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Removal of Organic Micropollutants from Wastewater by Ozone Activated Carbon Filtration and Porous Cyclodextrin Polymers Adsorption: A Laboratory Batch Study

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Introduction

Organic micropollutants (OMPs) are present in all compartments of the water cycle. A specific case is the presence of pharmaceuticals in wastewater. Removal of pharmaceuticals by traditional wastewater treatment plants is limited, which necessitates the application of advanced treatment processes. A new adsorption process concerns the use of porous cyclodextrin polymers (P-CDPs) as an alternative for activated carbon. Insoluble polymers of β-cyclodextrin, an inexpensive, biobased macrocycle of glucose, are of interest for removing micropollutants from water by means of adsorption. This study explored the use of a mixture of positively and negatively charged P-CDPs for the removal of pharmaceuticals from real wastewater, and compared the results with the removal by activated carbon filtration and ozone-activated carbon filtration as mature processes.

Methodology

Treated effluent from the secondary clarifier of the wastewater treatment plant Horstermeer was spiked with a mixture of 14 OMPs (6 positively, 2 negatively, 6 neutrally charged) at individual compound concentrations ranging between 0.29 and 47 µg/l. P-CDP batch adsorption experiments were performed with a 50%/50% mixture of a positively and negative charged P-CDP obtained from CycloPure USA (Dexsorb) at dosages of 0.5-2-5-10-30-50 mg/l at 72 h contact time. Experiments were performed in demi water and in Horstermeer wastewater effluent.

In the ozone-activated carbon experiments the Horstermeer wastewater effluent was first ozonated at ozone dosages 0.2-0.4-0.8-1.4 gO₃/gDOC, followed by batch experiments with pulverized GAC (Cabot GAC 612WB) at carbon dosages 0.5-2-5-10-30-50 mg/l. As a reference same experiments with GAC were carried out without pre-ozonation. All GAC adsorption experiments applied 48 h contact time.

Results & Discussion

Ozone-activated carbon experiment

The removal of the target compounds with pulverized GAC is shown in Figure 1. Combining GAC with O₃ increased the removal efficiency.

P-CDP adsorption experiments

Figure 2 shows the removal efficiencies in demi water and Horstermeer wastewater effluent.

Conclusions and further perspectives

In Horstermeer wastewater effluent, pulverized GAC and O₃-GAC outperformed P-CDP, especially for neutrally charged OMPs. However, P-CDP may be attractive for its fast kinetics and easy, on-site regeneration with methanol. In contrast to the energy intensive and degradative regeneration processes of GACs, P-CDPs are easily regenerated by rinsing with methanol at room temperature. Research into more effective P-CDPs continues.