# PAC-UF treatment for micropollutant removal in municipal wastewater treatment

**G. Hoffmann*, A. Boekels**, D. Antakyali**, R. L. Lange***, S. Panglisch***

* University Duisburg-Essen, Chair for Mechanical Process Engineering / Water Technology, Lotharstr. 1, 47057 Duisburg, Germany
** Sweco GmbH, Graeffstr. 5, 5032 Cologne, Germany
*** Emschergenossenschaft, Kronprinzenstr. 24, 45128 Essen, Germany

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## Introduction

A measure to prevent the emission of micropollutants (MP) into the aquatic environment is to upgrade municipal wastewater treatment plants (WWTP) with additional MP removal processes (Joss et al., 2008). The extended abstract presents actual results of an ongoing research project[1], investigating the combination of ultrafiltration (UF) and adsorption by powdered activated carbon (PAC) acting as a tertiary treatment step of a WWTP. The focus of this research is placed on MPs removal as well as the synergistic performances in advanced phosphorus and COD removal. Process optimization is based on previous results from lab scale investigations (Hoffmann et al. 2014) and their implementation in pilot scale.

## Material and Methods

A series of lab-scale batch-tests were conducted for the selection of the most efficient PAC. 15 PACs have been selected and their performance in removal of both MPs and dissolved organic matter from WWTP effluent has been evaluated. Pulsorb WP260 UF (Chemviron Carbon) was chosen for pilot tests due to its excellent performance. The pilot plant, PURON®MP hollow fiber UF system (Koch Membrane System, Inc., Massachusetts, US) was installed as tertiary treatment step at a technical scale WWTP in Dinslaken (Germany). Flocculation is conducted with the dosage of poly aluminium chloride (PACl) in a concentration of 4 mg Al/L.

## Results and Discussion

As a reference pilot study were started only with coagulation and UF and was focussed on both optimization of process parameters and advanced removal of phosphorus (P), COD, and dissolved organic substances, measured as $UV_{254}$. A recovery rate of 96-97% was achieved by applying a filtration cycle of 40 min and a flux of 80 LMH. An air assisted backflush (backflush flux = 1.5 times filtration flux, duration 30 sec) as well as an air assisted fast flush (duration 30 sec) after each filtration cycle were found to be best performing. Further on average removal of 41±5, 85±8 and 25±4 % for COD, P, and $UV_{254}$ respectively, were attained (average feed values: COD = 35 mg/L, P = 0.3 mg/L and $UV_{254}$ = 19 1/m). Afterwards 15 mg/L PAC was added to the system during the highest flux phase of 80 LMH, resulting in an increase of COD and $UV_{254}$ removal to 64±6 and 49±14 % (average feed values: COD = 37 mg/L and $UV_{254}$ = 15 l/m). As expected, P removal showed no significant difference (91±4%). Further on removal of MP was evaluated and compared to batch experiments (see Figure 1). Although the carbon layer on the

[1] Funded by the Ministry for Climate Protection, Environment, Agriculture, Conservation and

membrane provides a very short adsorption contact time MPs removal is close to that of batch tests and possible up to 95 %.

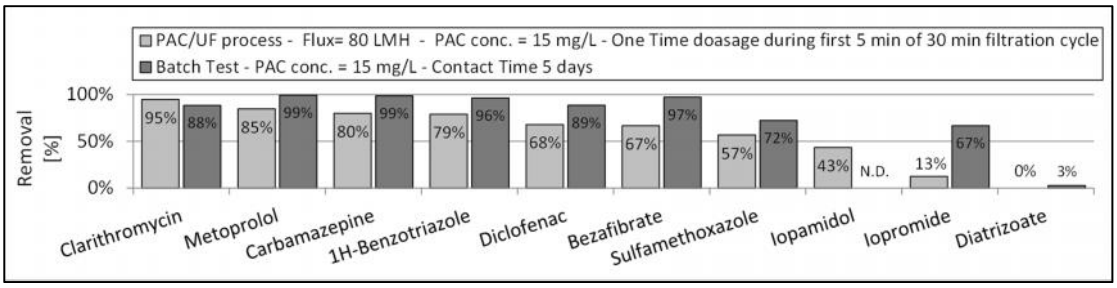


**Figure 1.** Removal of selected micropollutants for 15 mg/L Pulsorb WP 260 UF – Comparison of batch tests (5 days contact time) and PAC/UF process (one time dosage of carbon; 30 min filtration)

But the process has further potential to be optimized. By means of a transparent housing it could be identified that carbon agglomeration occurred during carbon addition leading to inhomogeneous carbon distribution on the membrane. However, negative effects on the process due to both inhomogeneous layer and reduced adsorption kinetics of carbon agglomerates has already been shown in laboratory tests (Hoffmann et al. 2014). Currently the pilot study thus focuses on the prevention of PAC agglomerates. First, increment of the carbon addition time has been investigated from 5 to 15 and then to 25 min (last step will be 40 min, representing a continuous carbon dosage). Optimization is initially evaluated by simple online measurement of $UV_{254}$ using an online multiparameter probe (s::can spectro::lyser). Figure 2 illustrates the removal of selected MPs: $UV_{254}$ removal could be enhanced by increasing the carbon addition time from 5 to 15 min. An increase up to 25 min addition time showed however no further positive effect.

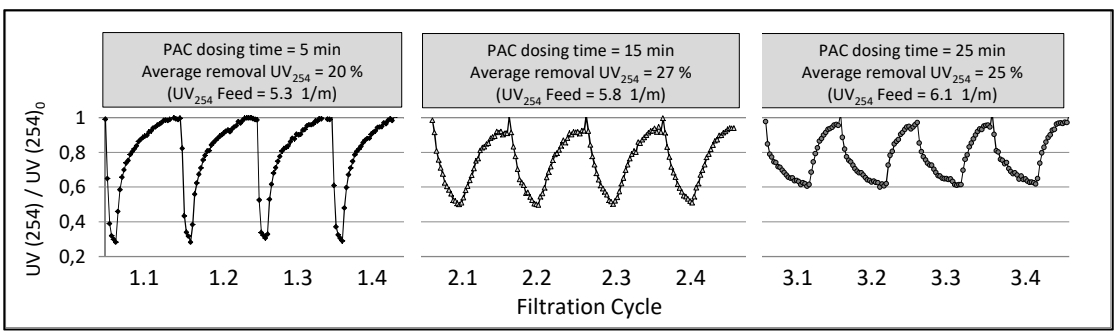


**Figure 2.** Breakthrough of $UV_{254}$ in PAC/UF process for 15 mg/L Pulsorb WP 260 UF – Comparison of different carbon addition times (Flux= 50 LMH; 40 min filtration time)

## Conclusions

The use of the process combination of UF, coagulation and PAC dosage as tertiary treatment step is auspicious. Several treatment objectives can be achieved at the same time: Sanitation and COD, P and MP removal. Further on the combination provides additional options as the use of super fine PAC or single pulse dosage. However, in order to elevate its economic feasibility further process optimizations are required.

## References

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