



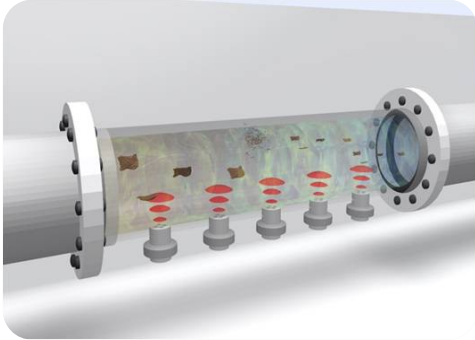
Application of ultrasound enhanced online ozonation

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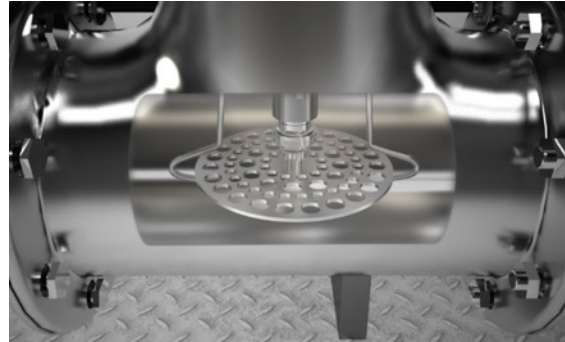


**Dutch Innovation on Micropollutants
Removal from Municipal Wastewater**
November 7th 2019 Aquatech Amsterdam

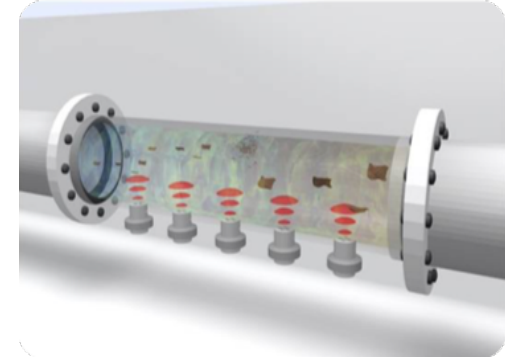
Technology: O₃ + US



Ultrasound



Ozone



Ultrasound

US:

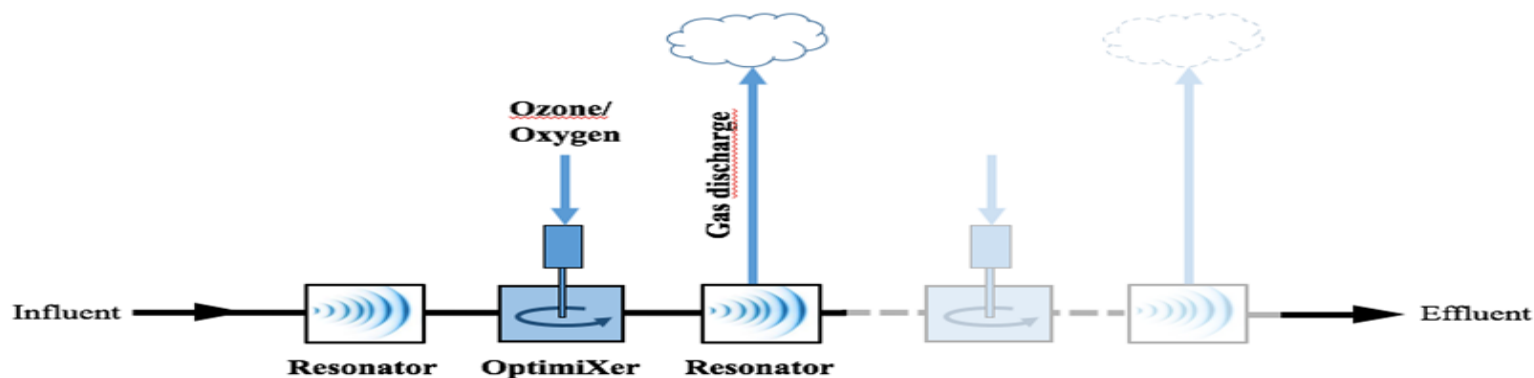
- breaks organic clusters
- creates hydroxyl radicals
- enhances ozone decomposition

Combined effect of O₃+US:

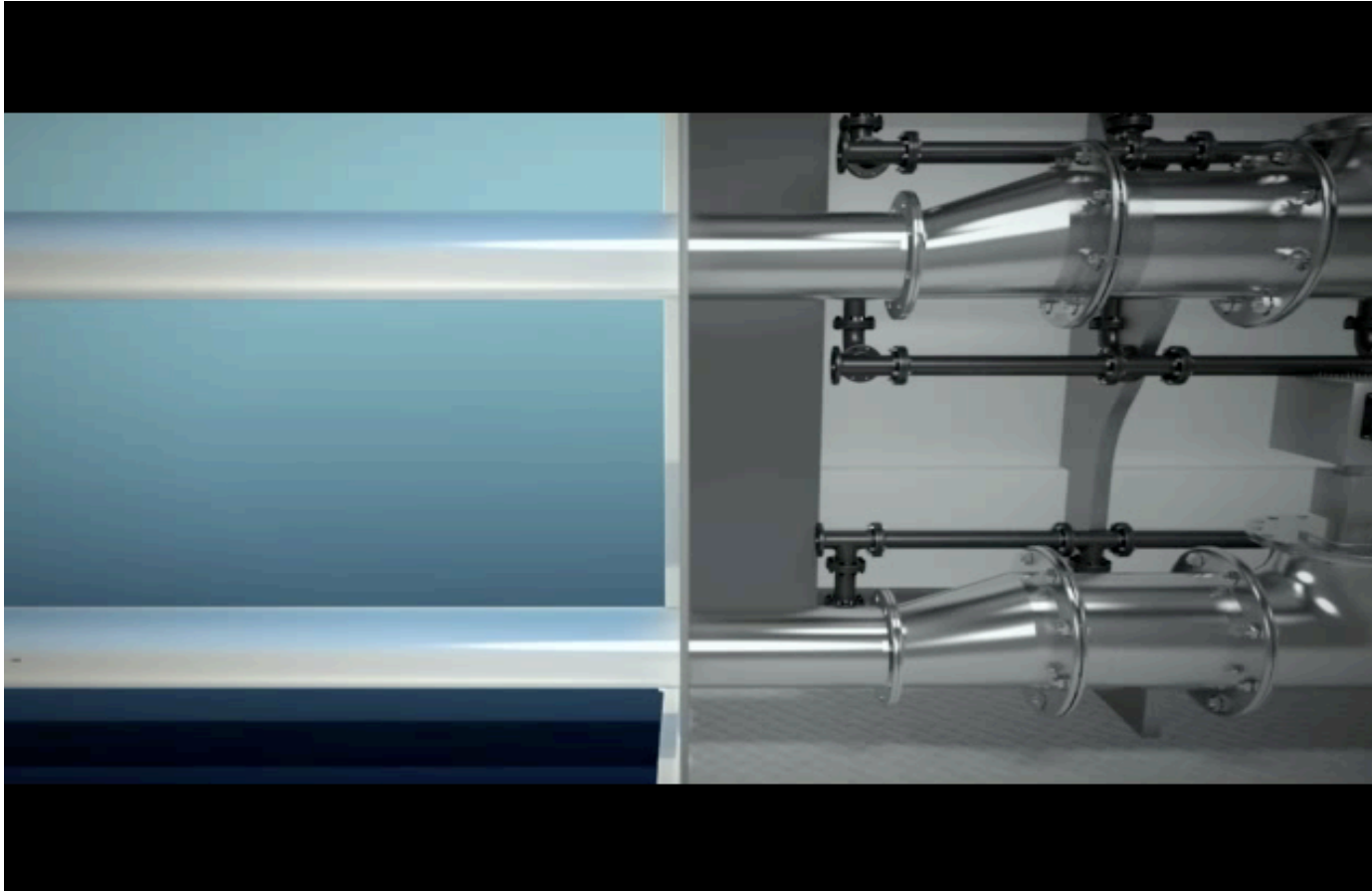
- More efficient ozonation
- Smaller O₃-dose needed
- Small spatial footprint
- Adaptable to changing requirements incl. disinfection

USONiQ™ Technology

- Patented Advanced Ozonation Technology
- Online-Reactor with US – O₃ – US configuration
- O₃ dissolution via Patented Online Injection
- Reduced reaction times < 1min.
- In existing infrastructure – no additional reactors needed
- Fully and easy controllable single step process
- Modular system – scalable – for WWTP and hotspots



Ultrasound enhanced online ozonation



Feasibility Study

- Feasibility combined effect 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)



Results

Criterion	Scores in respect to ozonation + sand filtration
Removal of micropollutants	+
CO ₂ footprint	++
Costs	0
Ecotoxicity	0
Microplastics	0
Antibiotic resistance	0 (or + ?)
Disinfection	+

Results

- Literature results on bacterial disinfection

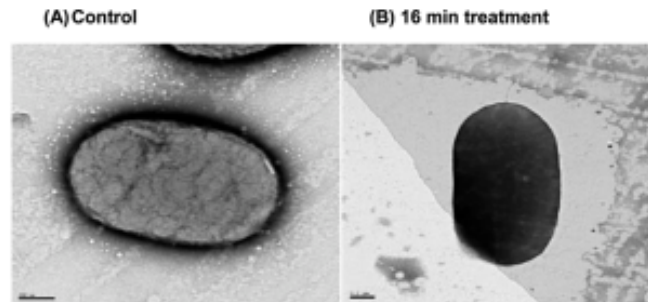


Figure 10. TEM images showing the effect of ozone alone on the biological structure of *E. coli* treated with the USO_3 system: (A) control and (B) 16 min ozone treatment.

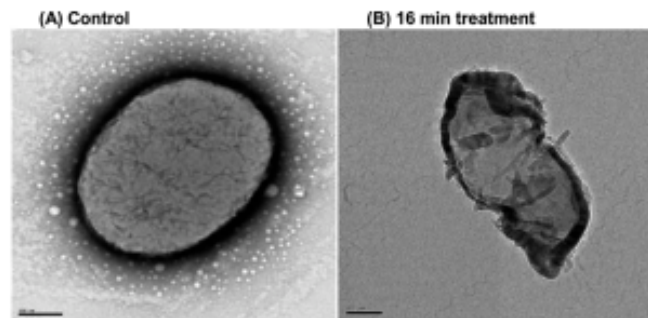
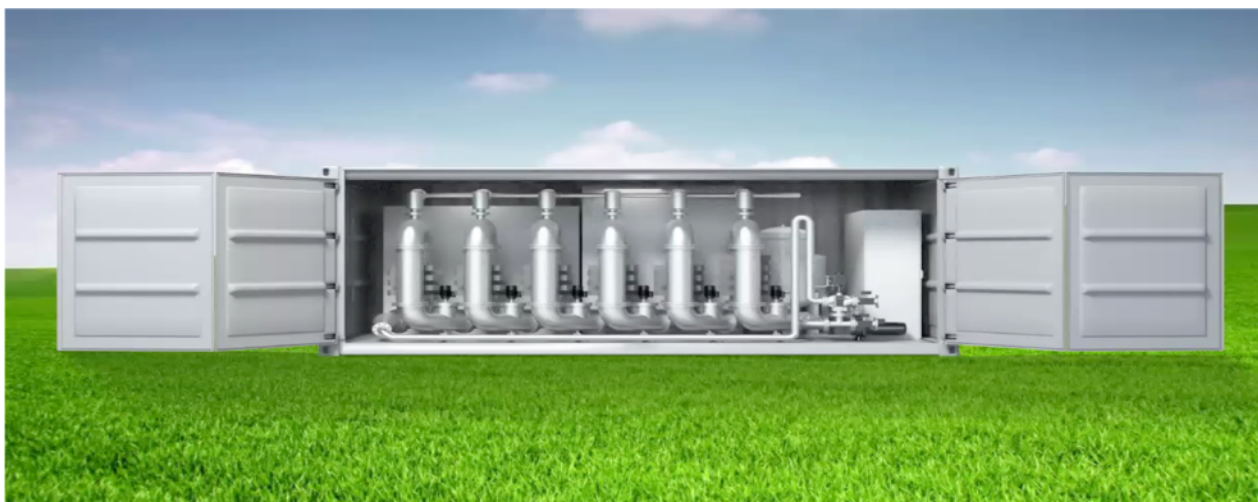


Figure 11. TEM images showing the effect of ultrasound and ozone on the biological structure of *E. coli* treated with the USO_3 system: (A) control and (B) 16 min treatment with ultrasound and ozone.

Further research

- Pilot installation with USONiQ™ technology:
 - Determine the micropollutant removal efficiency
 - Determine the design criteria (O_3 dosage + kWh usage)
 - Determine the impact on antibiotic resistant bacteria
 - Determine the production of bromate
 - Determine cost efficiency for small WWTPs
 - Collect experience in operational ease





Thank you for your attention!

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