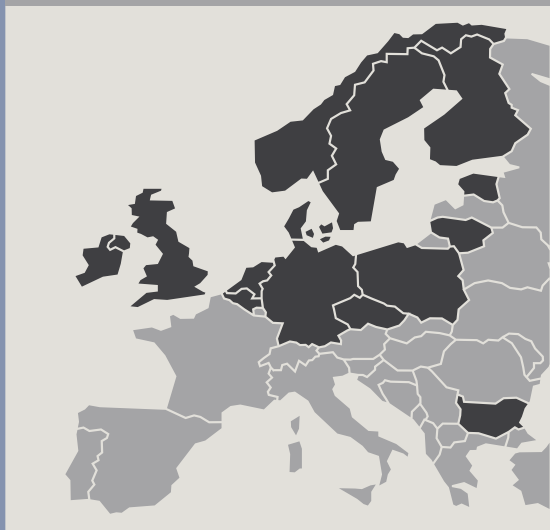
#1

On the European market¹

¹ Based on reported Net sales 2020, annual reports.

17 500

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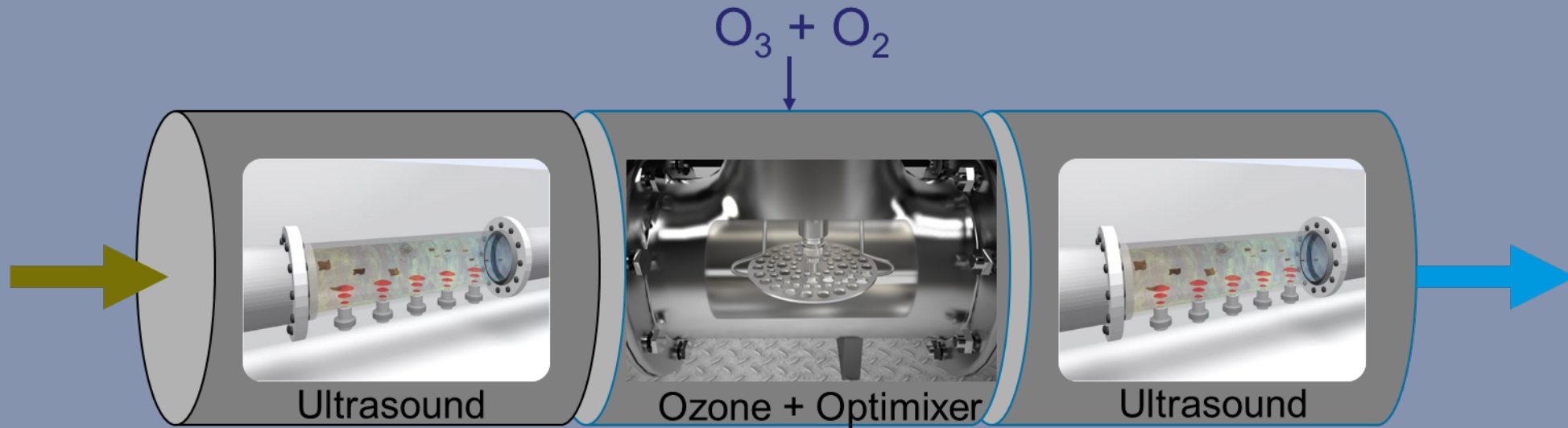
Transport infrastructure

Content

- The technology
- Feasibility study 2019-2020
- Pilot 2021-2022



Technology



- Patented Advanced Ozonation Technology
- Online-Reactor with US – O_3 – US configuration
- O_3 dissolution via Patented Online Injection
- Ultrasound boosts oxidation process

Technology

- More efficient ozonation compared to conventional ozonation;
 - Lower ozone dosage possible for the same removal rates
 - Short residence time -> smaller spatial footprint
- Optional disinfection for various purposes
- Modular system – scalable – for WWTP and hotspots
- Adjusted to local wastewater matrix
- Dry and Rain weather flow



Feasibility study STOWA 2020-24

- Feasibility of the combined effect of O_3 +US is based on:
 - Scientific literature & Company information
- Results regarding micropollutant removal are based on:
 - Pilot research, TU München (Germany)
 - Pilot research, USONiQ™ (USA)
 - Pilot research, Ostfalia Hochschule (Germany)



Conclusion feasibility study STOWA 2020-24

	Unit	REFERENCE: O ₃ en sand filtration	O ₃ + ultrasound USONiQ
CO ₂ -footprint	g CO ₂ /m ³ ¹	128	108-123
Costs	€/m ³	0,17	0,17 ³
Removal rate Ministry I&W	% ²	80-85%	85-90%

¹ Per m³ treated wastewater

² Removal rate method for minimally 7 out of 11 indicative compounds: benzotriazool, claritromycine, carbamazepine, diclofenac, metoprolol, hydrochloorthiazide, mengsel van 4- en 5-methylbenzotriazool, propranolol, sotalol, sulfamethoxazol, trimethoprim.
Removal rate is calculated based on the effluent after extra treatment step compared to the influent of the wwtp

³ € 0,10/m³treated for sand filtration

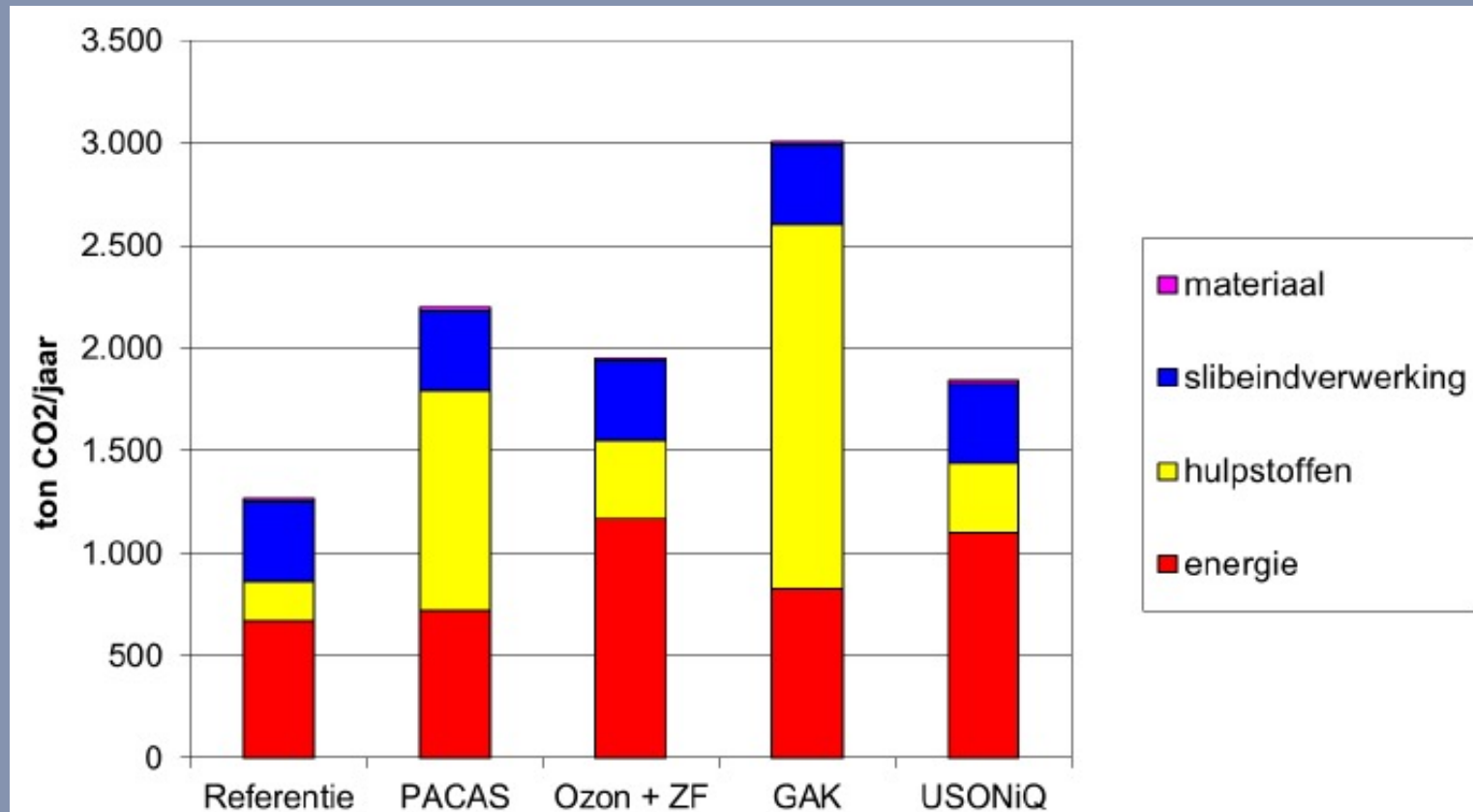
Removal rate of 85-90%

TABEL 2.1 OVERZICHT VAN DE TOEGEPASTE OZON DOSIS EN BIJBEHOREND VERWIJDERINGSRENDEMENT IN HET PILOTONDERZOEK IN WOLFSBURG MET USONIQ (9), HET DOC GEHALTE IN DIT ONDERZOEK WAS 11 MGD_{OC}/L

Verbinding	Gidsstof Min I&W	Ozon dosis (mg O ₃ /mg D _{OC})	Verwijderingsrendement in de behandelde stroom (%)
Citalopram	-	0,28	93,3
Diclofenac	ja	0,15	99,8
Furosemide	-	0,15	99,9
Hydrochloor-thiazide	ja	0,37	99,6
Sulfamethoxazol	ja	0,37	98,3
Metoprolol	ja	0,56	99,3
1-H-Benzotriazool*	ja	0,85	100
		0,56	76,9

* Er zijn twee verschillende ozon doses (0,85 en 0,56 mgO₃/mg D_{OC}) gegeven in de tabel, zodat zichtbaar is wanneer deze volledig verwijderd is en bij welke dosis in de test de verwijdering >75% is.

CO₂-footprint



Source: STOWA 2020-24, figure 4-1

Other advantages

- Disinfection
- Possible positive effect on the removal of antibiotic resistant bacteria
- Lower (thus improved) ecotoxicity
- A lower bromate production is assumed
- The technology is able to treat complex micropollutants (such as in industry or hospital)

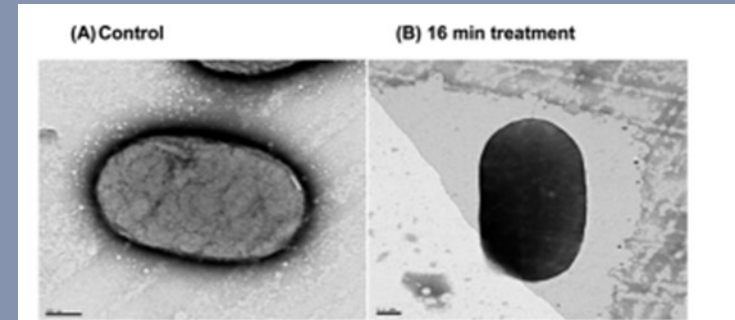


Figure 10. TEM images showing the effect of ozone alone on the biological structure of *E. coli* treated with the USO_3 system: (A) control and (B) 16 min ozone treatment.

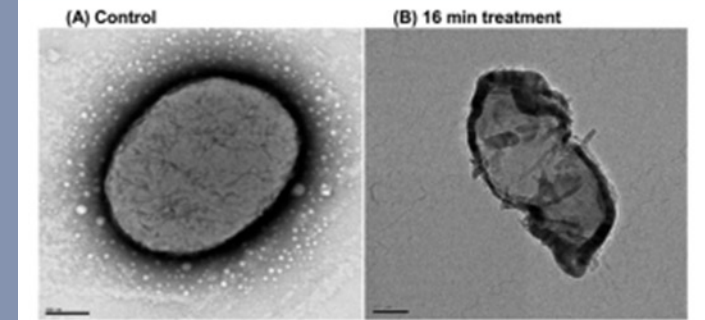


Figure 11. TEM images showing the effect of ultrasound and ozone on the biological structure of *E. coli* treated with the USO_3 system: (A) control and (B) 16 min treatment with ultrasound and ozone.

Pilot 2021-2022

- 2 pilot installations:
 - US04 pilot (4 m³/h)
 - US02020 (50 m³/h)



USO4 pilot (4 m³/h)

- 5 ozone dosages are tested between 0.2 and 0.9 g O₃/g DOC
- Each dosage is spiked with bromid up to 1,000 µg/l
- Analyses performed:
 - Micropollutants
 - Bromate



USO2020 (50 m³/h)

- 2 phases:
 - 5 ozone dosages are tested between 0.2 and 0.9 g O₃/g DOC
 - Extended test: 1 dosage will be chosen
- Analyses performed in both phases:
 - Micropollutants
 - Bromate
- Additional analyses in the extended test:
 - Energy (kWh)
 - Ecotoxicity
 - Disinfection
 - Antibiotic resistant bacteria





Thank you for your attention!



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Tackling Micropollutants in Wastewater
Approaches on Implementation and Innovation in Europe and The Netherlands



Rijkswaterstaat
*Ministry of Infrastructure
and Water Management*

November 3 and 4 2021
Aquatech Amsterdam

