PFASSELECT

Selective removal of PFAS from different wastewater matrices

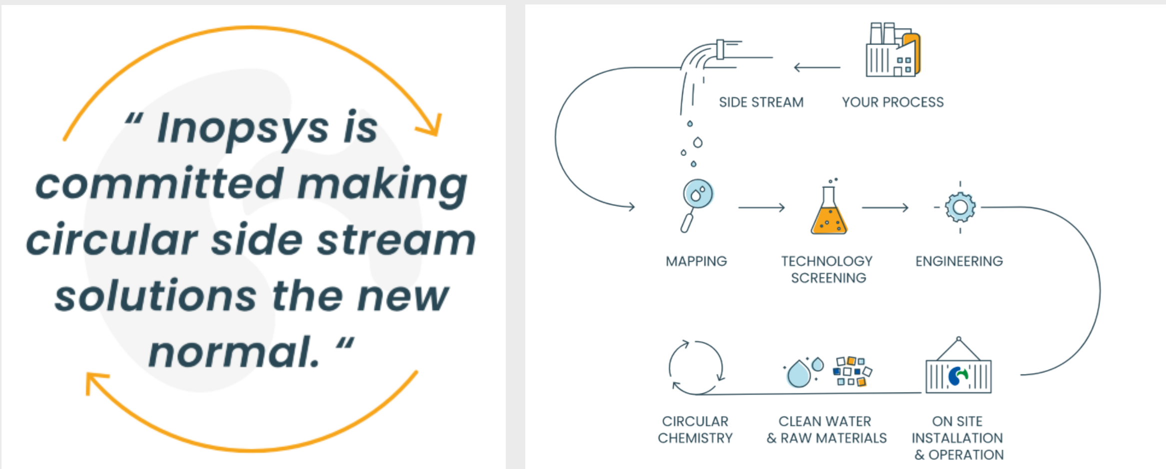
PFASSELECT aims to select the right membrane, and the right pre- or post-treatment steps, depending on the wastewater chemistry, the target PFAS compounds, and the required removal efficiency.

THE CONTEXT

Per- and polyfluoroalkyl substances (PFAS) constitute a group of synthetic chemicals widely utilized in various products for their water- and grease-resistant properties. The persistent nature of PFAS in the environment and potential health concerns have sparked a growing interest in devising effective methods for their removal from water sources.

Current technologies for treatment are mainly IEX or adsorption-based technologies. The efficiency of these processes depends largely on the wastewater matrix and the type of PFAS which needs to be removed.

Membrane technologies are also considered as a treatment possibility for PFAS. The required performance and choice of membrane will depend on the re-use water quality requirements, the wastewater matrix and the PFAS profile in the wastewater. When implemented as a pre-treatment, membranes can play a part in reconditioning the wastewater by altering the wastewater matrix. Compounds which inhibit possible post-treatments can be separated from the target PFAS compounds, which improves the overall process efficiency.



Vision on side stream solutions by Inopsys (www.inopsys.eu)

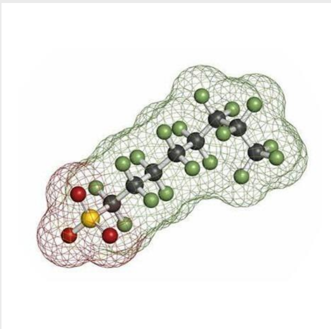
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 862330

THE CHALLENGE

The PFASSELECT project aims to test the selectivity of a large variety of membranes for different PFAS compounds in different real PFAS matrixes. Particular focus will go to the feed streams with ionic compounds and other organic pollutants that inhibit possible post-treatment. Moreover, at least one real stream will be selected containing predominantly ultrashort PFAS molecules.

Membrane screening will encompass not only flat polymeric nanofiltration (NF) or reverse osmosis (RO) membranes already known for efficient PFAS removal. Also, other commercial flat and tubular polymeric membranes, as well as 2 types of hollow fiber membranes by the partner NXFiltration will be tested. Moreover, tubular ceramic NF membranes from partner Rauschert will be included, in native form as well as grafted by VITO. The screening will be followed by Proof-of-Concept testing at a larger scale using the most interesting membranes.

The analysis of those PFAS species also plays a key role in the project, as it is crucial to assess the performance of all membranes properly. Especially, the ultrashort PFAS poses high



Typical PFAS molecule and NXFiltration membranes efficient in PFAS removal (www.nxfiltration.com)

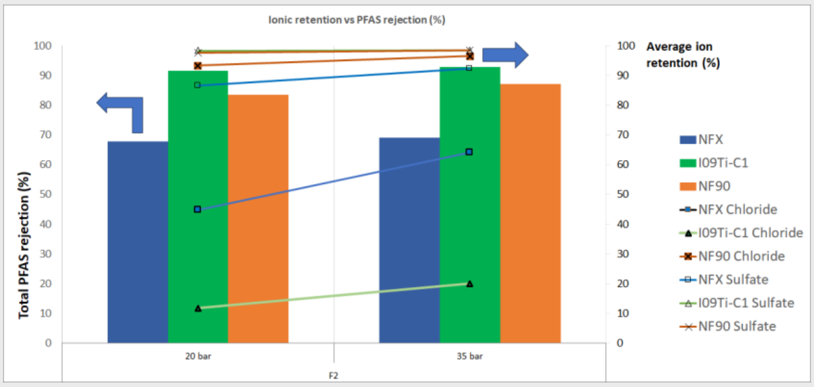
THE RESULTS

Inopsys provided three real-life PFAS-spiked wastewater streams. The streams varied in ionic concentration, as well as the amount of ultrashort (< 200 Da), short (200 to 350 Da), and bigger (> 350 Da) PFAS compounds they possess. VITO finetuned efficient analysis methods and adapted a filtration loop by changing PTFE-based valves and O-rings with materials less likely to attract PFAS for a safe operation.

In general, screening results show that PFAS retentions for all membranes are between 50 and 95% depending on the PFAS distribution in the feed. Even retentions for ultrashort PFAS are above 80% for different feed–membrane combinations (KPI 1).

Ceramic NF membranes, Grignard grafted in-house at VITO, provide low ion-rejection characteristics while maintaining a similar PFAS rejection compared to the polymeric membranes (KPI 2).

Long-term Proof of Concept tests showed that PFAS species – even the problematic and non-regulated ultra-short chains, were concentrated in the feed stream, up to 70% feed recovery rate. The process showed robust performance over several days (KPI 3). Flux decline encountered during concentration is limited.



Average PFAS versus ion retentions for a variety of different membranes

CONCLUSION

The PFASSELECT project was successful and the following conclusions can be drawn:

- The 7 selected polymeric and ceramic membranes show relatively high PFAS retentions, even for the ultrashort PFAS species (< 200 Da). Retentions vary between 50 and 95% depending on membrane, PFAS chain length, and PFAS distribution in the feed.
- Several membranes show retentions for short-chain PFAS > 80% (KPI 1).
- Especially Grignard grafted ceramic NF membranes show separation of ions and PFAS species: PFAS are well retained, while ions typically inhibiting post-treatments are transported. Recovery of purified PFAS > 80% is feasible (KPI 2).
- Proof of Concept testing has shown the robustness of PFAS concentration and purification process over several days (KPI 3).

TECHNIQUES USED

In PFASSELECT the following services and capabilities of the INNOMEM OITB were used:

- Extensive analysis of the process solutions selected, feasible at INNOMEM partner VITO.
- Synthesis of hollow fibre polymeric NF membranes up to commercial scale at INNOMEM partner NXFiltration.
- Synthesis of ceramic NF membranes up to commercial scale at INNOMEM partner Rauschert.
- Grignard grafting of some ceramic NF membranes by INNOMEM partner VITO.
- Screening and Proof of Concept testing of polymeric and ceramic NF membranes requiring adapted filtration equipment at lab and intermediate scale, available at INNOMEM partners VITO and NXFiltration .

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