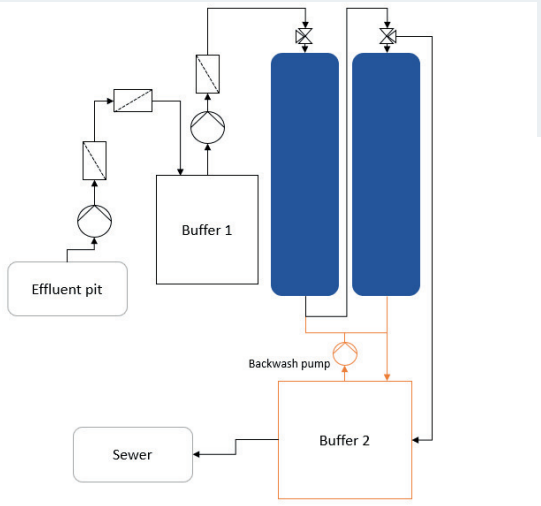
DEXfilter

for removing micropollutants and PFAS from municipal wastewater

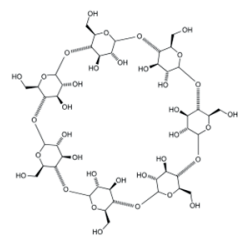
DEXSORB by cyclopure

- DEXSORB is a biobased adsorbent made from cyclodextrin, utilized in the DEXfilter.
- DEXSORB is based on hydrophobic interactions and exhibits selectivity towards small molecules (150 - 1000 Da).
- Saturated DEXSORB can be regenerated with ethanol at room temperature reducing regeneration energy usage and concentrating waste streams.
- The main goal of the pilot was to evaluate the functionality of the DEXfilter with Dutch wastewater while examining the removal efficiency and water quality concerning micropollutants and PFAS.

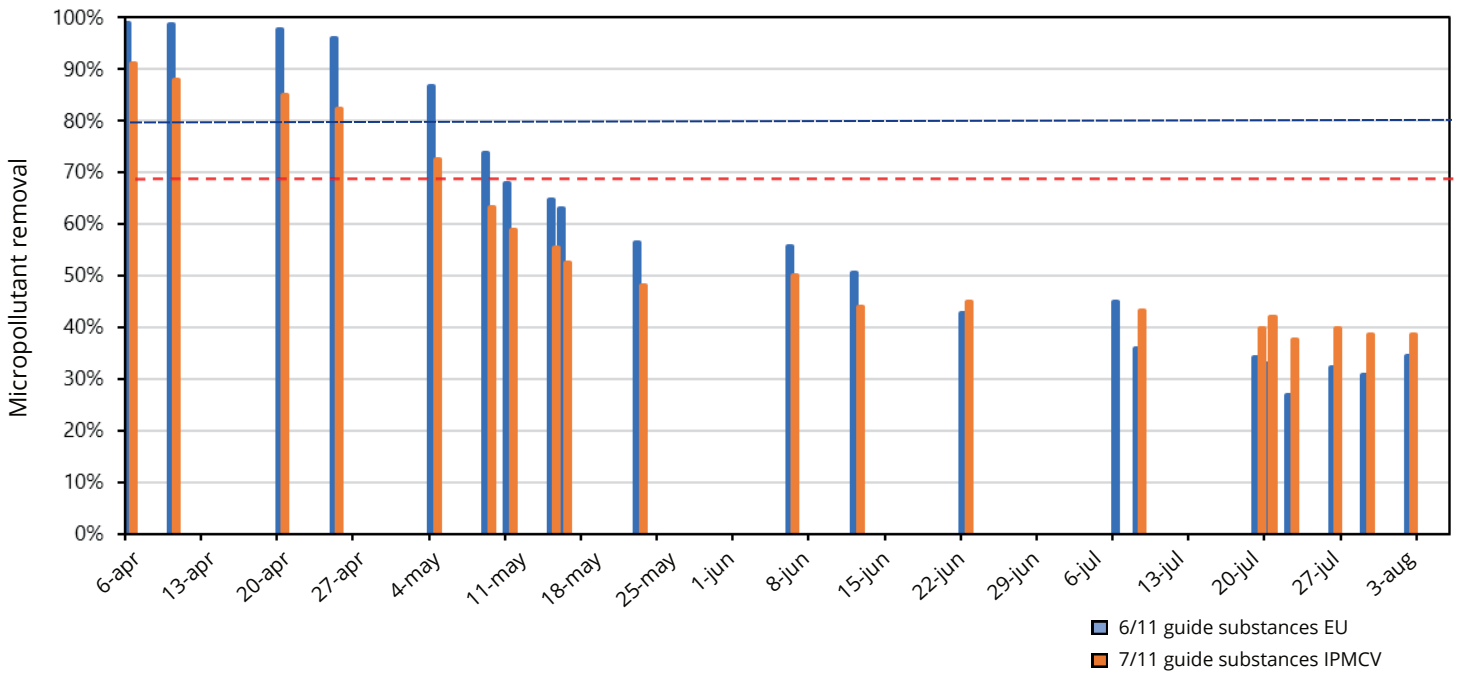
Feedwater	Duration pilot	EBCT	Flow
Secondary clarifier	6 months	5 min per column	0.5 m³/hr



After prefiltration, waste water effluent of WWTP Lelystad was treated through two columns. The first column targeted PFAS and other anionic and neutral contaminants, while the second column targeted cationic and neutral contaminants. During the first phase of the pilot, the installation was optimized, and during the second phase, long-term research was conducted to determine operating performance of the adsorbent and its treatment capacity.



Results



In the first phase of the pilot, the micropollutant removal was more than 90% and an average PFAS removal of 92% was observed. It should be noted there were low influent PFAS concentrations, but promising PFAS removal of the DEXfilter is in line with other pilot research projects.

After 4,000 bed volumes, a gradual reduction in removal efficiency was observed. Residence time tests, sieve tests, shaking experiments, and microscopic analysis confirmed filter bed clogging, leading to channel formation and a decrease in EBCT. Hydraulic optimalization is required for the DEXfilter to be feasible. When optimized, a filter bed lifespan of 20,000 to 40,000 bed volumes is estimated. Based on these projected bed volumes, estimates for the costs and CO_2-footprint are made.

Conclusions

During the first 4.000 bed volumes, micropollutant removal achieved the goals set by the IPMV and the EU (70-80%). Furthermore, an average PFAS removal of 92% was observed.

The hydraulic capacity should be optimized with frequent backwashing and air flushing. Stratification during backwashing can be reduced by using industrially uniform granules.

DEXfilter successfully achieved a 70% reduction in ecotoxicity, meeting the IMPV requirement of a minimum 50% reduction.

The production process for DEXSORB is similar to ion exchange, resulting in a CO_2-footprint of 3.5 kg CO_2/kg DEXSORB. For DEXSORB regeneration, an estimated impact of 7.1 kg CO_2/kg DEXSORB is calculated. The latter will likely be lower in practice, this will become clear when a complete LCA is performed. Using projected bed volumes of 20,000 and 40,000, a total CO_2-footprint of 90-176 kg CO_2/m³ is calculated respectively for processed wastewater.

Costs will depend on developments in the EU-market. In a sensitivity analysis, two scenarios with the projected bed volumes are considered with three different cost-developments. Resulting a cost range of 0.11 and 0.29 EUR/m³

Concluding, the main goal to evaluate the functionality of the DEXfilter has been achieved. Prior to full-scale implementation of DEXfilter, optimization of flow conditions in the filter column and confirmation of backwash efficiency are required. This pilot proved DEXSORB's promise for advanced effluent treatment to remove micropollutants and PFAS. Concurrently, Cyclopure has gained knowledge of DEXSORB performance from pilot operations with municipal wastewater in the United States.

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