Hybrid systems based on ultrafiltration membranes and powdered activated carbon for advanced waste water treatment

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Open-Minded

Abstract

Objective: reducing emission of micropollutants (MPs) into the aquatic environment

Approach: hybride ultrafiltration and powdered activated carbon dosage (PAC-UF) for advanced tertiary treatment in waste water treatment plants (WWTP)

Labscale investigations (Hoffmann et al., 2018) already revealed the influence of PAC characteristics and limiting parameters to control PAC dosage

Pilot study shows furtherly that upscaling of the hybrid process is quite challenging

Pilot study overview

Technical scale WWTP (1000 PE) → Secondary Effluent → PAC addition (15 mg/L) Single pulse (first 6 min) + Coagulation: Continuous (30 min) or „Pre-coating“ (6 min) Polyaluminium chloride: 4 mg Al/L → Short system contact time (~ 0.5 min) → 80 m² „IN/OUT“ UF Unit (PES) inge GmbH

- 40-60 L·m^{-2}·h^{-1} Flux
- 55 s backflush at 230 L·m^{-2}·h^{-1}
- 30 min filtration
- PAC dosage control by online UV_{254} probe

Objectives are investigation of…

- **Influence of coagulation on the adsorption process**
- **Influence of PAC suspension concentration** (0.2 – 20 g/L)

Key to diagrams

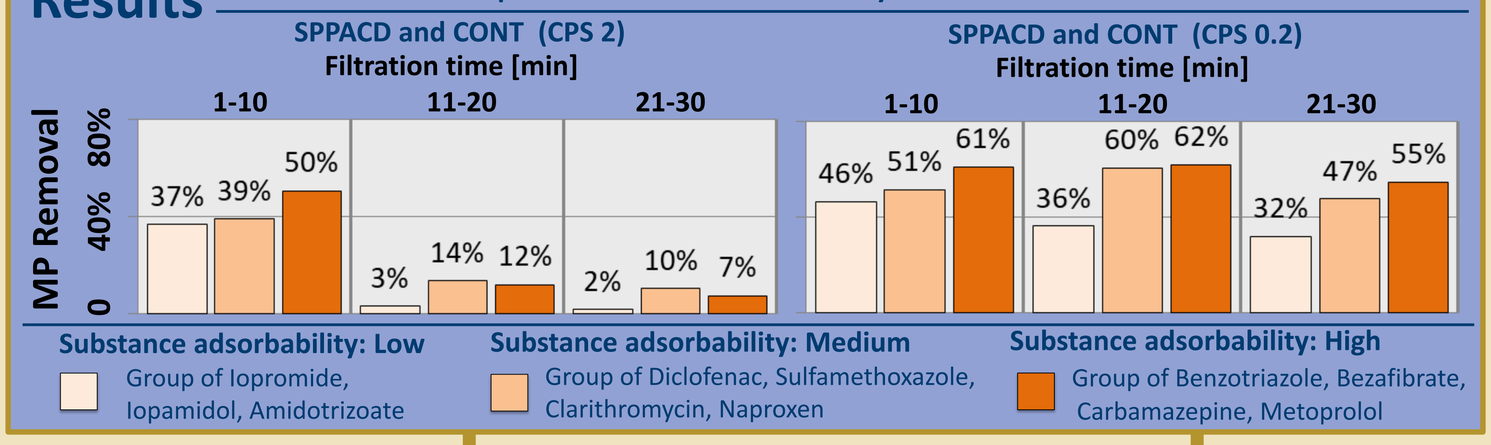
CONT – Continuous coagulation (30 min)
PREC – Precoating – coagulation (6 min)
SPPACD – Single pulse PAC dosage (6 min)
(CPS XX) – Concentration of PAC suspension XX g/L

Average removal UV_{254} in m^{-1}
Average removal DOC in mg/L
Average removal COD in mg/L

MP removal – Collecting sample of one filtration cycle
Substance adsorbability: Low Medium High

Results

Micropollutant removal - filtration cycle divided into 3 time intervals



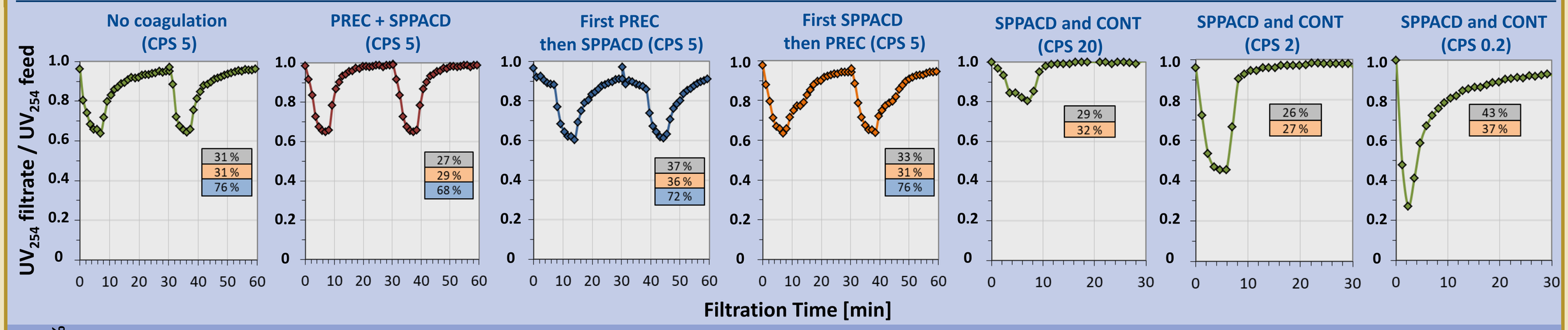
Substance adsorbability: Low — Group of Iopromide, Iopamidol, Amidotrizoate

Substance adsorbability: Medium — Group of Diclofenac, Sulfamethoxazole, Clarithromycin, Naproxen

Substance adsorbability: High — Group of Benzotriazole, Bezafibrate, Carbamazepine, Metoprolol

Results

UV_{254} breakthrough (upper part) and respective average MP removal per cycle (lower part)



Influence of coagulation on the adsorption process

Removal of micropollutants by PAC only (no coagulation) resulted in 35%, 51% and 59% removal for low, medium and high adsorbable substances, respectively.

Coagulation is influencing significantly the micropollutant removal in the case of simultaneous addition of coagulant and PAC.

Higher micropollutant removal can be achieved when a so-called „Pre-coating“ (discontinuous coagulation) is applied together with either a previous or a subsequent PAC addition.

„Pre-coating“ process was stable and resulted in a slightly higher transmembrane pressure and a limited higher energy demand; however, remarkable saving of coagulant chemicals is achieved.

Removal of UV_{254}, DOC and COD differed slightly upon comparing the processes data.

Influence of PAC suspension concentration

Formation of PAC agglomerates at high concentrated PAC suspensions was found to be a highly influencing parameter in both lab-scale and pilot-scale experiments.

Substantial differences in the micropollutant removal were observed at the investigated high, medium and low PAC suspension concentrations (20 g/L – 2 g/L – 0.2 g/L).

The highest removal of micropollutants, UV_{254} and DOC was observed at low agglomerated PAC suspension.

Accumulation of PAC agglomerates at the modules dead-end due to the high flow velocity in the capillaries might be the reason for the negative impact on the adsorption process, therefore low concentrated PAC suspensions are strongly recommended.

References

Hoffmann, G.; Panglisch S. (2018) Generating synergy effects in hybrid processes by the example of interconnecting membrane filtration and powdered activated carbon dosage. F&S Global Guide 2018-2020, page 204-210

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