



Implementation of Ozone: Lessons Learned, Knowledge Gaps and Future Research

Ruud Schemen

Tackling Micropollutants in Wastewater

workforce

Ozone



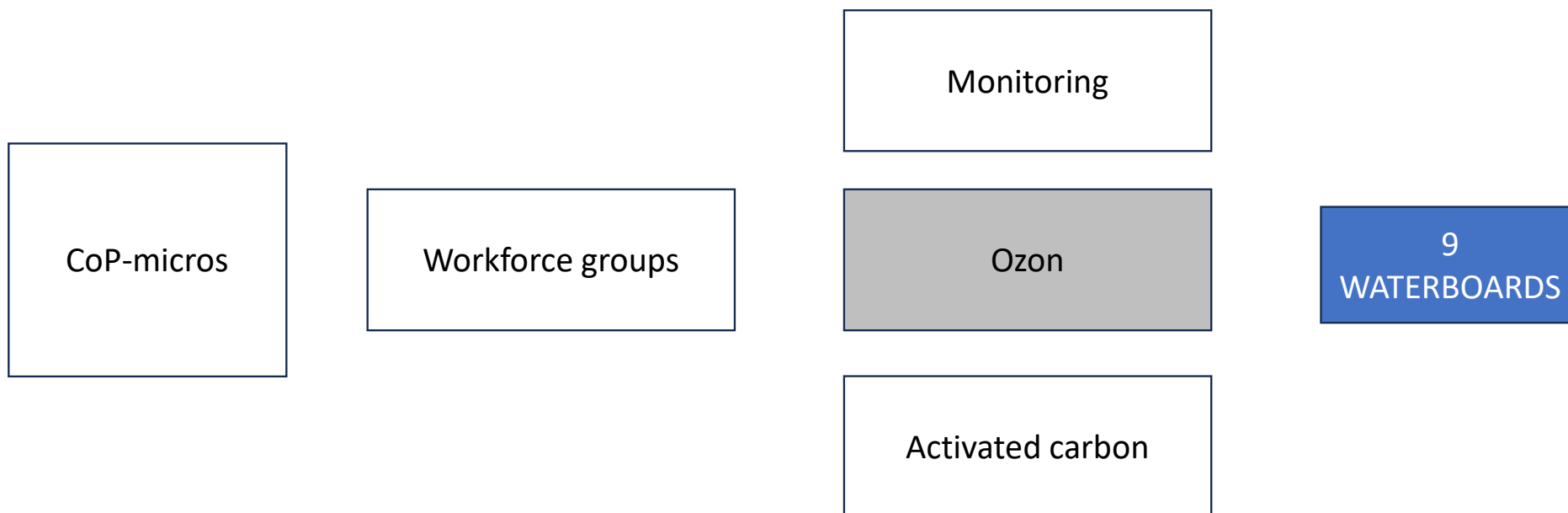
Ministry of Infrastructure
and Water Management

stowa

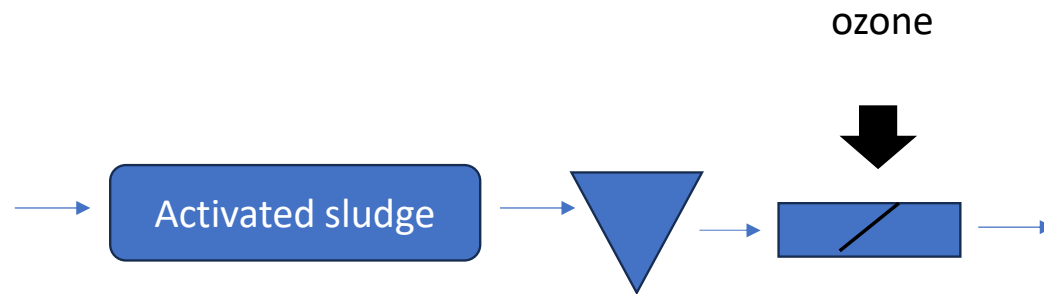
November 8 and 9 2023
Aquatech Amsterdam

1. Workforce
2. Ozone
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5. Ozone experiences
6. Bromate
7. Future research and development

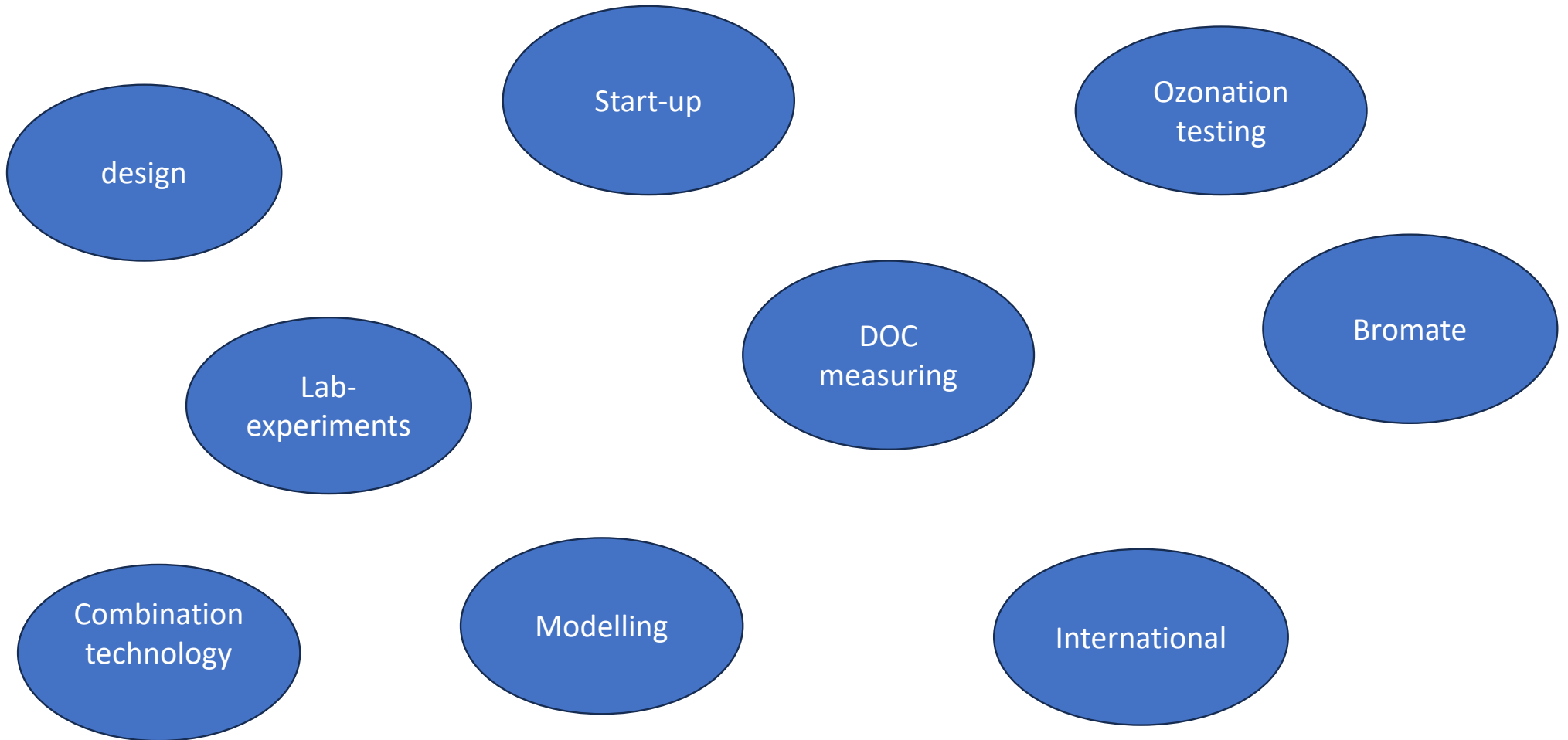
Workforce implementation ozonation



Ozone (sandfiltration)



Exchange information

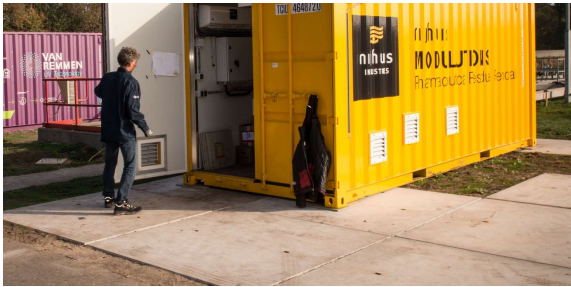


2021

2022

2023

2024



Aarle Rixtel



Houten



Wervershoof



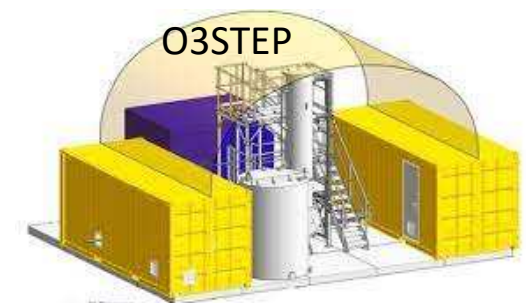
Winterswijk



Dinther



Hapert



Horstermeer

Ozone-WWTP's in NL

Ozone – experiences

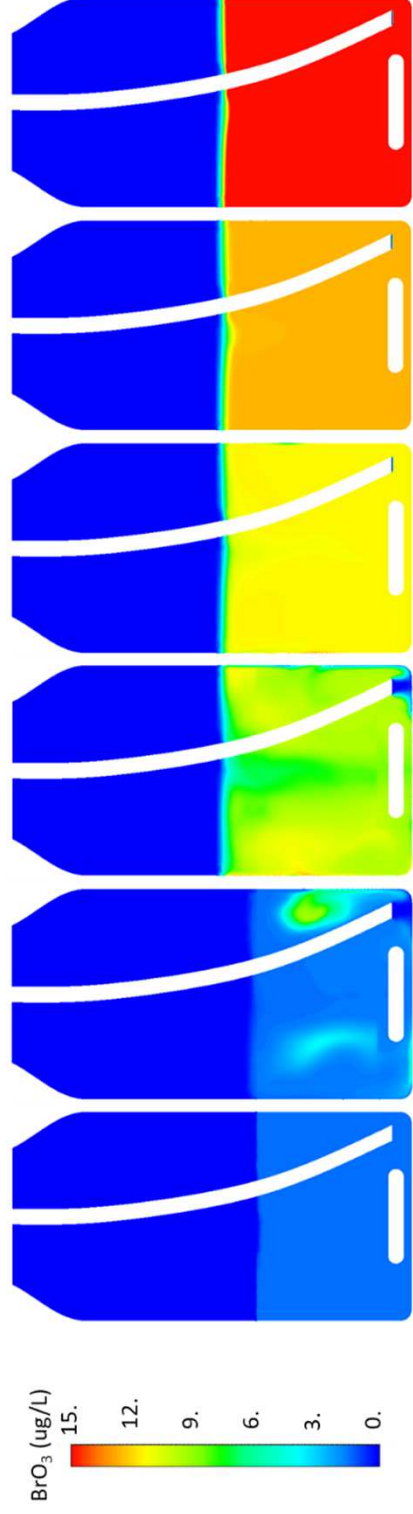
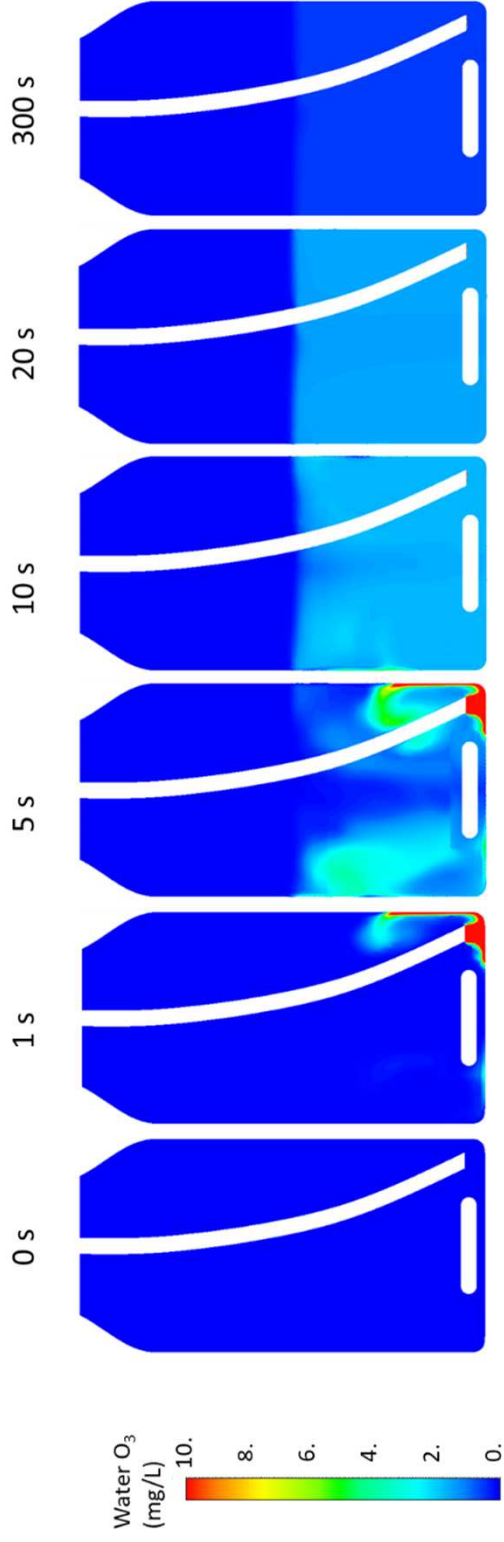
- Bromate: new standard for surface water
- Ozone detection: personal protection equipment
- DOC monitoring: maintenance and drift
- Start-up: leak detecting
- Licensing
- Modelling: Bromate and CFD

Ozone – experiences

- Bromate: new standard for surface water
- Ozone detection: personal protection equipment
- DOC monitoring: maintenance and drift
- Start-up: leak detecting
- Licensing
- **Modelling: Bromate and CFD examples**

Ozonation testing

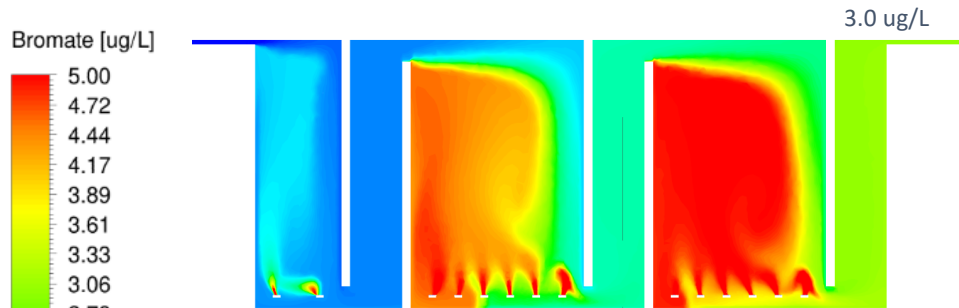
- We noticed big differences between laboratories
- Modelling of the ozonation testing
- Concentration stock-solution
- Dosing speed (amount excess ozone)



Bromate and CFD

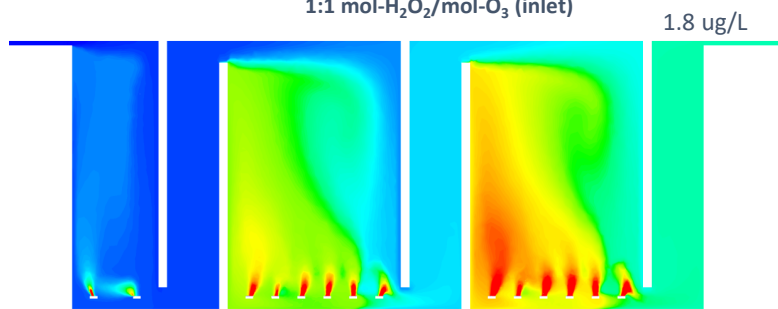
Base design
5-12-12 diffusers

Ansys



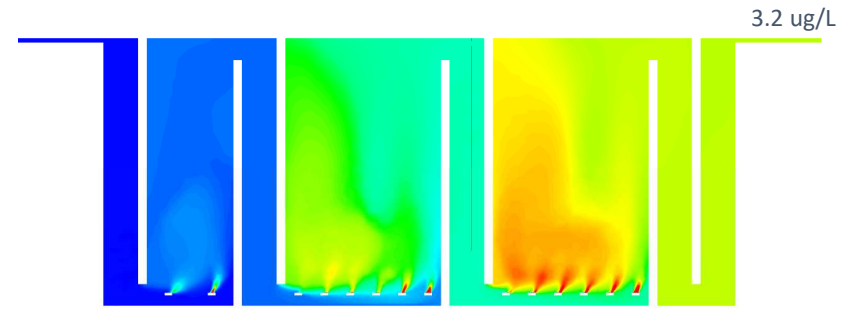
Ansys

Base design
5-12-12 diffusers
1:1 mol-H₂O₂/mol-O₃ (inlet)



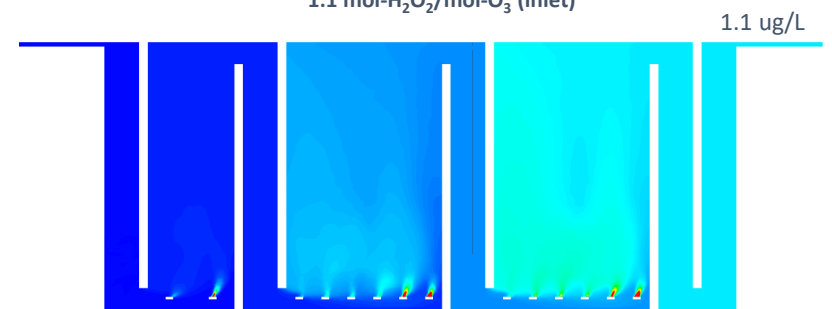
Co-current design
5-12-12 diffusers

Ansys

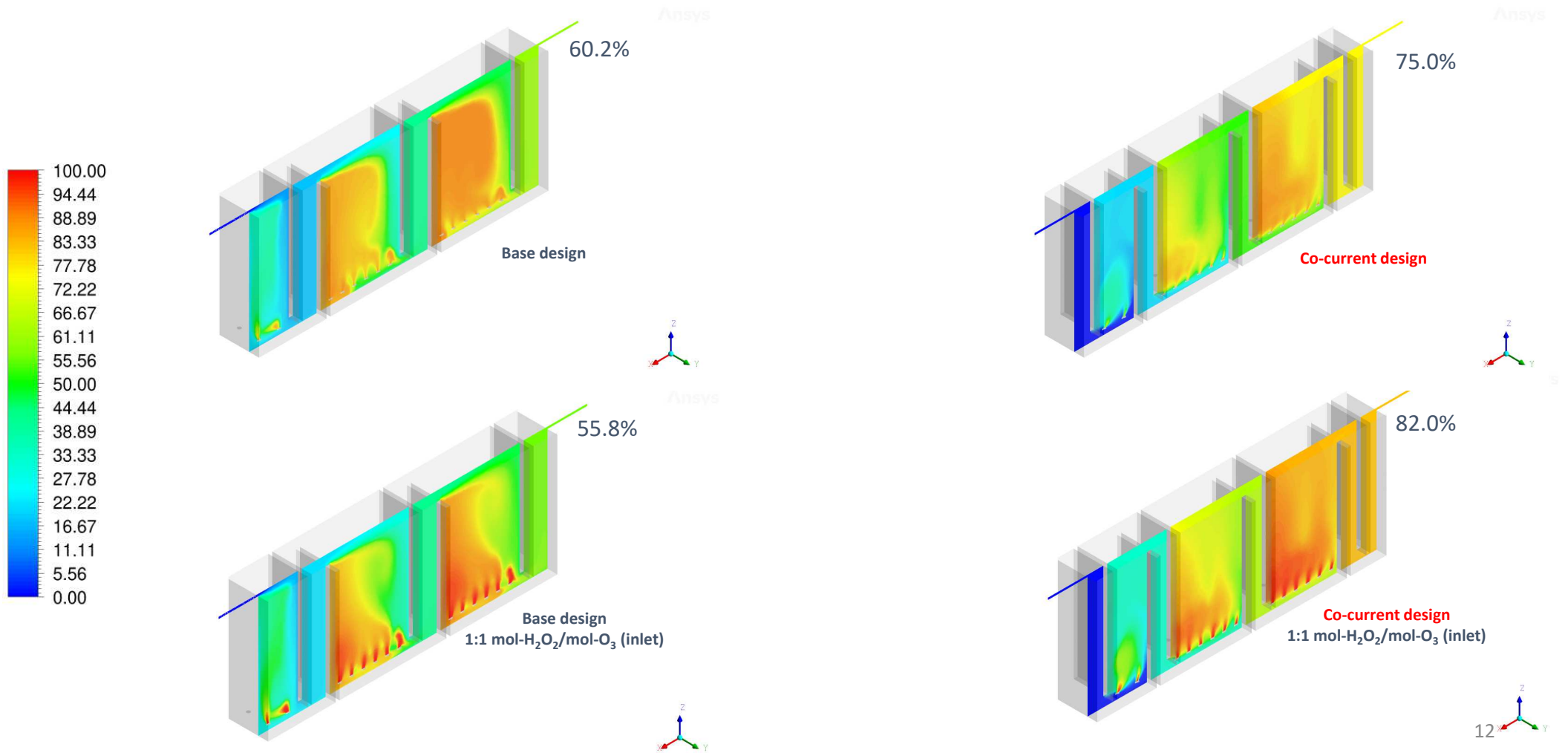


Ansys

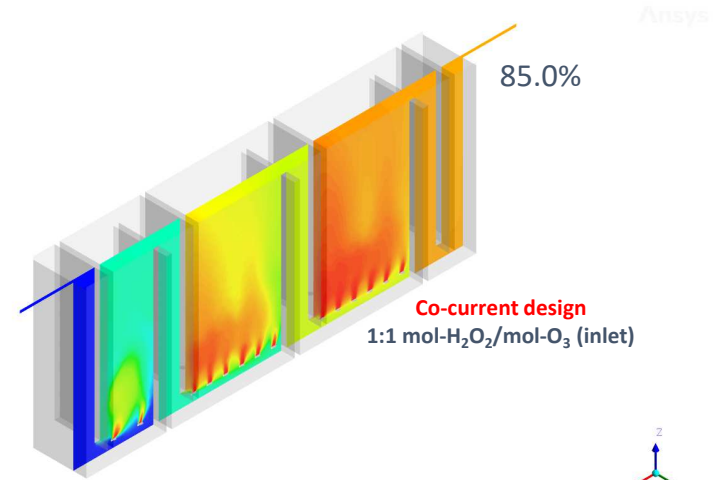
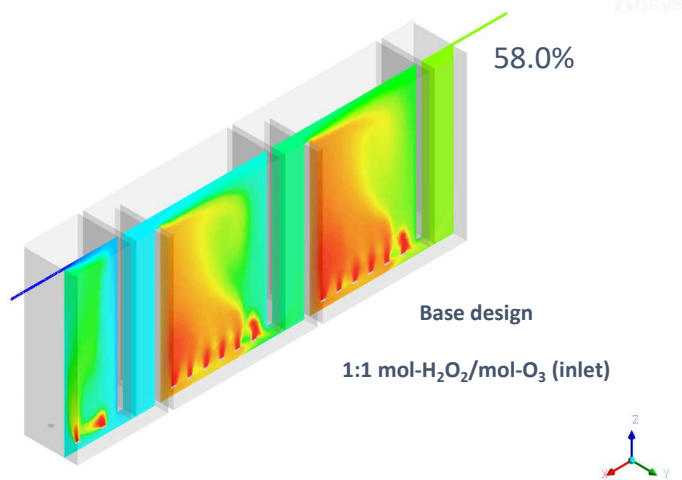
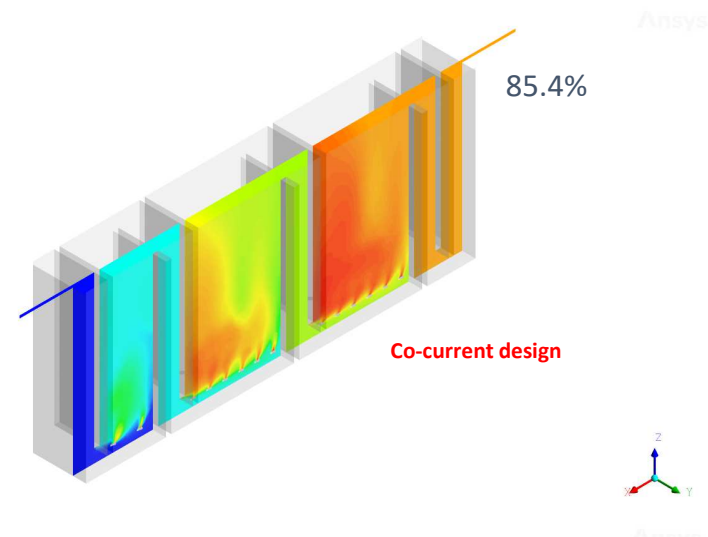
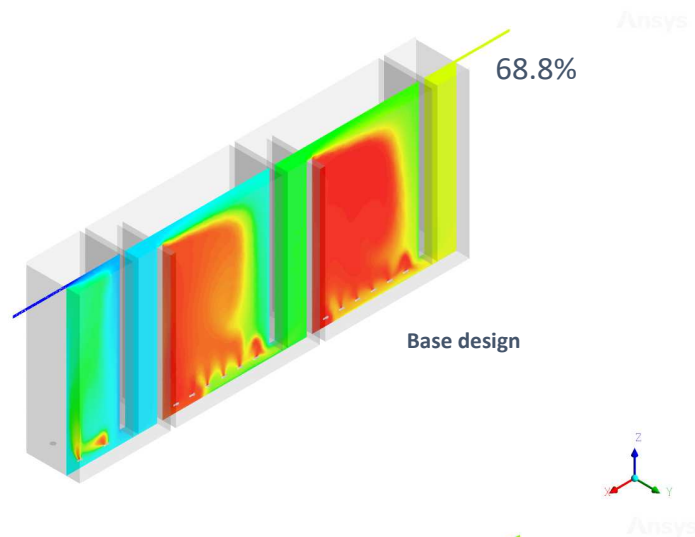
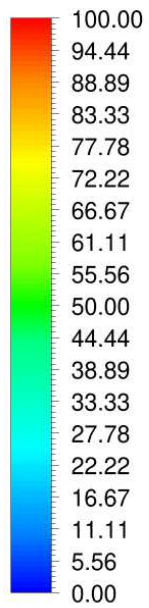
Co-current design
5-12-12 diffusers
1:1 mol-H₂O₂/mol-O₃ (inlet)



Benzotriazole



Venlafaxine



Bromate

- Prevent formation
 - low concentrations excess ozone
 - dosing peroxide
 - amount of difusers
 - co-current vs counter-current
 - amount of ammonium
- Bromate breakdown (anoxic circumstances)

Future Research – development

- Bromate: reduction and mitigation
- Digital Twin
- Optimisation of control strategies
- International colaboration (Interreg)
- Combination of technologies
- Combination with nutrient removal
- Interaction :

Monitoring

Activated carbon

Ozone



Thank you for your attention!

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**Tackling Micropollutants in Wastewater
Results of the Dutch Innovation and Implementation Program**

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*Ministry of Infrastructure
and Water Management*

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