RESEARCH BRIEF
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NAWI National Alliance for Water Innovation

Development of HPRO Membrane Platform for the Desalination of High Salinity Waters

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Challenge

Highly saline brine streams (TDS > 80,000 mg/L) are expensive to dispose of and could also be an important water resource in the future. Today, thermal concentration is the only commercially-available method to further concentrate these brines. Thermal processes are energy-intense and cost-prohibitive while also being difficult to scale down for distributed treatment needs. In theory, reverse osmosis (RO) could be used to further concentrate highly saline brine streams, but only if they could be operated at very high pressures of up to 200 bar (often referred to as high pressure reverse osmosis, or HPRO). However, existing RO membranes compress and deform at the high pressures needed to concentrate brines and suffer performance limitations. We need to develop a better understanding of how RO membranes perform in high salinity and extreme pressure environments.

Research Approach

The main objective of this project is to create platform approaches to understanding how membranes behave when exposed to high pressures and salinities. Our team has created molecular dynamics platform to study transport across thin film composite membranes, an imaging platform to quantify membrane compaction at high pressures, and an experimental platform that utilizes an incompressible ceramic support to verify the modeling platform. These tools will be used in future projects to develop high performance HPRO membranes that can withstand the pressures of HPRO.

Impact

This project will demonstrate modeling and characterization platforms for understanding RO membrane performance at extreme pressures and salinities. The development of molecular dynamics and porous support compression and flow models will help in the development of HPRO membranes as new materials for selective and support layers in membranes are considered. X-ray microscopy techniques will enable imaging of membrane support structures and permeate spacers under pressure. These tools will support NAWI follow-on work in HPRO membrane development.

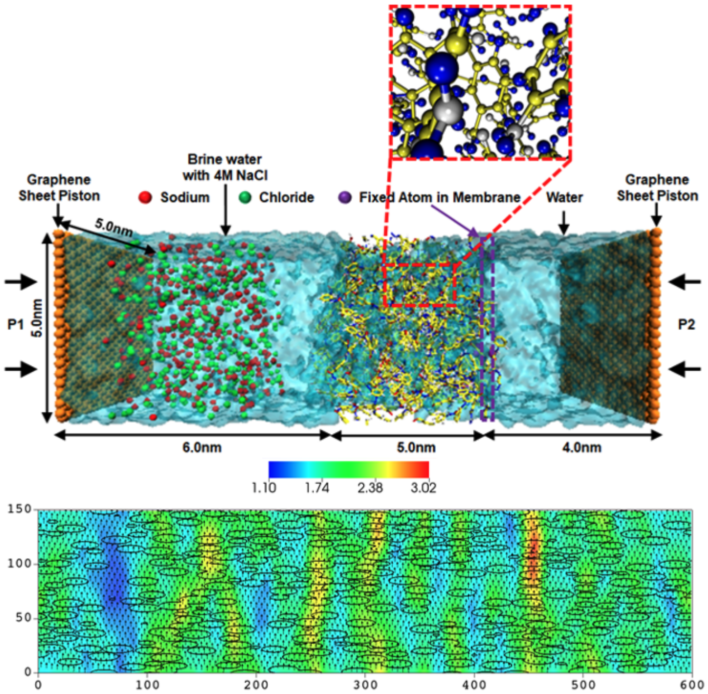

Figure 1. (top) Molecular dynamics simulation of membrane transport at high pressure, (bottom) Model predicting compaction and flow channeling in porous supporting layers of membranes

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