RESEARCH BRIEF
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NAWI
National Alliance
for Water Innovation

Reciprocating Piston Batch Reverse Osmosis: Pushing the Limits of Efficiency and Fouling Resistance

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Challenge

Conventional RO is limited to certain salinities and subsaturated conditions, high cost, and diminished opportunities for energy improvement. Batch and semi-batch reverse osmosis configurations are potentially the most efficient RO variants, but have remaining inefficiencies from brine mixing, high downtime, and mechanical complexity -- from time-varying pressure, volumetric flow rates, and flow directions . While semi-batch processes like Closed Circuit Reverse Osmosis (CCRO or CCD) have had success at scale, the full-batch process with low downtime ha s not yet been tested at full scale .

Research Approach

Our batch reverse osmosis (Batch RO) configuration can extend achievable recoveries for a wide range of salinities (2 g/L to 80+ g/L) and can be integrated with renewable resources. Our goal is to take this conceptual design from theoretical study to a full pilot scale. This will encompass material design and system modeling, experiments, and validation. This will be done at lab-scale, then pilot-scale. The team will work on a detailed design of a batch RO system capable of integrating both a reciprocating piston and bladder design for alternative tests. The involvement of industry team members throughout the project will provide valuable input to develop an innovative solution that is responsive to market demand. Pilot-scale allows us to identify any potential technical, operational, and design issues under realistic conditions, as opposed to the lab-scale tests. Paired to the construction of the pilot, a one-to-one model will provide further insight. Model optimization will aid preparation for further engineering design. This will reduce the number of iterations required to: narrow down ideal operating condition; identify influential factors (pump efficiencies, temperature, recovery, etc.); and assist us in testing different operation scenarios to evaluate pilot-scale performance.

Impact

The ability to treat a wide variety of traditional water sources, even high saline water sources at high recovery ratios, will break the status quo in water treatment and

narrow the gap between the achievable efficiency of the batch RO system and the ideal conditions in desalination systems. The pilot would demonstrate the long-term operational effects such as pipe fatigue, long exposure to salinity cycling to membranes, and flow stability to ensure consistent cycle operation. These effects are not well understood today.

We will find and interpret technical key challenges when operating the batch RO pilot system that would serve as a basis for future R&D such as reusing brine to be utilized economically and decrease the amount of concentrate (brine) discharge. Lastly, reported reductions in energy requirements, capital cost, and operational cost will prove batch RO to be an attractive technology for investors and industrial applications.

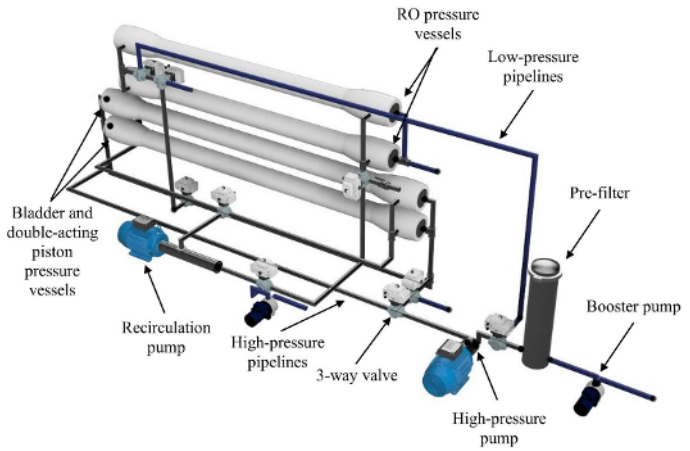

Figure 1. A diagram of the lab-scale research configuration.

RESEARCH PARTNERS

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