RESEARCH BRIEF
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NAWI National Alliance for Water Innovation

Ultra-High Pressure Reverse Osmosis Membrane Module Design Optimization

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Challenge

Highly saline brine streams (TDS > 80,000mg/L) are expensive to dispose; however, brine could be an important water resource in the future. Today, thermal concentration is the only commercially-available method to further concentrate these brines, but thermal processes are energy-intense and cost-prohibitive in most situations. They also do not easily scale down in size.

Research Approach

In theory, reverse osmosis (RO) could be used to further concentrate highly saline brine streams. However, existing RO membranes are damaged at the high pressures needed to concentrate brines. The membranes compress and become denser through their cross-section -- a process called "compaction." This causes loss of water production. Also, RO membranes deform into the corrugated shape of the permeate carrier material -- a process called "embossing". This causes pin-hole defect formation and loss of rejection. Ultra-high-pressure RO (UPHRO) membranes that can maintain flux and rejection at the pressures needed to concentrate brines over 200,000mg/L-TDS would greatly increase fresh water recovery and dramatically lower the cost and energy of concentrating high-salinity brines.

Impact

Preliminary estimates suggest that if a UHPRO membrane can be developed that tolerates up to 200 bar of applied pressure without suffering performance decline and damage due to compaction and embossing, it could reduce the energy and cost of recovering water from the brine stream by up to 50%.

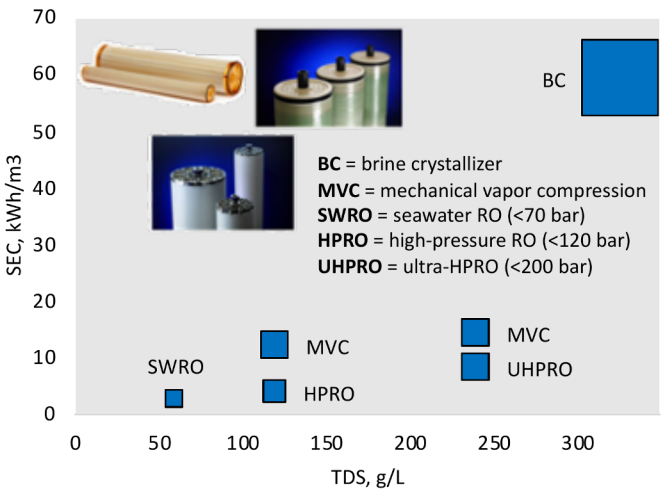

Figure 1. Specific energy consumption by conventional RO, HPRO, UHPRO, brine concentrator, and brine crystallizer. The specific energies shown in the figure are in kWh per cubic meter of feedwater.

RESEARCH PARTNERS

National Renewable Energy Lab (NREL), University of California, Los Angeles (UCLA), University of Connecticut, Yale University.

REFERENCES

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