# Innovative technologies for quaternary wastewater treatment

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# News

Council of the EU | Press release | 29 January 2024 16:40

## Urban wastewater: Council and Parliament reach a deal on new rules for more efficient treatment and monitoring

European Commission

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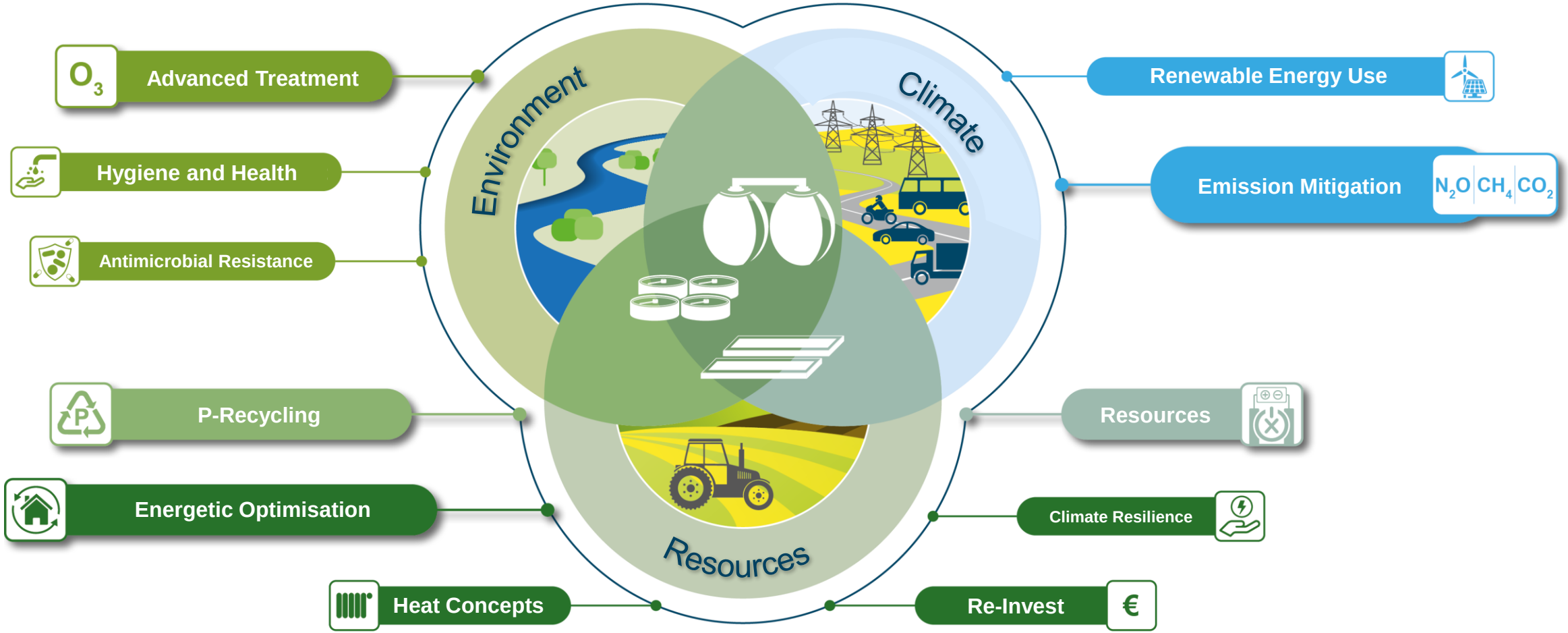
NEWS ARTICLE | 20 December 2024 | Directorate-General for Environment | 3 min read

## New rules for more thorough and cost-effective urban wastewater management enter into force

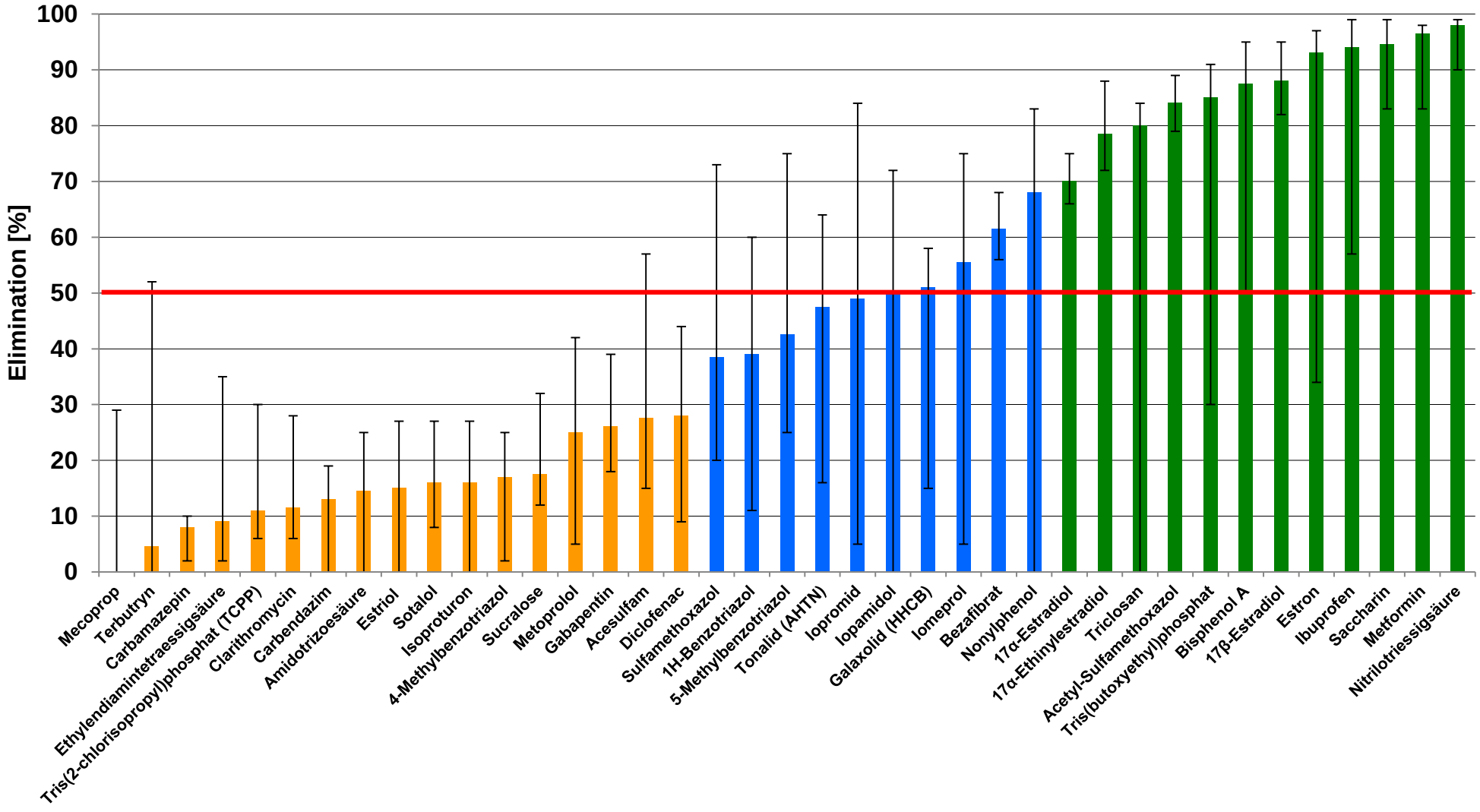

https://www.environet.ie/news/new-urban-wastewater-treatment-directive; joint-research-centre.ec.europa.eu; European Commission

# Fields of action in Wastewater Treatment – e.g. through New UWWT Directive




Source: FiW e.V. (2024)

# Micropollutants and removal conventional Wastewater Treatment




**Source:** Keysers, 2016



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# Quaternary Urban Wastewater Treatment – Micropollutant Removal

## Revised Urban Wastewater Treatment Directive addressing micropollutants:

**2025** → **2033** → ***2039*** → **2045**

| 2025 | 2033 | *2039* | 2045 |
|---|---|---|---|
| Setting up extended producer responsibility schemes | Interim target for facilities above 150k P.E. and at risk (20%) | Interim target for facilities above 150k P.E. and at risk (60%) | All facilities for facilities above 150k P.E. and at risk equipped with advanced treatment |

DIRECTIVE 2024/3019 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning urban wastewater treatment (recast)

*Article 8*

**Quaternary treatment**

1. Member States shall ensure that discharges from urban wastewater treatment plants treating urban wastewater with a load of 150 000 p.e. and above satisfy, before being discharged into receiving waters, the relevant requirements of quaternary treatment set out in Part B and Table 3 of Annex I in accordance with the methods of monitoring and evaluation of results laid down in Part C of Annex I by:

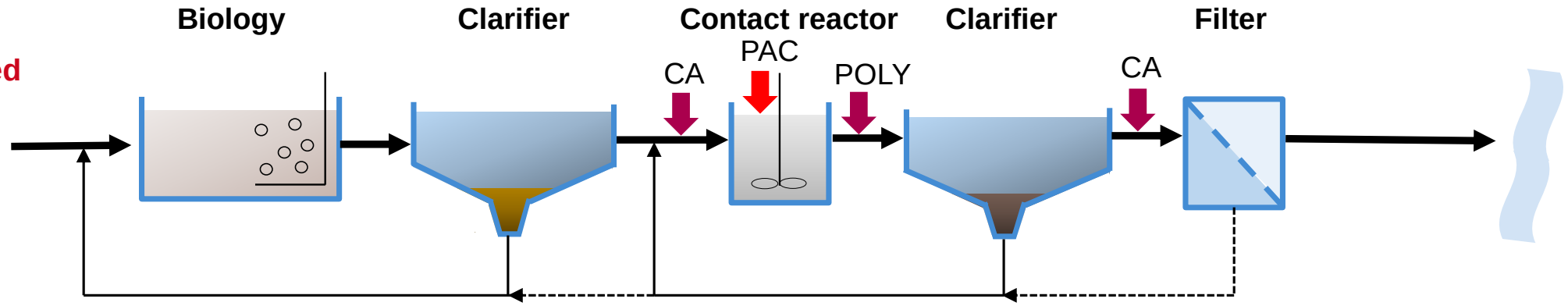
Table 3: Requirements for quaternary treatment of discharges from urban wastewater treatment plants referred to in Article 8(1) and or from urban wastewater treatment plants serving agglomerations referred to in Article 8(4).

| Indicators | Minimum percentage of removal in relation to the load of the influent |
|---|---|
| Substances that can pollute water even at low concentrations (see Note 1) | 80 % (see Note 2) |

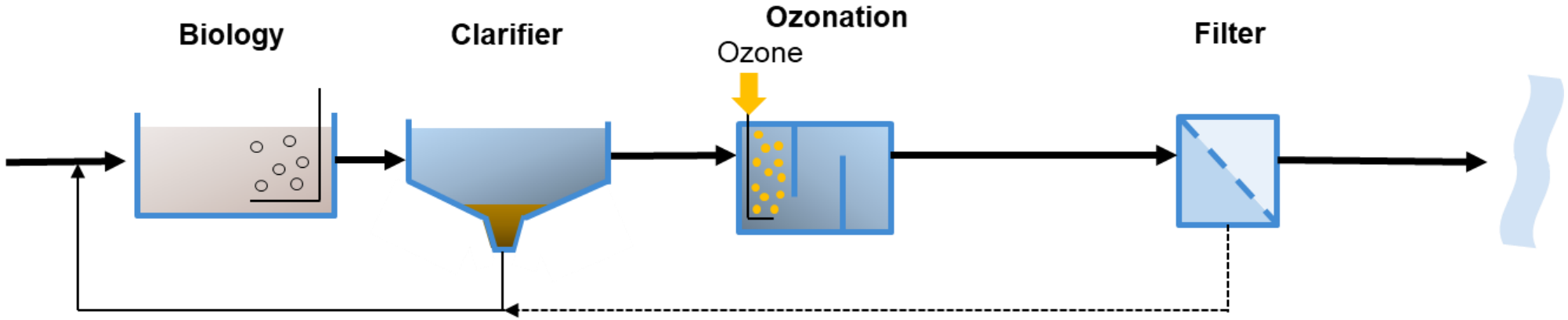
Note 1: The concentration of the organic substances referred to in points (a) and (b) shall be measured.

# Treatment processes for micropollutant processes from wastewater

**Dosing of Powdered activated carbon (PAC) in a treatment stage (Ulm Process)**
CA: Coagulant
POLY: Flocculant




**Ozonation with biologically active post-treatment**

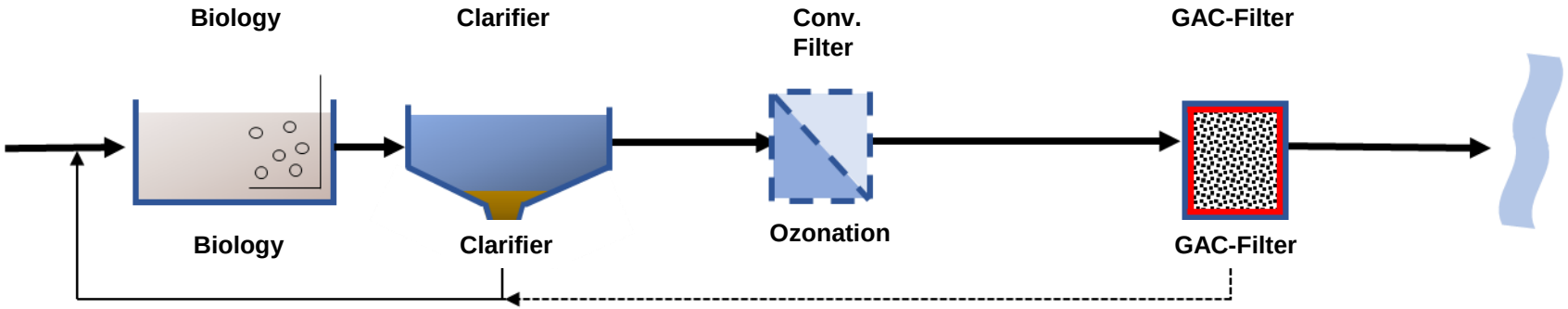



**Adsorption** **Oxidation**

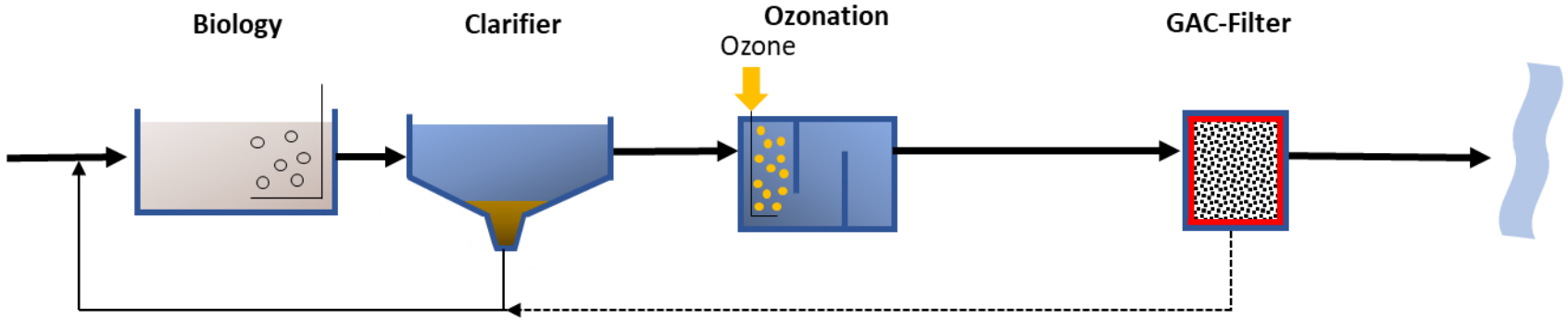
Verfahrensdarstellung gemäß Arbeitsbericht des DWA-Fachausschusses KA-8, KA Korrespondenz Abwasser, Abfall - 2020 (67) - Nr. 10

# Treatment processes for micropollutant processes from wastewater

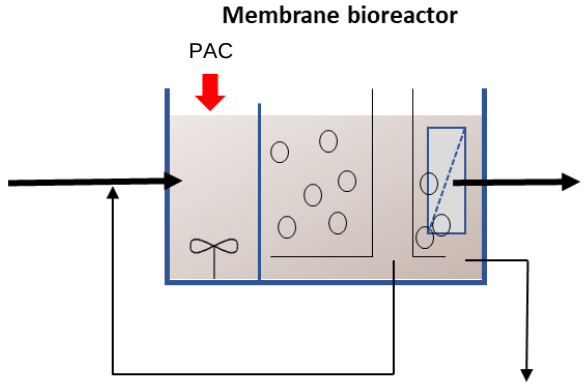
**Granular activated carbon (GAC) as deep bed filter**




**Ozonation with GAC-Filter**




**Simultaneous dosing of Powdered activated carbon (PAC) in a membrane bioreactor**




Adsorption — Oxidation —

Verfahrensdarstellung gemäß Arbeitsbericht des DWA-Fachausschusses KA-8, KA Korrespondenz Abwasser, Abfall - 2020 (67) - Nr. 10



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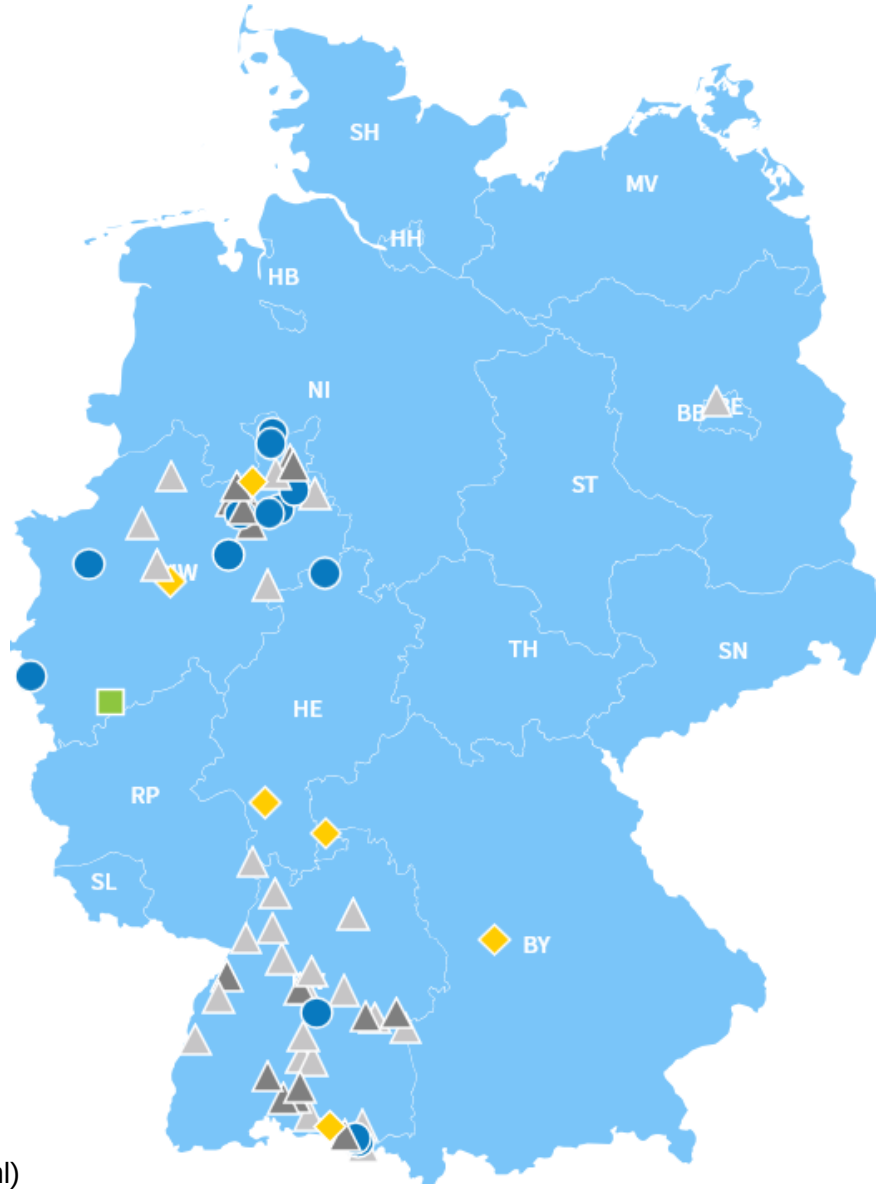
# Municipal Wastewater Treatment Plants with Micropollutant Removal - Germany




**Process in operation**

- Adsorptive – GAC
- Adsorptive – PAC
- Oxidative
- Combination
- Special procedure

Source: DWA e.V. (de.dwa.de/de/landkarte-4-stufe.html)

Effective 04/2025



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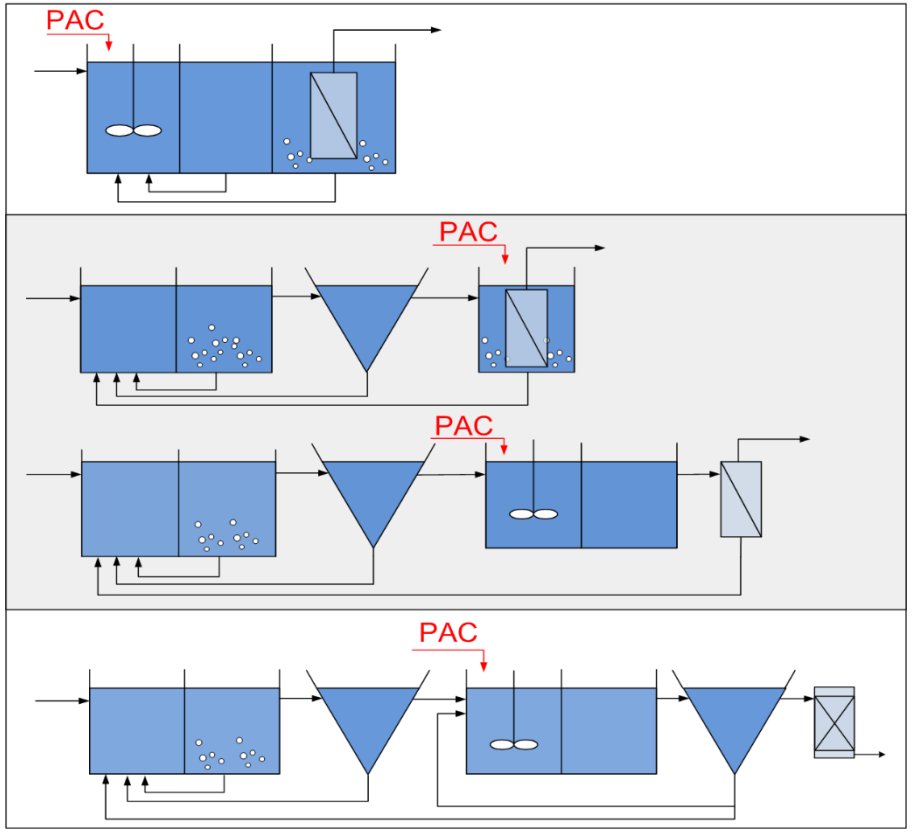
# Micropollutant removal: Process options for powdered activated carbon adsorption

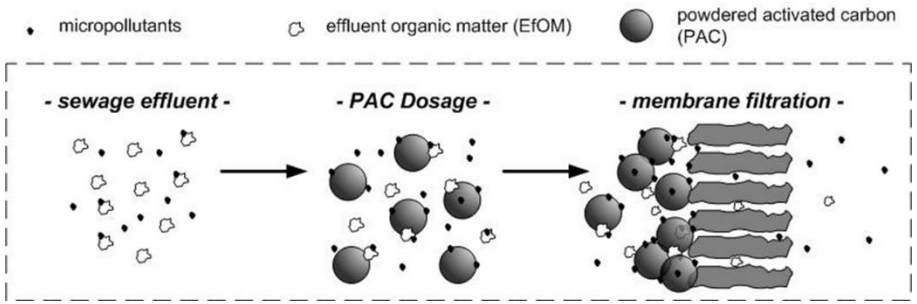
**PAC/MBR**
+ low footprint, simple add-on
– high PAC dosage (comp. ads.)

**Submerged PAC/UF**
+ extended PAC contact time
– sludging

**Pressurized PAC/UF/NF**
+ PAC cake layer
– short contact time

**PAC + Settler + Filtration**
+ PAC recycle, low dosage, simple
– large footprint, PAC retention




Li et al. (2011), Nguyen et al. (2013), Metzger (2009)



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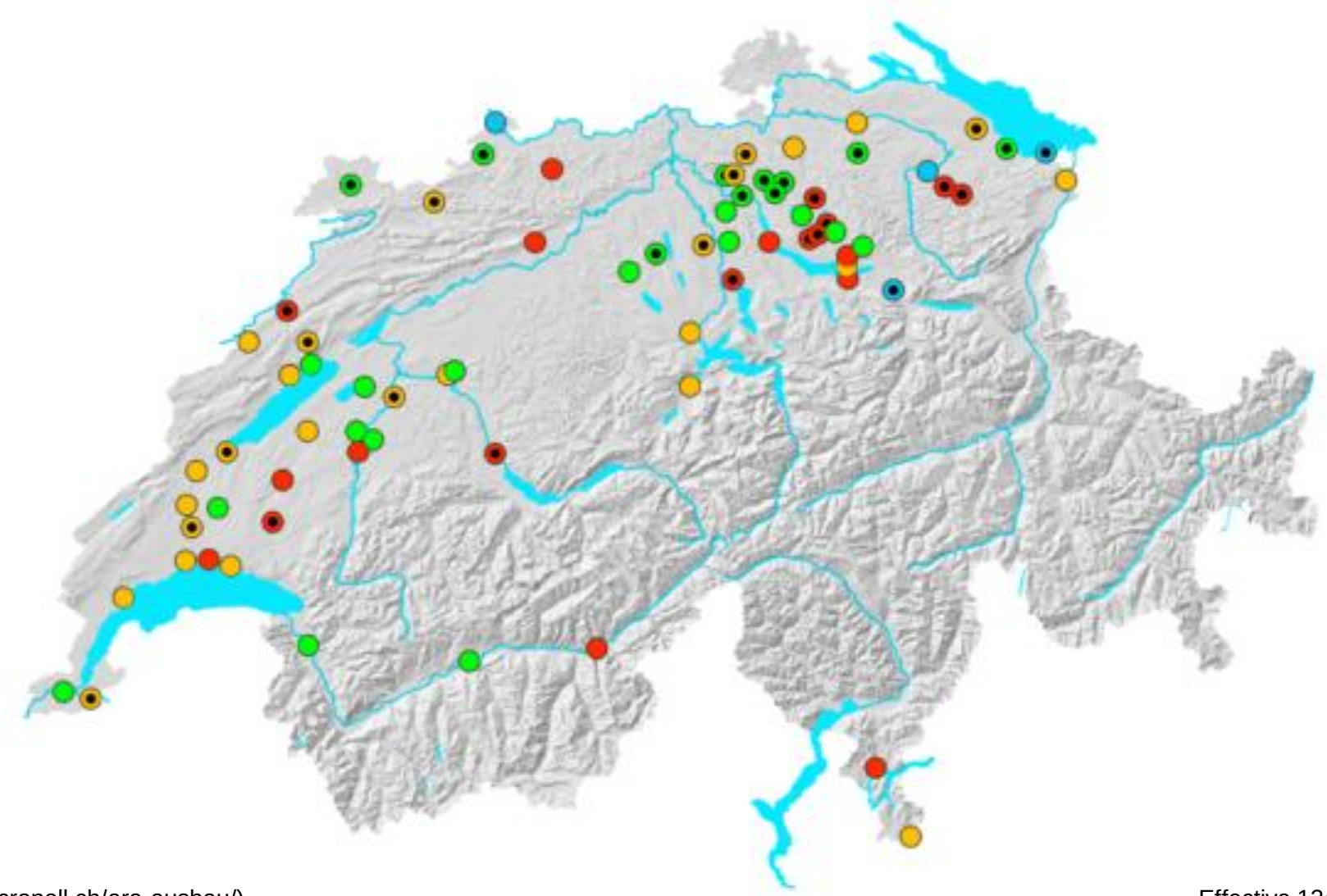
# Wastewater Treatment Plant Aachen Soers (WVER)

# Municipal Wastewater Treatment Plants with Micropollutant Removal - Switzerland

**Process/status**

- Ozone in operation
- Ozone planned/under construction
- PAC in operation
- PAC planned/under construction
- GAC in operation
- GAC planned/under construction
- Combi in operation
- Combi planned/under construction



Source: Federal Office of Topography swisstopo (micropoll.ch/ara-ausbau/)

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# PAC-MBR Projects – Switzerland (Design HBT)

| | Zimmerberg | Falkenstein | Briglina |
|---|---|---|---|
| Capacity | 78’000 PE | 66’500 PE | ca. 80’000 PE |
| $Q_{max}$ | 840 l/s | 540 l/s | 520 l/s |
| Pre-treatment | Drum screen | Primary clarifier+2 mm Fine screen | Primary clarifier+2 mm Fine screen |
| Biology Type / TSS | Conventional, 7.2 g/l | Alternating-intermittent, 7 g/l | Cascade, 6 g/l (N) |
| Membrane filtration concept / TSS / Redundancy | pump from, 12 g/l 8 (7+1) | pump to, 11.2 g/l 6 (5+1) | pump from, 10 g/l 6 (5+1) |
| Organic micropollutant removal | PAC simultaneous | PAC simultaneous | PAC simultaneous |

Source: HUNZIKER BETATECH AG (HBT), Winterthur (CH)



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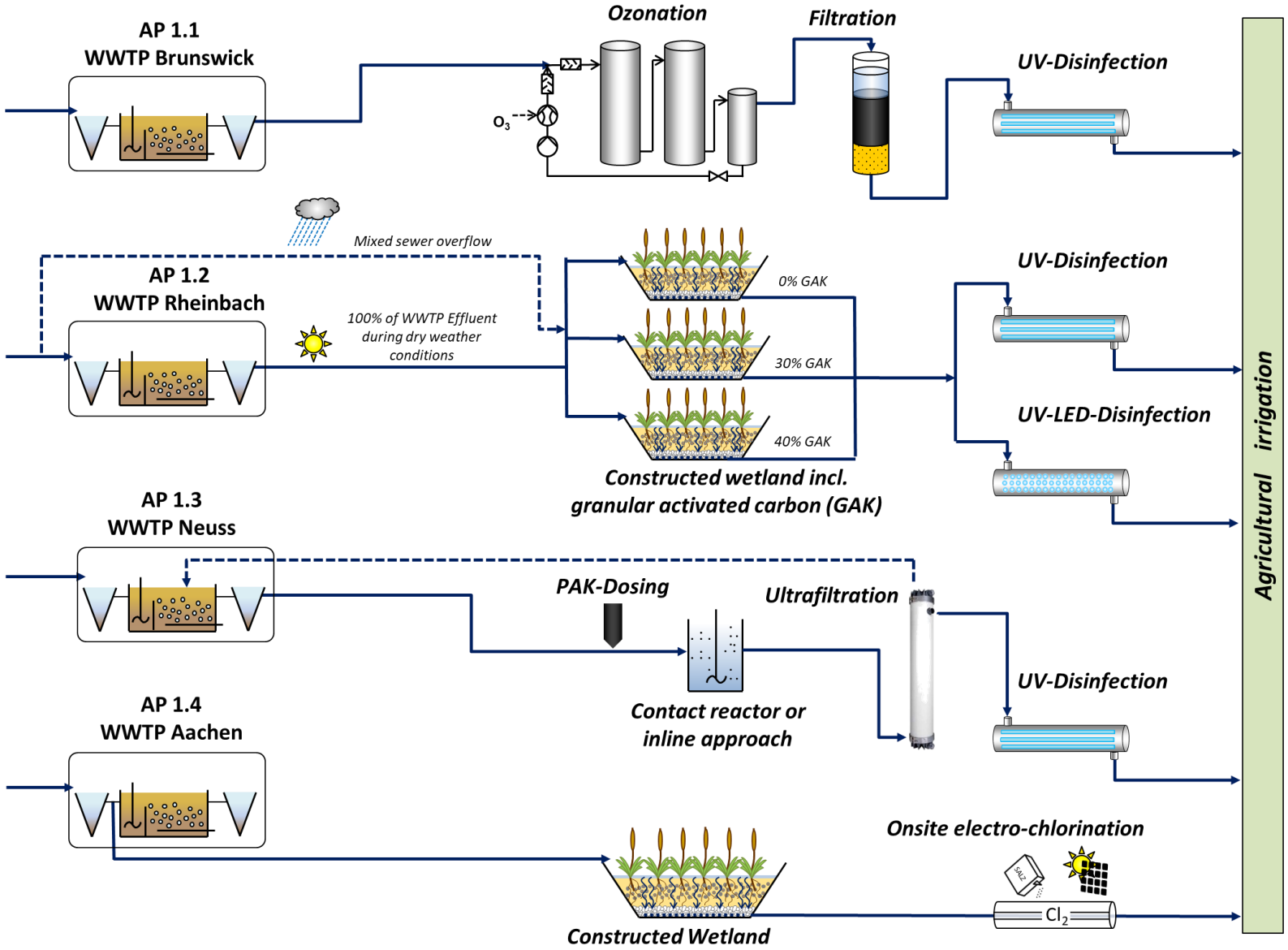
# *Flex*Treat Pilot Plants




FlexTreat

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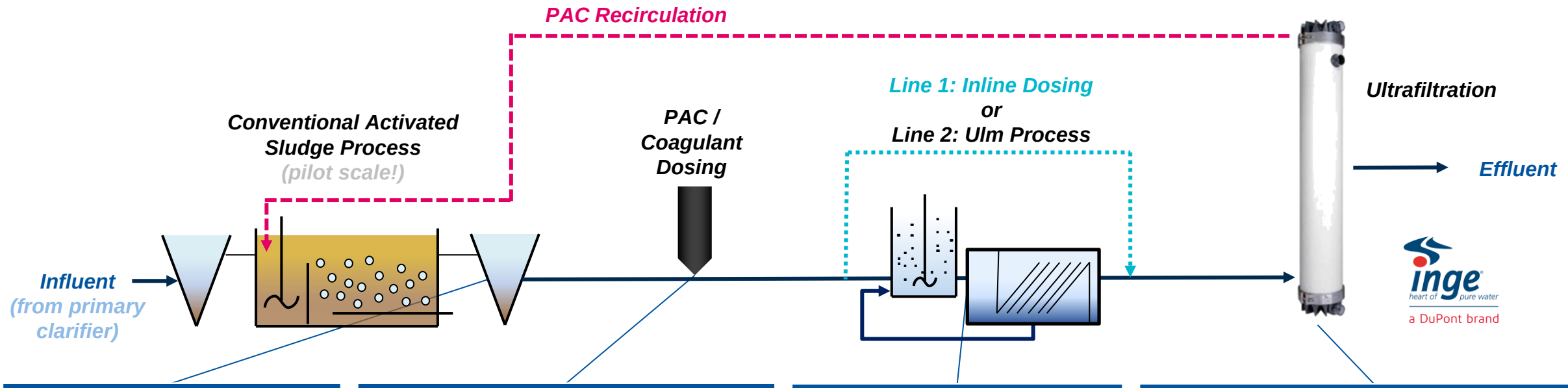
# *Flex*Treat Pilot Plant Neuss



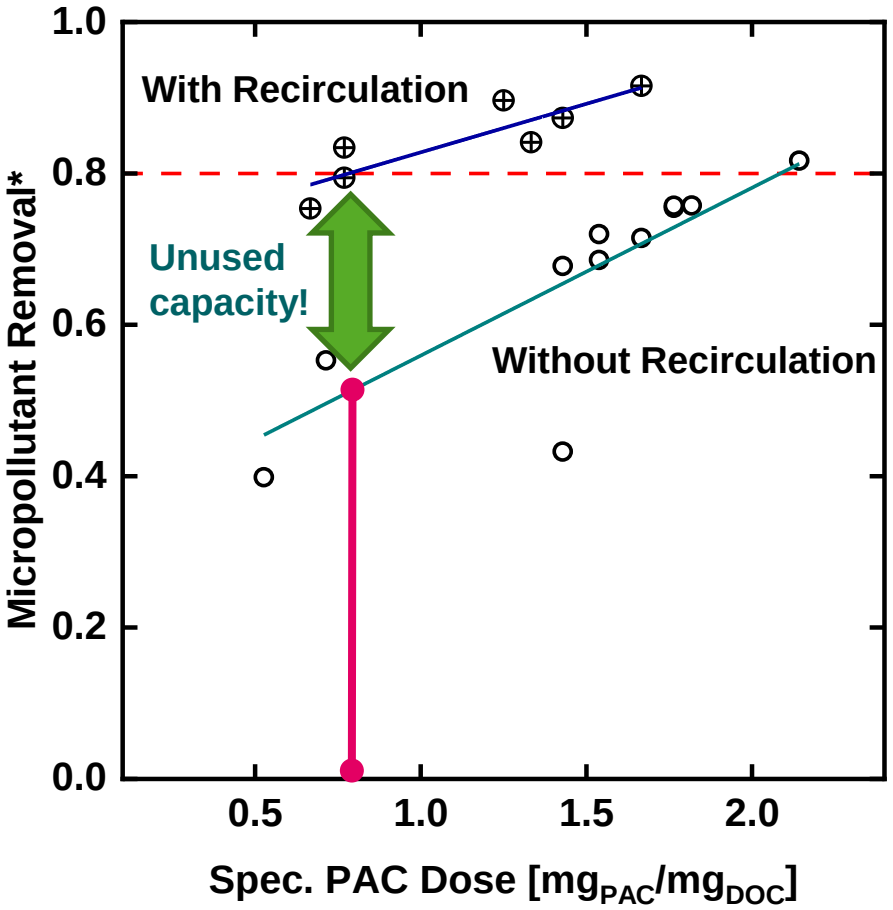

| Waste Water Matrix | | |
|---|---|---|
| TOC | 17 ± 5 | mg / L |
| DOC | 15 ± 2 | mg / L |
| TSS | 10 ± 4 | mg / L |
| $SAC_{254nm}$ | 27,9 ± 1,9 | 1 / m |

| Powdered Activated Carbon and Coagulant | | |
|---|---|---|
| Ulm Process | Chemviron Pulsorb WP 260 | $D_{50}$ = 28 µm |
| Inline Process | Chemviron Pulsorb WP 260-UF | $D_{50}$ = 5 µm |
| PAC Dose | 10 - 20 | mg / L |
| Poly Aluminium Chloride | 2 | mg/L |

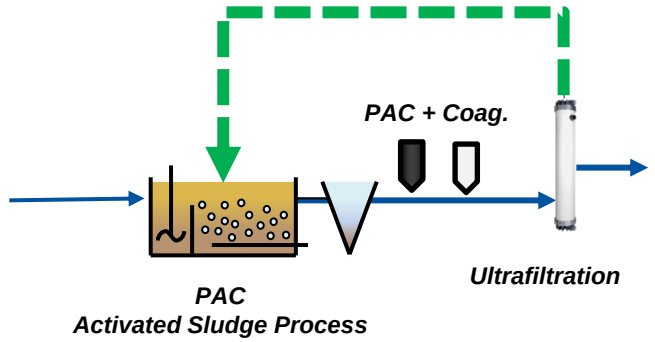
| PAC Process (Contact Times) | | |
|---|---|---|
| Ulm Process | 30…60 | min |
| Inline Dosing | 30…60 | sec |

| Ultrafiltration | | |
|---|---|---|
| Module | hollow fibre | dead-end |
| Material | PESm | |
| Filtration mode | in-out | |
| Capillary Diameter | 0.9 | mm |
| Nominal Pore Size | 20 | nm |
| Membrane Area | 3.2 | m² /module |
| Capacity | 192 | L/h/Line |
| Filtration Cycle | 40 | min |
| Recovery | 92 | % |

# Micropollutant elimination in PAC+UF Inline-Dosing process + PAC recirculation




PAC Recirculation




*Average elimination of micropollutants acc. to KomS-BW, Germany: Carbamazepine, Diclofenac, Hydrochlorothiazide, Irbesartan, Metoprolol, 1H-Benzotriazole, ∑4, 5-Methyl-Benzotriazole

Zimmermann et al. in preparation



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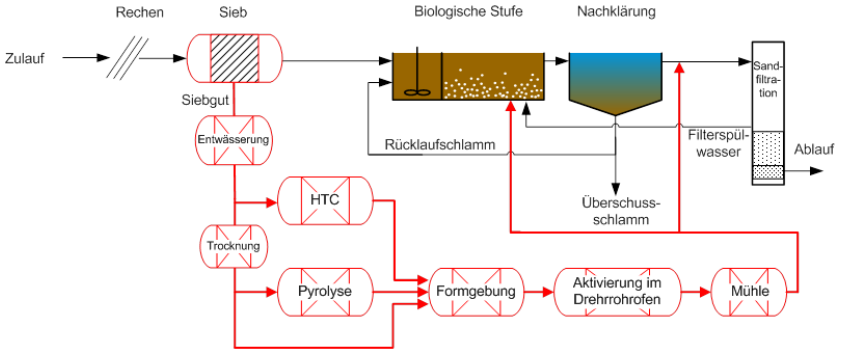
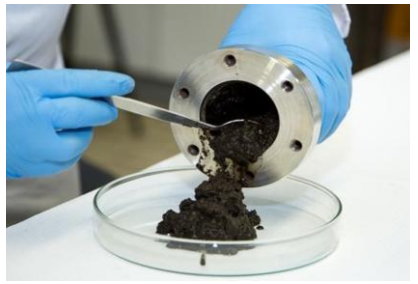
# Resource saving and integrated activated carbon production

- **Aims:**
  - Production of activated carbon from organic materials, which are extracted from the raw wastewater by screening
  - Application and evaluation of the new activated carbon for the elimination of micropollutants in wastewater treatment plants
- **Methods:**
  - Development of production chains for innovative activated carbon production on a semi-technical and technical scale
  - Characterization and evaluation of the produced activated carbons using indicators and adsorption tests in the laboratory
  - Determination of the ecological footprint of the new activated carbons
- **Funding:** BMBF (2019-2024)
- **Contact:** Peter Schleiffer, M. Sc.
- **Web:** https://projekt-rias.de/



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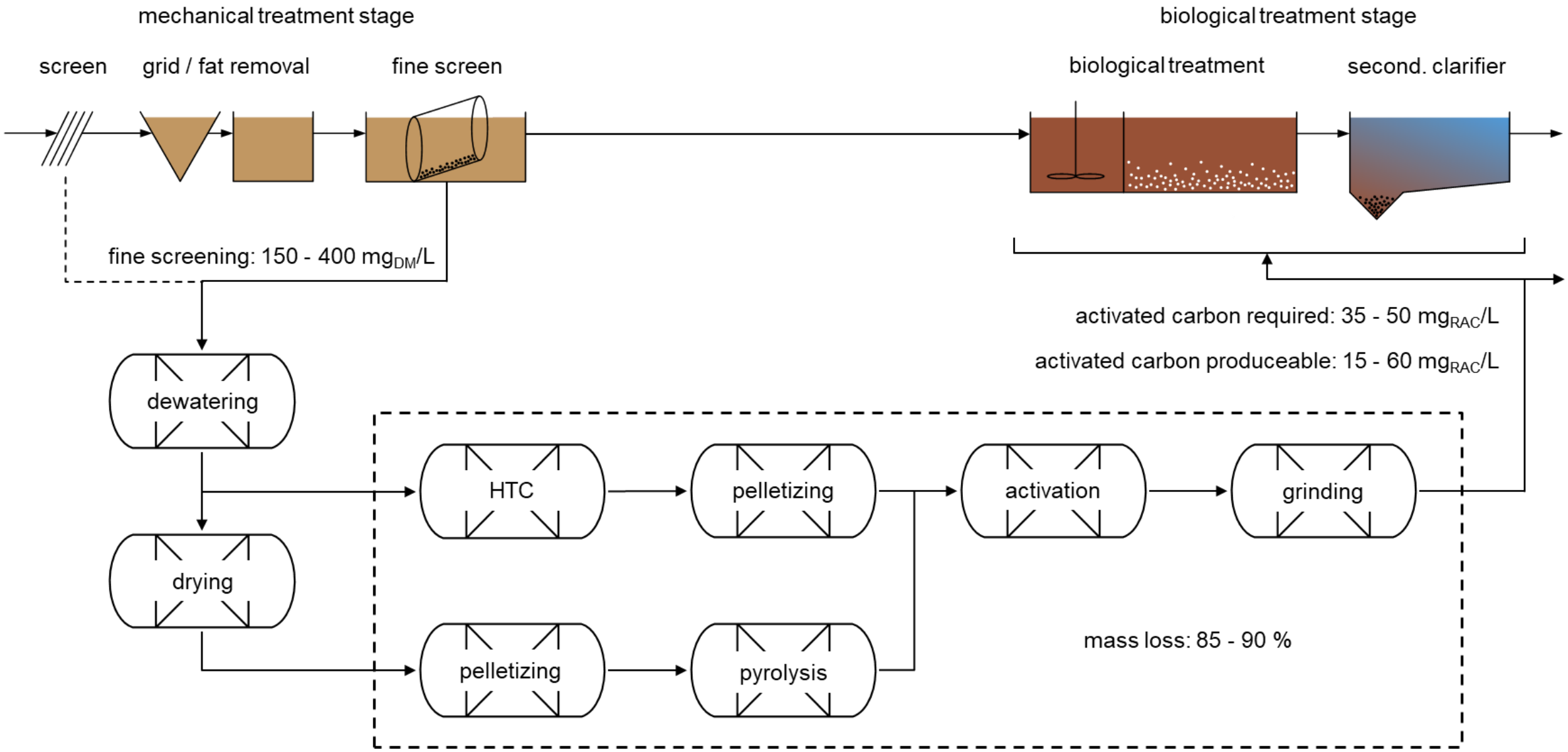
# Production process activated carbon from screenings @ WWTP



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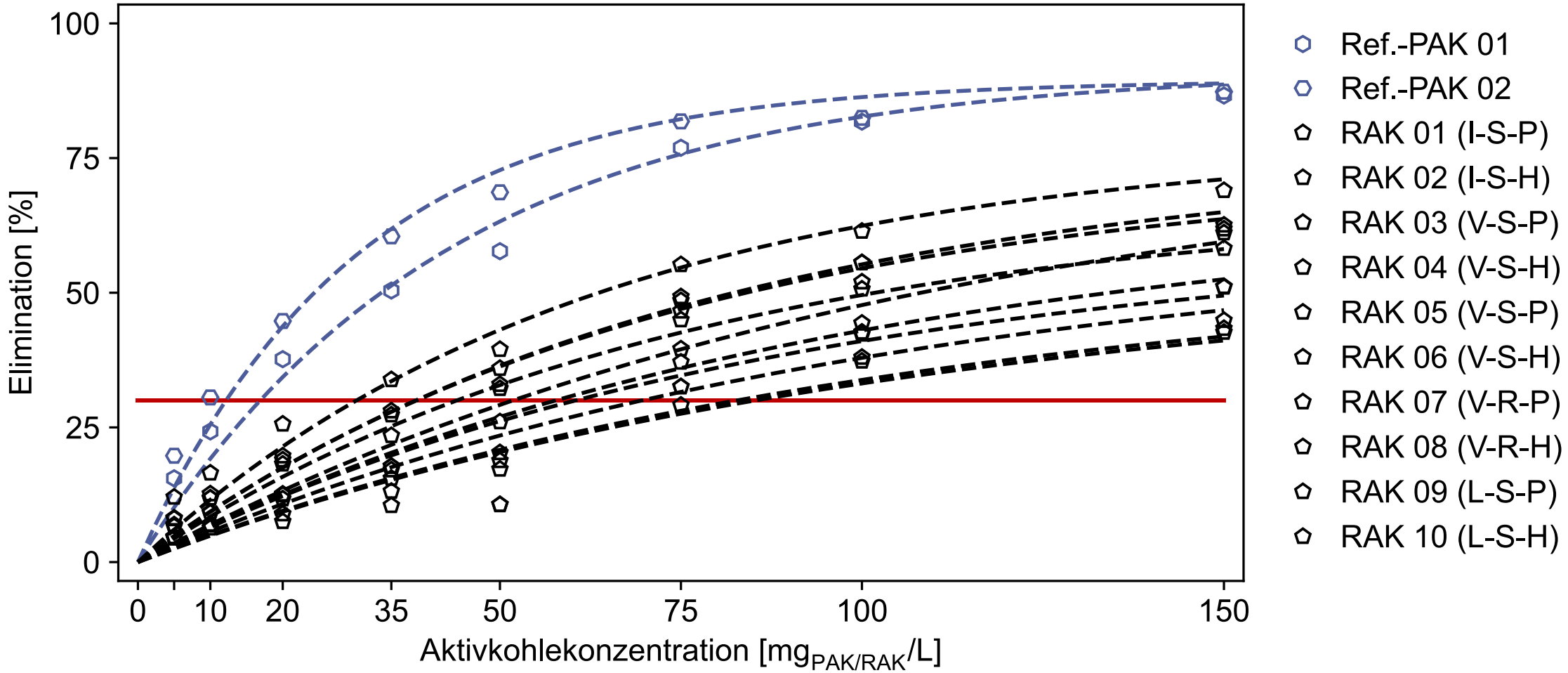
# Some impressions from RIAS


# Phase I Results: Reduction of indicator $SAC_{254}$



**Thank you very much for your attention!**

**Contributions from many partners and collaborators as well as funding agencies are kindly acknowledged!**