Study for the optimum production of Magnesium-Calcium Enriched Drinking Water and Lithium recovery from spent batteries

Nano-enabled Nanofiltration membranes for the production of Magnesium-Calcium Enriched Drinking Water and Lithium recovery from spent batteries (NANOGOM).
The goal is to reach sufficient Mg ion and Li ion rejection rates through a technically feasible and economically competitive solution.

THE CONTEXT

In the NANOGOM service project, it is proposed to use a layer-by-layer developed nanofiltration (NF) membrane to address mineral depletion in desalination plant product water, which often results in water product that lacks essential salts and minerals that are crucial for consumption. To this end, a hybrid nanofiltration (NF)-reverse osmosis (RO) desalination system is proposed to increase the magnesium content of the desalinated water.

Through a combination of pilot-scale NF experimentation and RO simulations, the NANOGOM service demonstrated the practicality and economic feasibility of this innovative treatment approach. Furthermore, in the NANOGOM service project, it is proposed to improve nanofiltration membranes using the layer-by-layer technique for the development of systems that are suitable for the cost-effective recovery of lithium from spent lithium batteries.

User: WATERPRO

INNOMEM partners involved: FORTH, DEMOKRITOS, HTF, SUK, ECOTECH

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THE CHALLENGE

The main objective of the Democase NANOGOM is to develop cutting-edge filtration technologies to address critical challenges in water desalination and lithium recovery, aiming to provide sustainable and economically viable solutions with significant industrial impacts. The service project employs a hybrid NF-RO filtration system designed to improve the mineral content in desalinated brackish water. NANOGOM also focuses on developing cost-effective methods to recover lithium from spent lithium batteries using oriented carbon-based membranes and polyelectrolytes. The flowsheet of a membrane-based ion rejection plant is designed able to achieve improved Mg ion rejection and Li ion rejection in streams of desalinated brackish water and treated spent lithium batteries.

The challenge is that the developed solution must be competitive both technically and economically against state-of-the-art solutions.

TECHNIQUES USED

For the NANOGOM Democase the assigned INNOMEM members have used the following services and techniques:

- Process design.
- Modelling and flow sheet simulations of modified HF membrane systems.
- Obtaining ion rejection data using a membrane demo unit.
- Techno-economic analysis and market validation.

THE RESULTS

Multiple configurations have been studied focusing on hybrid NF membrane systems.

- Hollow Fibre membranes were modified using polyelectrolytes, graphene oxides and carbon nanotubes, using layer-by-layer technique and optimizing the technology for scalability.
- By adding several layers of carbon-based materials, the rejection rates for Mg^{2+} and Li^{+} were further enhanced, reaching target levels.
- Process modeling & flowsheeting with scale-up has shown the applicability and feasibility of the proposed procedure, and its competitiveness with state-of-the-art technologies.

CONCLUSION

The preliminary results show that it is possible to achieve the targeted Mg and Li ions rejection with membrane-based plants.

Simply modified membrane systems are not able to comply with the requested rejection levels.

Advanced treatment with addition of several carbon-based layers provided most promising solutions

The techno-economical study through the flowsheeting modeling conducted provided feasibility support for the scale-up of the method.

More advanced techno-economical studies are required for each particular case as the selection of the optimum solution varies depending on several factors such as feed composition and scale.