

Salt-Free Electrodialysis Metathesis (EDM) for High Recovery Concentrate Management



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Challenge

Considering extended drought, aridification, and climate change, desalination is more valuable than ever, and abundant brackish groundwater resources are being identified throughout the U.S. (Xu et al 2022). For inland brackish groundwater desalination, concentrate disposal can be costly, so brine volume minimization is essential. Reverse osmosis (RO) is the most common desalination method in the United States, but its recovery is often limited to 70-85%, due to the solubility of sparingly soluble minerals as the brackish water is concentrated. There are great opportunities to leverage electro-driven desalination processes, especially for brine/concentrate management (Deemer et al 2023).

Research Approach

This project will evaluate Fujifilm's salt-free electrodialysis Metathesis (EDM) process (Figure 1), a continuous-flow high-recovery process that does not exploit kinetics but instead exploits the thermodynamics of highly soluble concentrates: by separating divalent cations and divalent anions into two separate concentrate streams. Salt-free EDM will be used to desalt the RO concentrate to produce a diluate product that can be blended with RO permeate. Salt-free EDM uses approximately half of the energy required by conventional EDM.

RESEARCH PARTNERS

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Impact

The objectives of this research are to: (a) demonstrate high recovery concentrate management in our existing solar-powered desalination pilot at BGDRF with Fujifilm's salt-free EDM and contribute data through the Water DAMS Repository, (b) understand the limits of hydraulic recovery of salt-free EDM, and (c) develop a salt-free EDM model within WaterTAP. Salt-free EDM could broadly enable small-scale desalination by significantly decreasing the required size of an evaporation pond, as well as by generating a beneficial product (i.e., calcium sulfate for an agricultural soil amendment).

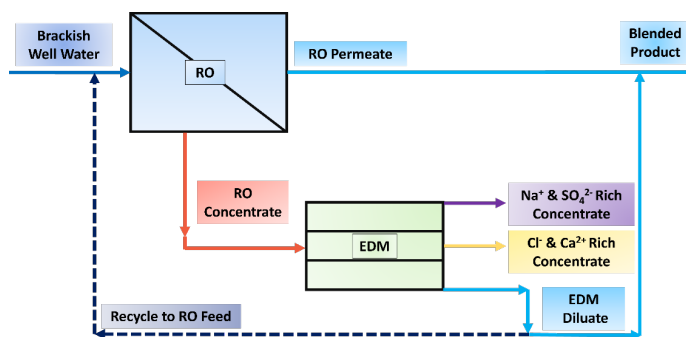


Figure 1. High-recovery desalination system (RO and salt-free EDM)

REFERENCES

- Xu et al. (2022) Brackish Water Desalination for Municipal Uses: Current State-of-the-Art, Challenges, Opportunities, and Future Prospects. ACS ES&T Engineering. <https://doi.org/10.1021/acsestengg.1c00326> ;
- Deemer et al. (2023) Challenges and opportunities for electro-driven desalination processes in sustainable applications. Current Opinion in Chemical Engineering. <https://doi.org/10.1016/j.coche.2023.100972>