Osmotic Processes in WaterTAP

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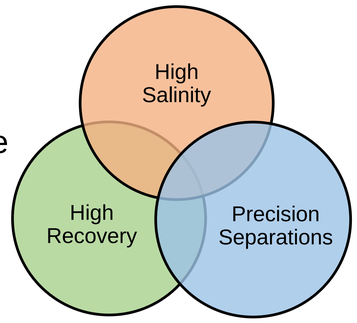
Motivation

- Reverse osmosis (RO) is a core technology used for seawater desalination
- RO has limited salinity range for operation (< 70 g/L TDS)
- Emerging osmotic technologies enhance RO capabilities and potential



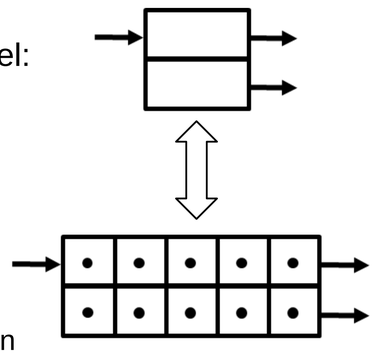
Modeling Approaches

Spatial Modeling

Assumed Performance Model:
- Fixed performance indices

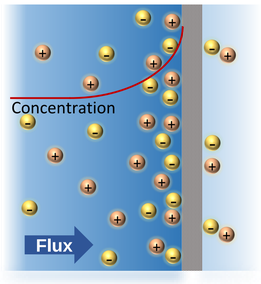
0D Model:
- Well-mixed material
- No spatial discretization

1D Model:
- 1D spatial variation
- Finite difference discretization

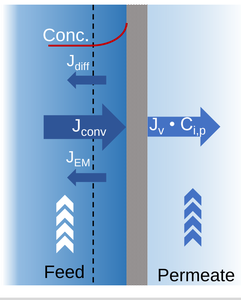


Mechanistic Modeling

Solution-Diffusion Model:
- Concentration polarization
- Predicts rejection of a single component

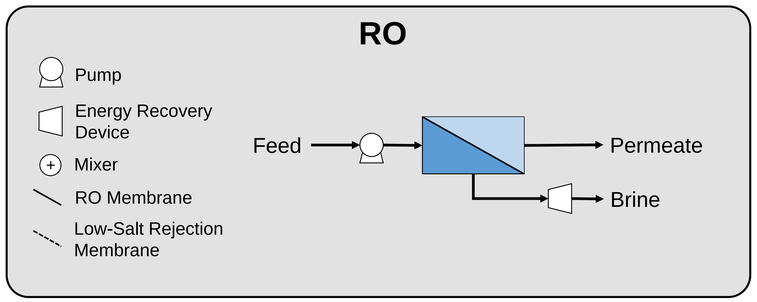


Donnan Steric Pore Model with Dielectric Exclusion (DSPM-DE):
- Predicts rejection of multiple components
- Diffusion, convection, and electromigration terms via extended Nernst Planck equation
- Accounts for steric, dielectric, and Donnan exclusion

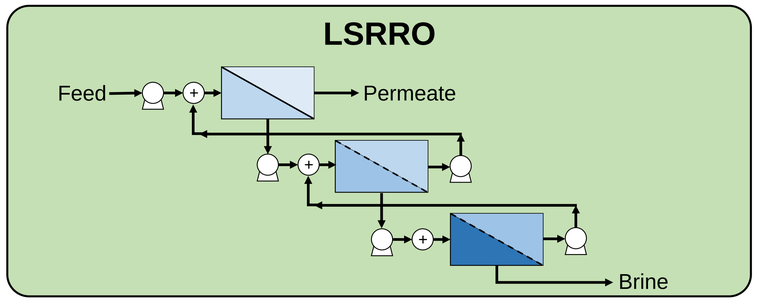


Osmotic Processes

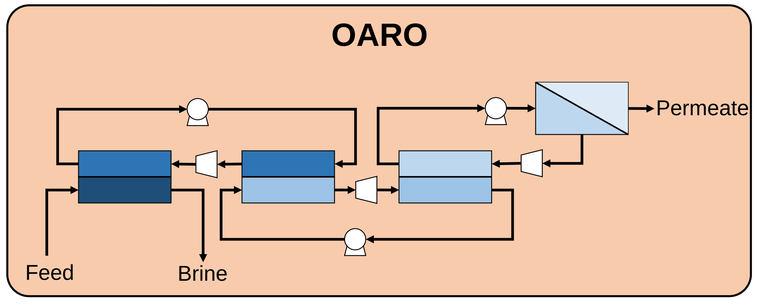
Reverse Osmosis



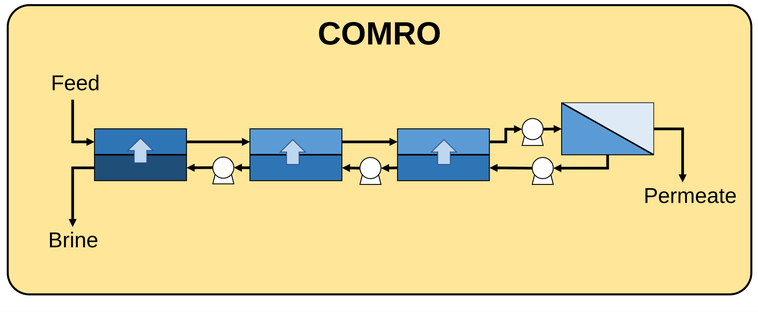
Low-Salt Rejection Reverse Osmosis



Osmotically Assisted Reverse Osmosis

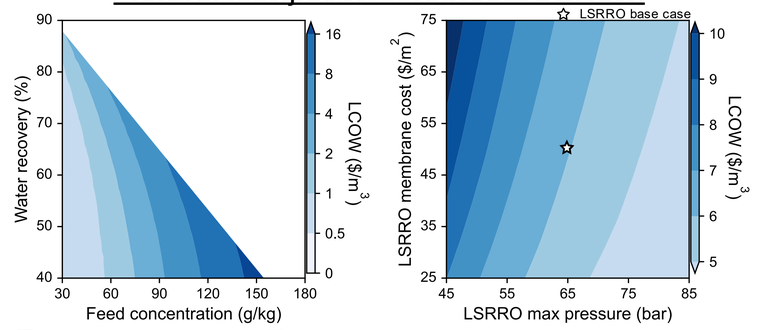


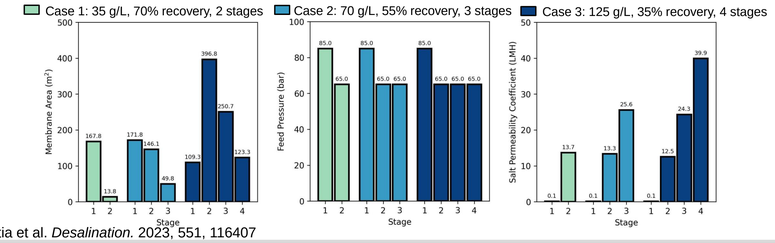
Cascading Osmotically Mediated Reverse Osmosis



Cost optimization and TEA

Low-Salt Rejection Reverse Osmosis



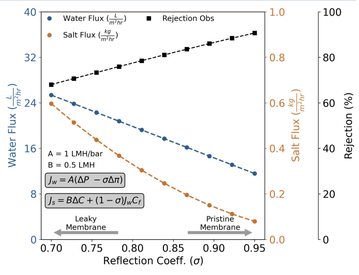


Atia et al. *Desalination*. 2023, 551, 116407

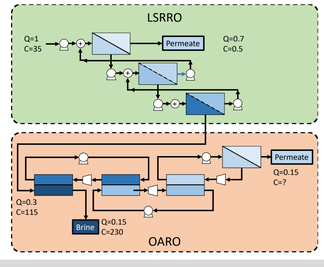
Remarks/Future Work

Compare Transport Models
- Solution Diffusion
- Solution-Friction
- Spiegler-Kedem-Katchalsky

$$J_w = A(\Delta p - \sigma\,\Delta\pi)$$
$$J_s = B\Delta C + (1-\sigma)J_w C$$



Hybrid-designs
- TEA and optimization for hybrid LSRRO-OARO
- Compared the optimized hybrid system to standalone OARO/LSRRO



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This material is based upon work supported by the National Alliance for Water Innovation (NAWI), funded by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), Advanced Manufacturing Industrial Efficiency & Decarbonization Office (IEDO), under Funding Opportunity Announcement Number DE-FOA-0001905.This presentation was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.