



## ***IPMV - bio-GAK - pilot WwTW Emmen***

Hans Wouters

November 8th, 2023

# Timeline and project set-up

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## Research WwTW Emmen

- IPMV pilot in operation: June 2022 – September 2023
- Executing partners: Waterboard Vechtstromen, NieuWater, RWB Water, Brightwork
- Participating partners: Waterboards Rijn & IJssel, Valei & Veluwe, Limburg, Drents Overijsselse Delta, Aquafin
- Final report available in November 2023
- Stowa webinar GAC in February 2024

## Research WwTW Aartselaar

- Referencing, comparing results

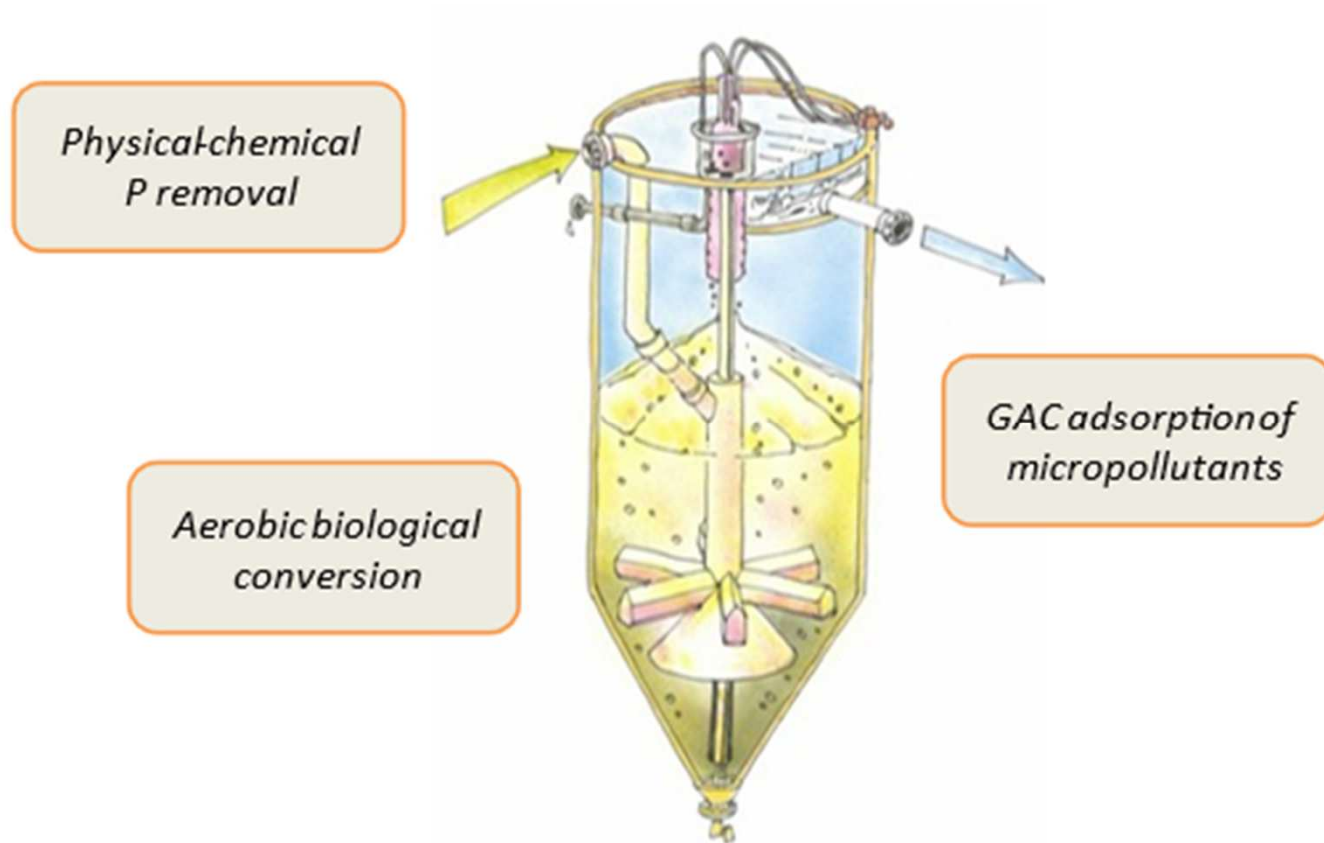
## Work in progress

- Research extension with participating partners
  - Conversion of existing plants into bio-GAK plants
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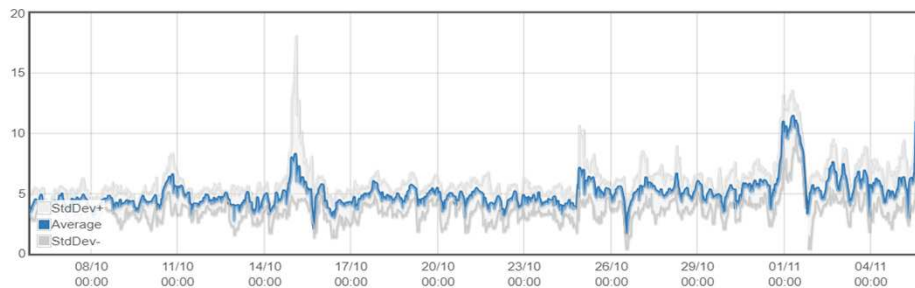
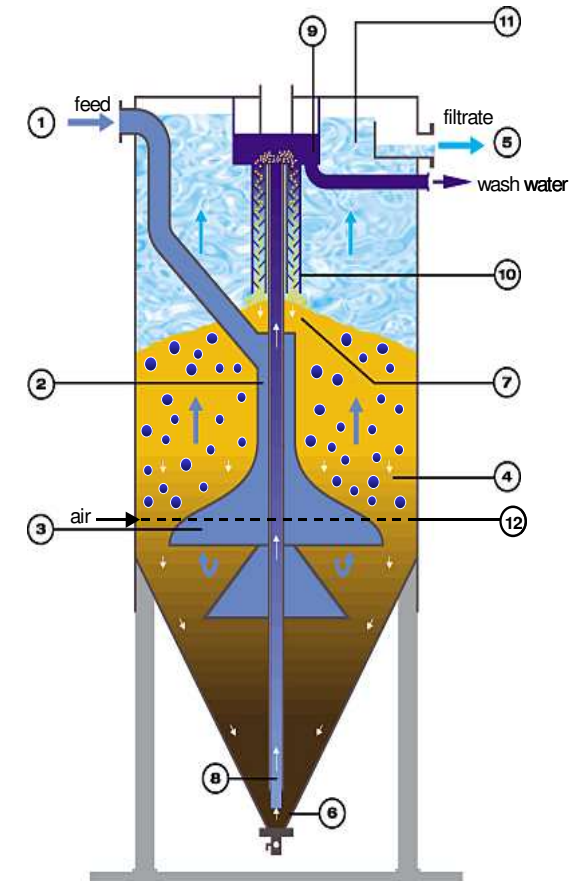
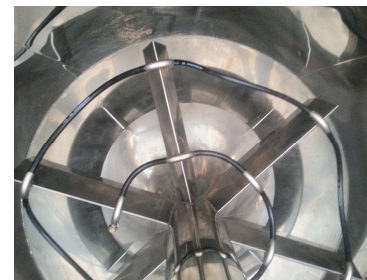
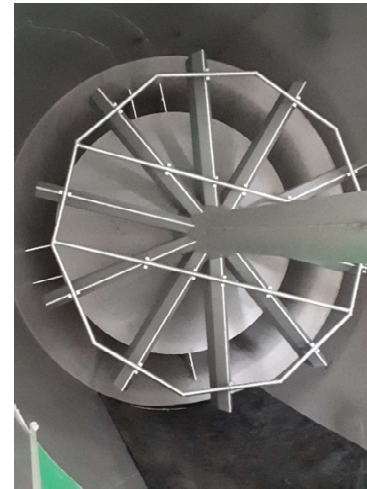
# Technology

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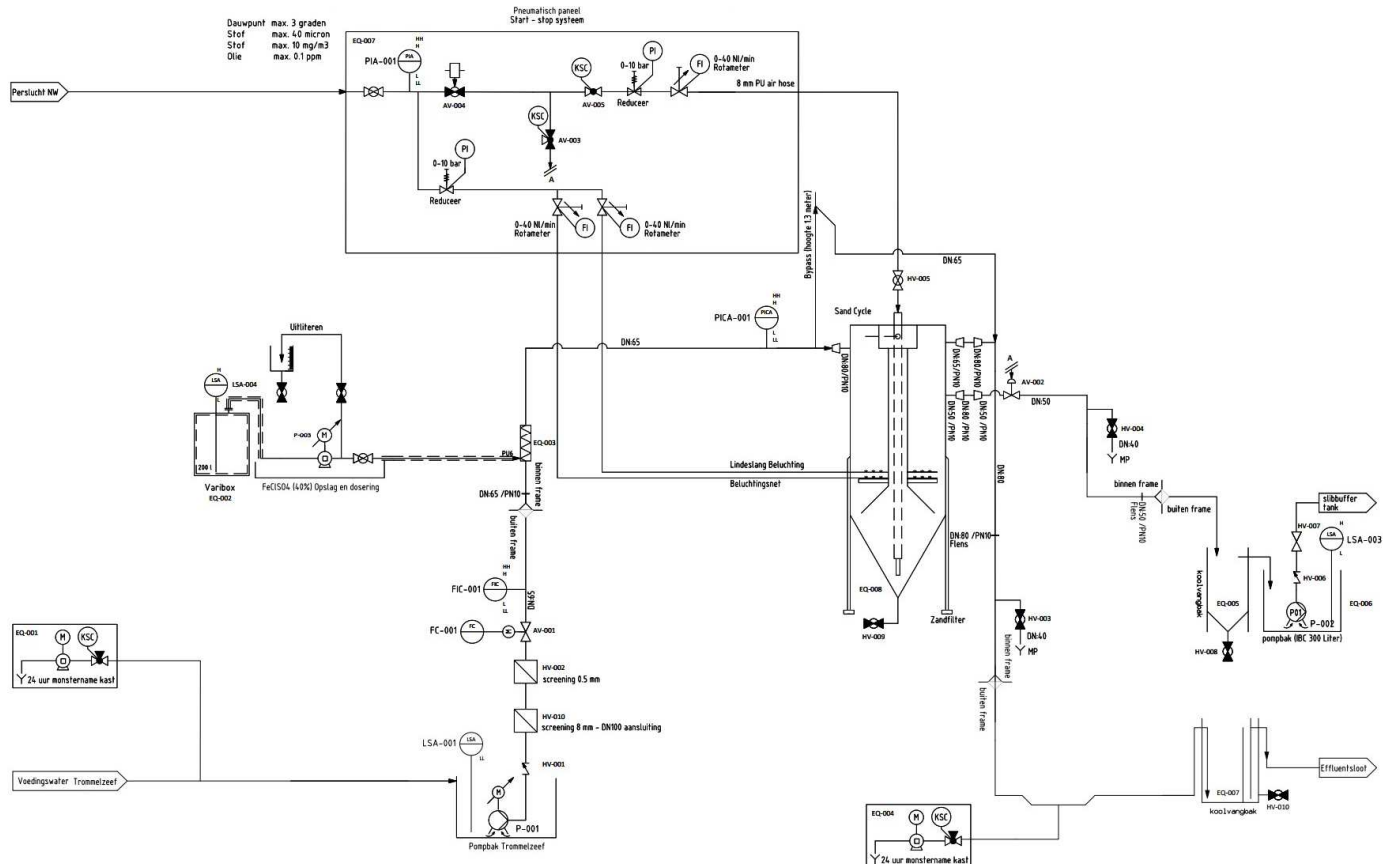


# Specifications

- Upward continuous filtration (5 – 6 m/h)
- Feed strainer 2 mm, 2D
- Granular activated carbon media (EBCT: 25 min)
- Fine bubble aeration inside filter bed
- Biological growth on top of granular media
- Inline feed coagulant dosing prior to static mixer
- Controlled circulation and washing of media
- Head loss control

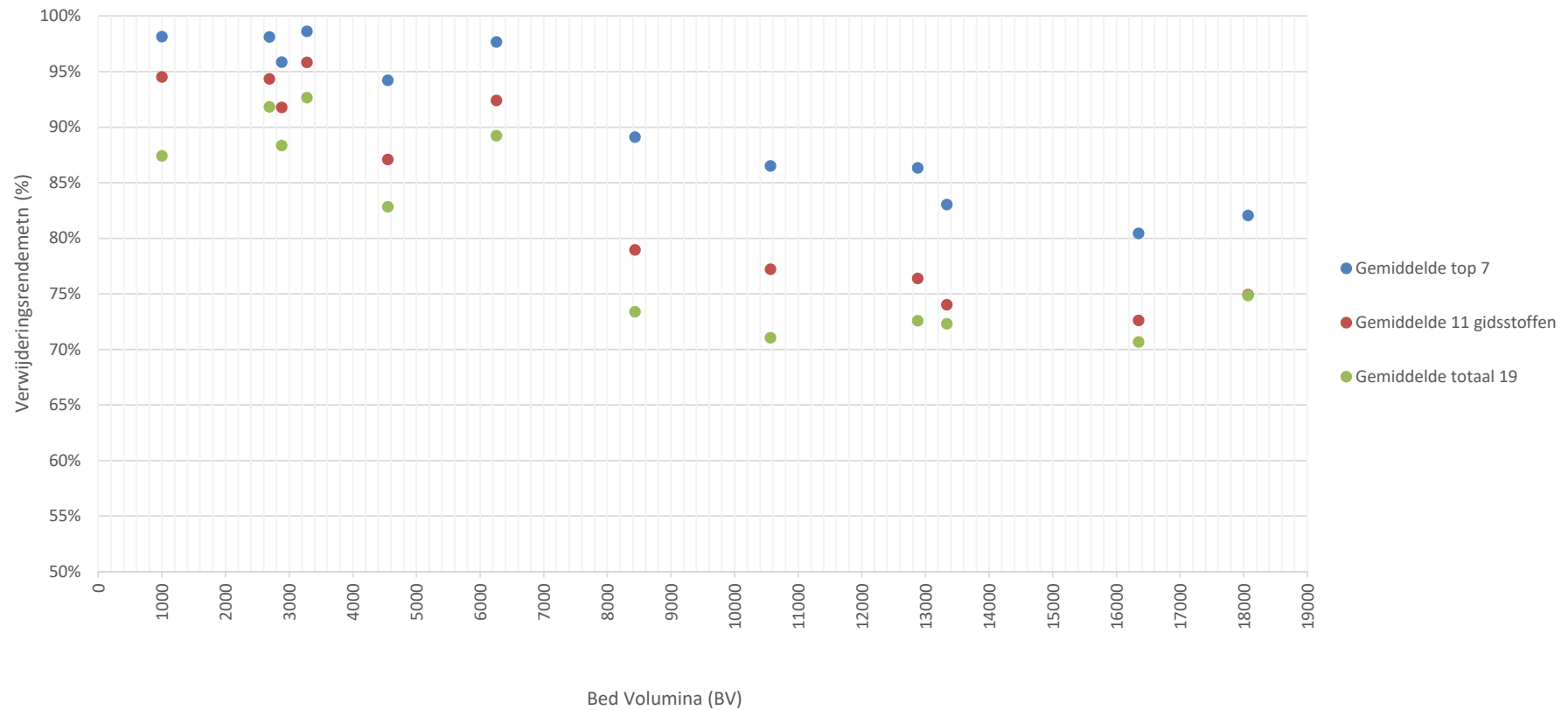


# Process set-up





# Timeline of removal efficiency



# Parallel research Aquafin



## Continuous filtration for micropollutant removal by Biologically Granular Activated Carbon (Bio-GAC)

Innovation in Micropollutant Removal from Municipal Wastewater  
November 8<sup>th</sup> and 9<sup>th</sup> 2023 - Aquatech Amsterdam

### Continuous Sand Filtration

- Moving bed filtration
- Continuous sand circulation and washing
- No filtration interruption

Combined adsorption, filtration and biodegradation  
No downtime for backwashing

### Bio-GAC

### Granular Activated Carbon (GAC)

- Granules
- Adsorption of micropollutants

Promotion of bacterial growth  
No formation of harmful substances  
Time till breakthrough is shorter

### Setup

- Location
  - WWTP of Aartselaar (conventional activated sludge system (CAS) = 54,000 IE (60 gBOD<sub>5</sub>·(IE·d)<sup>-1</sup>)
  - First full scale quaternary treatment (O<sub>3</sub> + GAC) in Flanders (Belgium) - in operation from November/December 2023
- Pilot study
  - Period: June 2022 - December 2023
  - Mean NH<sub>4</sub>-N concentration in CAS effluent of 0.4 ± 0.3 mg·L<sup>-1</sup>
  - Removal of suspended solids by drum sieve and filter bag
  - Oxygen supply (8-10 mg·L<sup>-1</sup>) before Bio-GAC filter
  - Flow = 600 L·h<sup>-1</sup> (or 48 bed volumes·d<sup>-1</sup>)
  - EBCT = 30 min

### Optimizing process design

- Indicators of biological activity
  - Increase in bed resistance over time
  - Increase in oxygen demand

- Controlled media circulation (Sand-Cycle)
- Redesign of airlift and washer assembly

### Next steps

- In-depth study of the microbial community using 16S rRNA gene amplicon sequencing
- Combination with P-removal?
- Other type of GAC?

### Micropollutant removal over time

Removal Efficiency (%) vs Bed volumes

Legend: Average of 7, Average of 11, Average of 19

Number of micropollutants removed

Legend: Drug, Drug Metabolite, Drug, Pesticide, Pesticide Metabolite, Other

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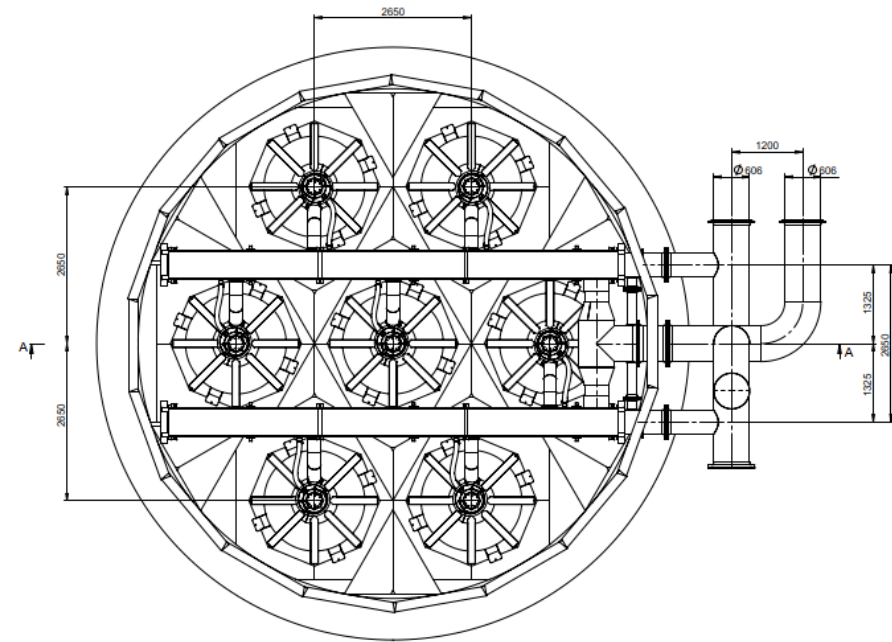
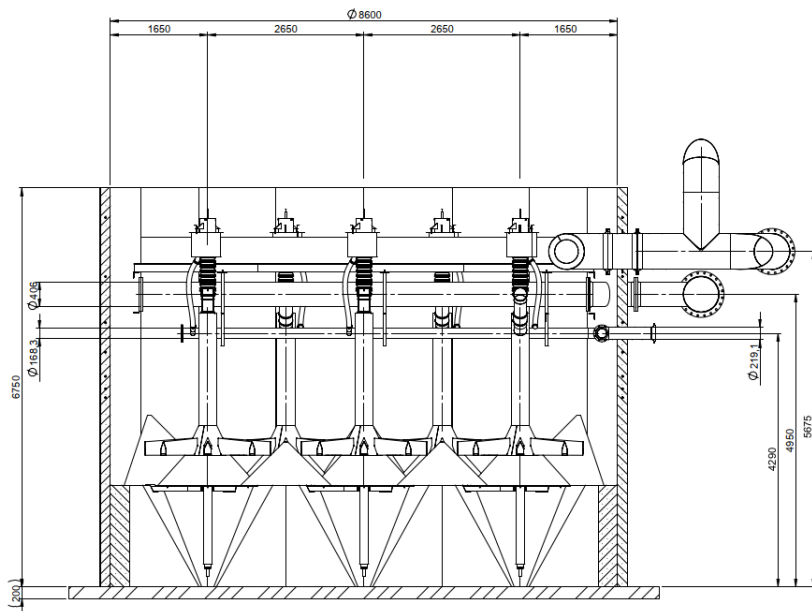
# 100,000 PE plant projection

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<b>Design parameter</b>	<b>Value</b>	
DWF design peak	1,040	m <sup>3</sup> /h
Treated annual volume in tertiary plant	6,130,000	m <sup>3</sup> /year
Gemiddelde debiet	700	m <sup>3</sup> /h
EBCT at DWF design peak	25	minutes
Required bed volume	430	m <sup>3</sup>
Number of filter units	3	
Surface area/unit	55	m <sup>2</sup>
Total installed surface area	165	m <sup>2</sup>
GAC	Norit 8 x 30	0,64 - 2,36 mm

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Overall plant dimensions: 16 x 32 m<sup>2</sup>



# Upgrading existing assets



RWZI Ruurlo, filter plant for P removal (1996)

3 x 20 m<sup>3</sup> filterbed volume

bio-GAK capacity 150 m<sup>3</sup>/h

RWZI Haarlo, filter plant for P removal (2011)

Transfer to RWZI Lichtenvoorde

6 x 12 m<sup>3</sup> filterbed volume

Bio-GAK capacity 250 m<sup>3</sup>/h



# Summary Performances

	UNIT	PACAS	Ozone + Sand Filtration	Bio-GAK
CO <sub>2</sub> -footprint <sup>1</sup>	g CO <sub>2</sub> /m <sup>3</sup>	122	128	109
Costs <sup>1</sup>	€/m <sup>3</sup>	0.05	0.17	0.21
Removal Efficiency Dutch guide substances <sup>2</sup>	%	70-75%	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.

Consequences stricter removal efficiencies Proposal EU Urban Wastewater Treatment Directive (80% in EU instead of 70% in NL and different guide substances):

- PACAS will have a footprint of 160 g CO<sub>2</sub>/m<sup>3</sup> and a cost level of € 0,08/m<sup>3</sup>; no changes for ozone
- **Bio-GAK** will have a footprint of **109 g CO<sub>2</sub>/m<sup>3</sup>** and a cost level of **€ 0.21/m<sup>3</sup>**



**Thank you for your attention!**

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**stowa**

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



*Ministry of Infrastructure  
and Water Management*

**November 8<sup>th</sup> and 9<sup>th</sup>, 2023**  
**Aquatech Amsterdam**