

**Recover.**

**Reuse.**

**Regenerate.**

**Water.**

# MicroForce<sup>++</sup>

*Intertwining Ozonation and Biological Oxidation for a Sustainable, Compact and Economical Removal of Micropollutants from WWTP Effluent*

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**PURE  
BLUE**

# Our mission



returning water to its natural state.  
PureBlue





# MicroForce<sup>++</sup>



Intertwining O<sub>3</sub> + Microbiology



Lower byproduct formation  
(e.g. bromate)



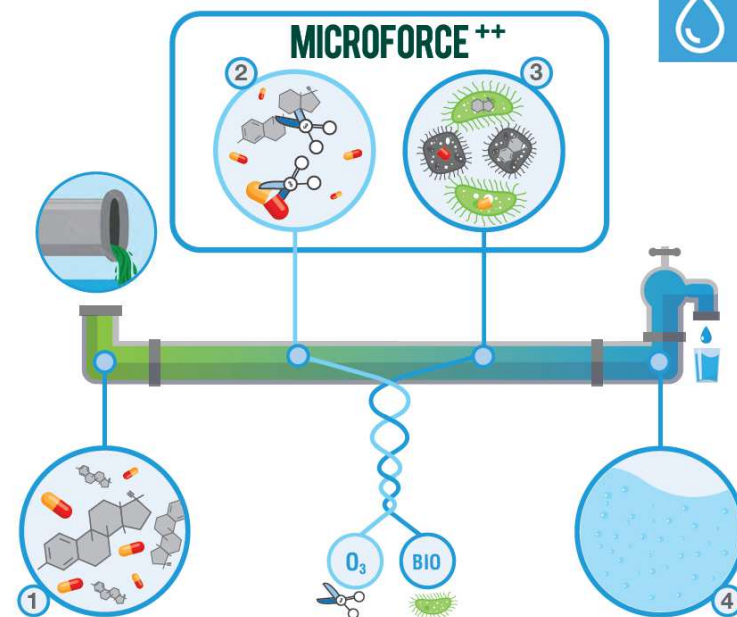
Lower CO<sub>2</sub> footprint & energy  
consumption



Compact & modular



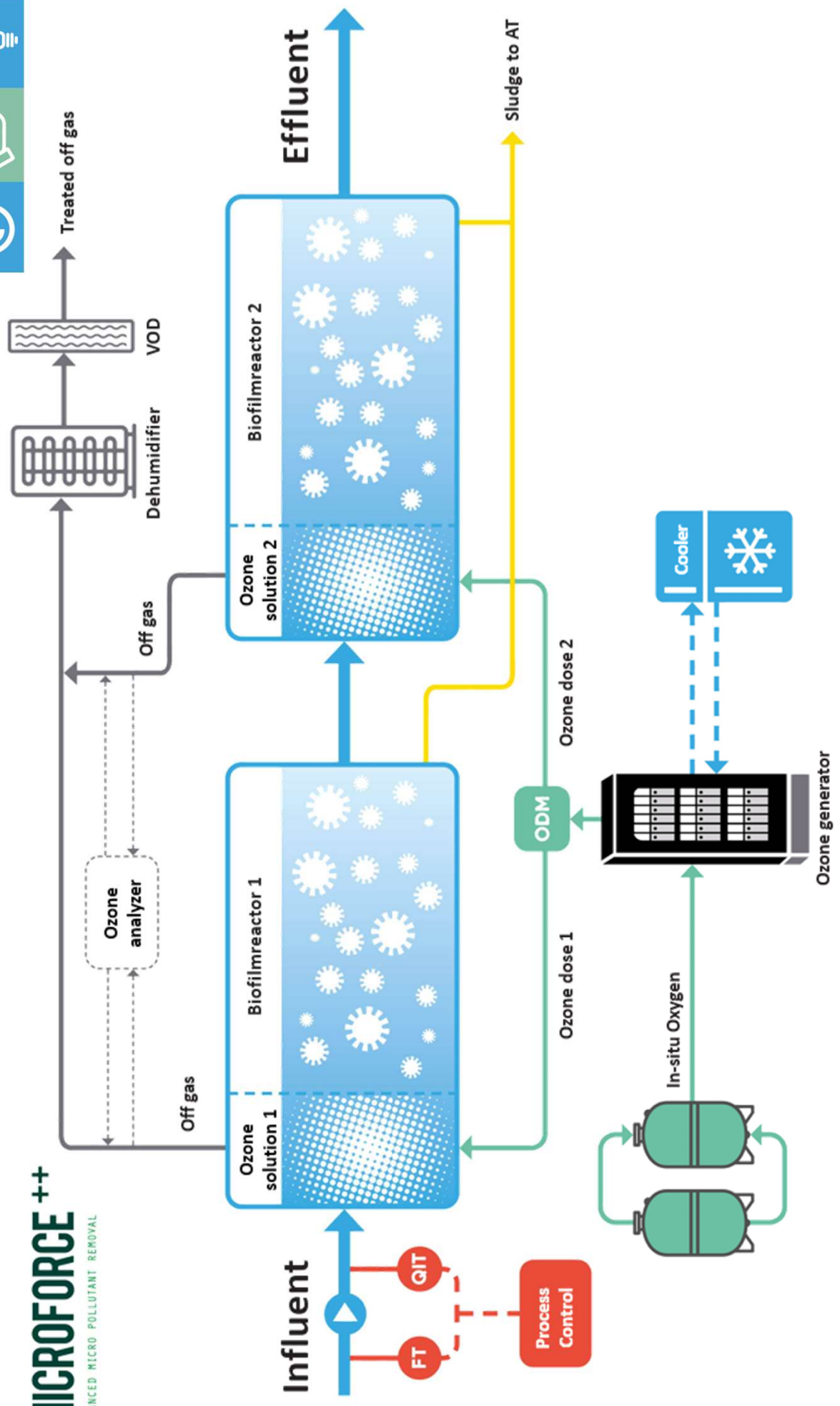
Extra removal of nutrients & SS





# MICROFORCE ++

ADVANCED MICRO POLLUTANT REMOVAL



# Scope pilot research WWTP Walcheren (NL)



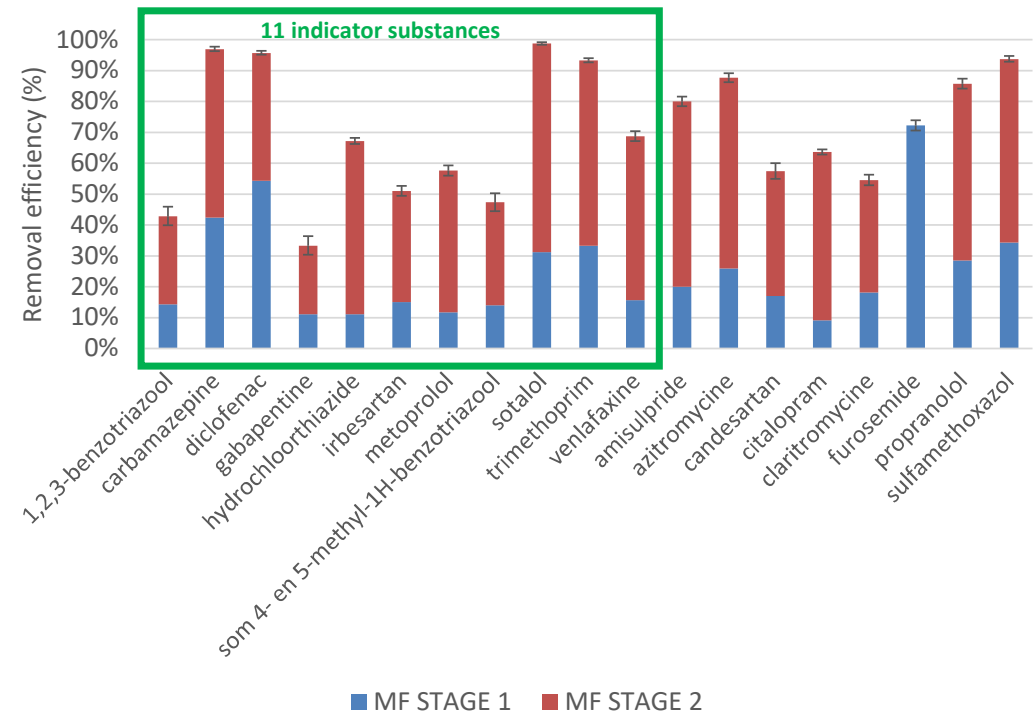
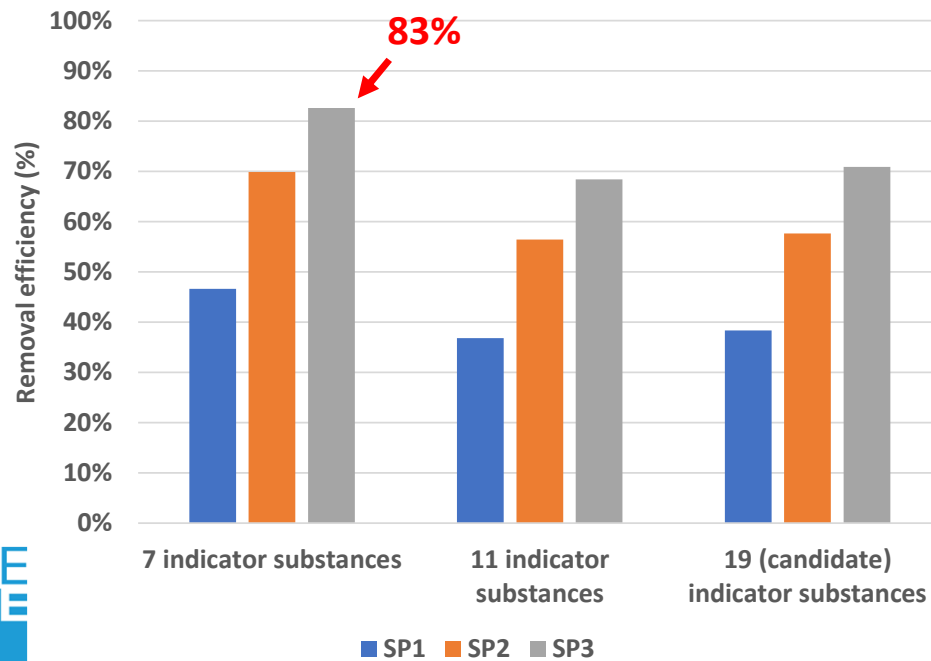
- Proof of principle on pilot scale (16 m<sup>3</sup>/h)
- Can MicroForce<sup>++</sup> reach current OMP removal targets with less ozone?
- What is the impact of a biological step on OMP removal efficiency, CO<sub>2</sub> footprint & TCO?
- How does MicroForce<sup>++</sup> perform on bromate formation and nitrogen removal?





# Results indicator substances (OMP's)

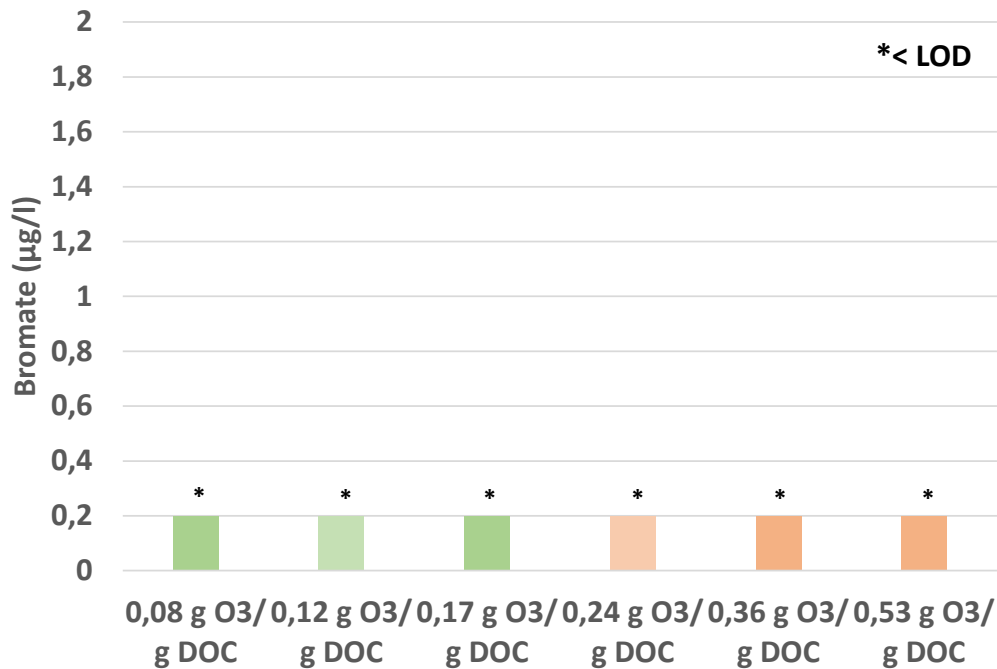
SETPOINT (SP)	Test variable	Target Ozondose (g O <sub>3</sub> /g DOC)	Ozondistribution (OR1/OR2)	HRT BR (min)
1	Orientalional	0,35	50/50	7,5
2	HRT/ozondistributie	0,35	33/66	15
3	Ozone dose	0,45	33/66	15



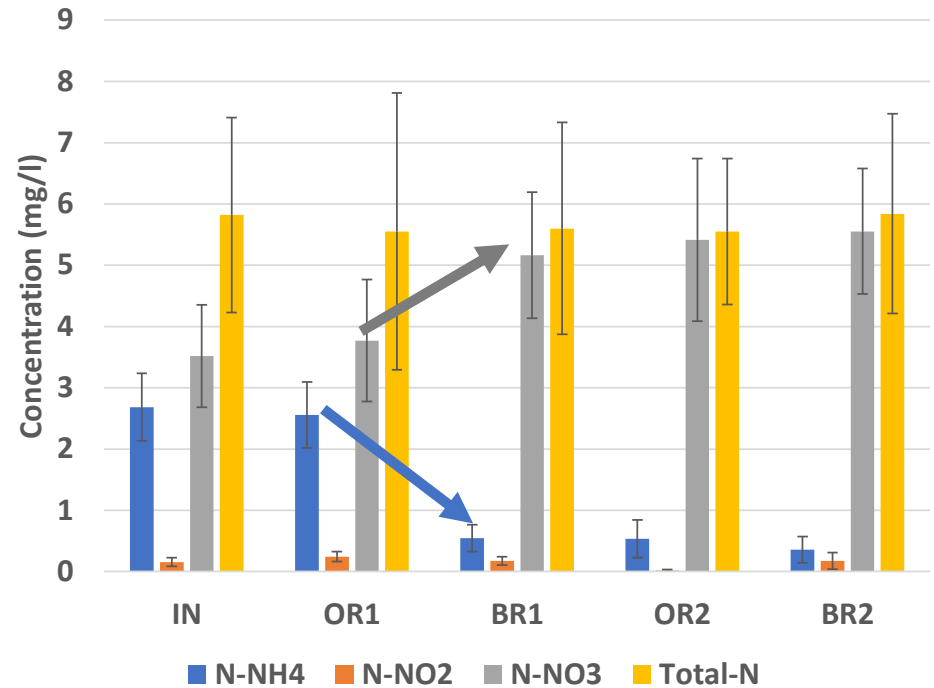
# Results bromate formation and NH<sub>4</sub> removal



## Bromate



## N-Balance



- No bromate formation even at bromide concentrations of 1800 (!) µg/l
- 2 step - PureBlue injection

- 80% Ammonia removal in BR1
- Oxygen recuperation as driving force of nitrification
- Next step: Denitrification in BR2

# Results Pilot Study MicroForce<sup>++</sup>



	Unit	Ozone + SF		MicroForce <sup>++</sup>
CO <sub>2</sub> -footprint	g CO <sub>2</sub> /m <sup>3</sup> <sup>1</sup>	130	- 50% →	66
Costs	€/m <sup>3</sup>	0,17	- 40% →	0,10
Removal efficiency Dutch indicator substances	% <sup>2</sup>	80-85	=	80-85%

<sup>1</sup> 1 Per treated m<sup>3</sup> wastewater: peak dry weather flow must be treated. **Please note: standardized cost and CO<sub>2</sub> levels for 2018**; recalibration of all CO<sub>2</sub>- and cost levels will take place during the evaluation of the Innovation Program in 2024

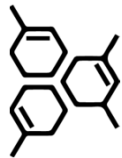
<sup>2</sup> Overall Removal Efficiency of effluent wwtp to influent wwtp (including bypass post treatment) for 7 of 11 guide substances: benzotriazol, carbamazepine, diclofenac, irbesartan, gabapentine, metropolol, hydrochloorthiazide, mixture of 4- en 5-methylbenzotriazol, sotalol, trimethoprim en venlafaxine in every 24h or 48h flow or time proportional sample. The sampling has to take the hydraulic retention time of the wwtp into account.



# Take home MicroForce<sup>++</sup>



Excellent performance on  $\text{CO}_2$  footprint & TCO



Removal efficiency OMP > 80% @ 0,43 g  $\text{O}_3$ / g DOC (= 40% reduction)



No bromate formation up to 0,55 g  $\text{O}_3$ /g DOC @ 1800  $\mu\text{g/l}$  Br



Modularity enables high applicability on WWTPs in NL



Goal: Simultaneous removal of OMP and nutrients with 1 installation



# Thank You!

**stowa**



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Ministry of Infrastructure  
and Water Management

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

November 8 and 9 2023  
Aquatech Amsterdam