Case Study
BIO-CEL® Activated Carbon Process

MANN+HUMMEL

Case Study: Municipal BIO-CEL® Activated Carbon Process

Examination of the performance of BIO-CEL® in combination with activated carbon for removal of micropollutants, microplastics, and bacteria.

PROBLEM
Presence of micropollutants, microplastics, and bacteria in wastewater

SITE
Test wastewater treatment plant in Hünxe, Germany

OUTCOME
Demonstrated removal of bacterial and microplastics in wastewater

OBJECTIVE

Micropollutants such as antibiotics, X-ray contrast media, hormones, pesticides, and microplastics occur in wastewater in the nano- to microgram range. Antibiotic-resistant bacteria and genescan arise in the environment when bacteria meet antibiotics and form mutations that are hazardous for human beings. Conventional wastewater treatment plants cannot remove micropollutants sufficiently and thus contribute to their widespread distribution when discharging to receiving waters. Therefore, wastewater treatments can be considered hot spots and a further treatment step is required.

The use of activated carbon to adsorb micro pollutants, and a membrane to provide a physical barrier, prevents microplastics and bacteria from passing into the product water. This hybrid process combines the advantages of two established processes and provides an answer to demanding effluent requirements.

MATERIALS & METHODS

Partnering with *Emschergenossenschaft-Lippeverband (EGLV)*, a test plant was set up at the WWTP in Hünxe, Germany. The hybrid technology was examined ibetween 2016 and 2018 as a research project. As detailed in Figure 1, the reactor with the submerged BIO-CEL Activated Carbon process is configured as an additional purification step treating the effluent of the clarifier.

The micropollutants are absorbed to the activated carbon, which is continuously

dosed at 10 mg/L with the influent. At the same time, the loaded activated carbon and the multi-resistant bacteria were separated from the treated wastewater by an ultrafiltration membrane. Activated carbon with a nominal grain size of 15 µm was used. For control of total solids, a fraction of the activated carbon was discontinuously discharged and can be either directly pumped to sludge treatment or pumped back to the nitrification stage.

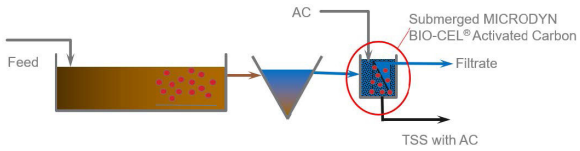

Figure 1 Schematic representation of the BIO-CEL® Activated Carbon process

RESULTS

Membrane Process Performance

The net flux of the test plant was increased step-by-step to a net flux of 31 L/m2/h without significant decrease in permeability as illustrated in Figure 2. For further cost reduction, the air flow was reduced to 25 % of the recommended default air flow rate. As a result, the energy consumption for this hybrid process was reduced up to 25 Wh/m3 (produced permeate).

It was further noticed that the backwashing of the membrane and the attainable total solids (TS) had a significant effect on the overall process performance. A better cleaning of the membrane surface was observed at higher TS.

Another test plant using the same process combination used a mixer in addition to aeration, which provided an additional option for cost reduction.

Micropollutants and Germs Removal

For the monitoring of micropollutants, the spectral absorption coefficient at 254 nm (SAK254) was determined for six micropollutants. This is a sum parameter used for representation of micropollutants removal. With an elimination rate of ≥ 20 %the results are comparable to other processes used for micropollutant removal. E. coli and total coliforms serve as common indicator organisms and were additionally monitored over the test period.

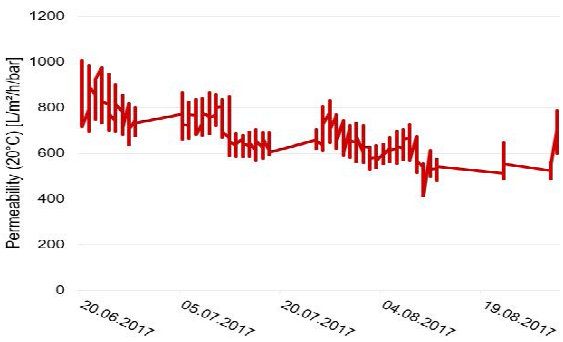

Figure 2 Temperature standardized permeability at a net flux of 31 LMH during the second trial period

Conclusion

The combination of an ultrafiltration membrane and activated carbon is an improvement compared to other fourth treatment stage processes because it provides the same removal efficiency but also removes bacteria and microplastics, and it prevents any slippage of activated carbon or production of hazardous by-products.

An initial cost estimate for a plant with 300,000 population equivalents shows that this hybrid process is economically competitive with other fourth treatment stage processes. Total costs are estimated at 0.08 €/m3 treated wastewater per year. This shows considerable cost savings compared to the 0.1 to 0.25 €/m³ expected costs for fourth treatment stage processes (DWA-T3/2015 "Möglichkeiten der Elimination von anthropogenen Spurenstoffe").

Top view into reactor of test plant

Results & Conclusions Based on Measured Parameters

Indicator	Elimination Rate
SAK_{254}	> 20 %
E.coli	100 %
Total Coliforms	100 %

Table 1 Elimination rates

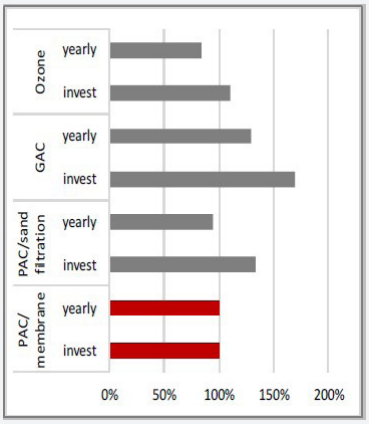

Figure 3 Comparison of the percentage cost

0220 © MANN+HUMMEL GmbH