Value of feed spacer optimization in reverse osmosis

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Objectives

- Conduct a systemic technoeconomic analysis to quantify the advantage of spacer optimization in membrane desalination modules.
- Develop surrogate mass transfer and pressure drop correlations for 3D printed spacers as a function of spacer geometry from CFD and experimental data

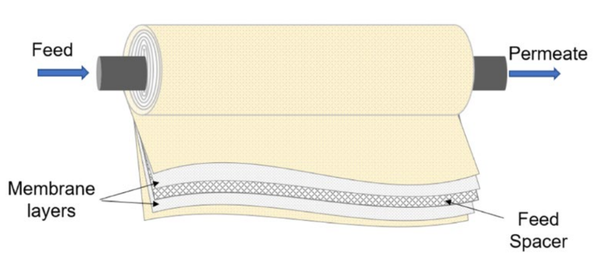
Challenges

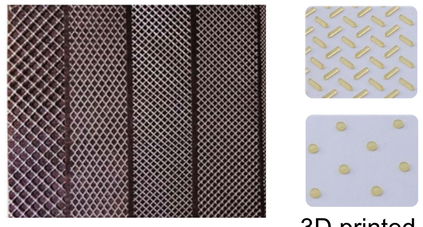
- Current mass transfer and pressure correlations for spacer design do not explicitly account for spacer geometry.
- Most mast transfer correlations, derived from bulk measurements and CFD simulations, lack direct validation leading to low confidence in estimates.

Approach

- Integrate mass transfer and pressure drop correlations for no spacer, net-type spacer, and 3D-printed spacer cases into WaterTAP 1D-RO model.
- CFD models will be employed to generate directly validated correlations for 3D printed spacers.
- Conduct a parameter sweep on spacer geometry

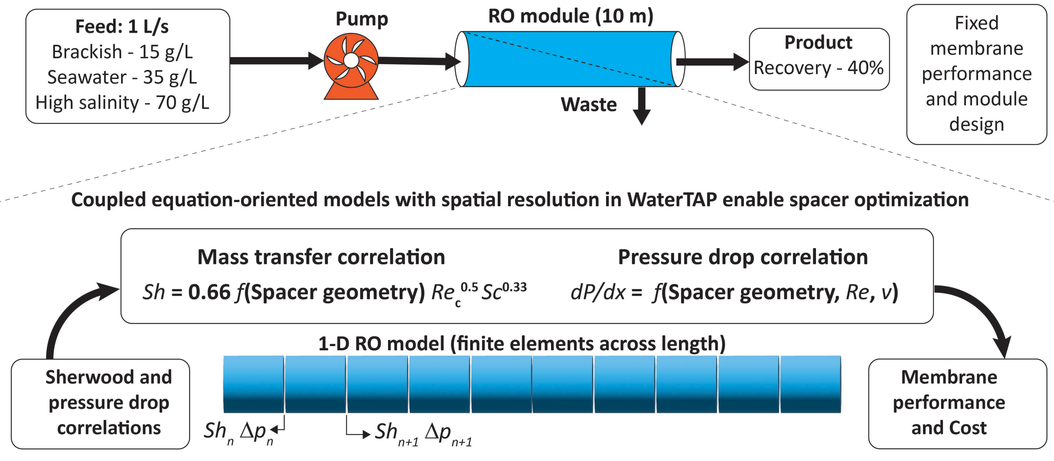
Workflow and preliminary results

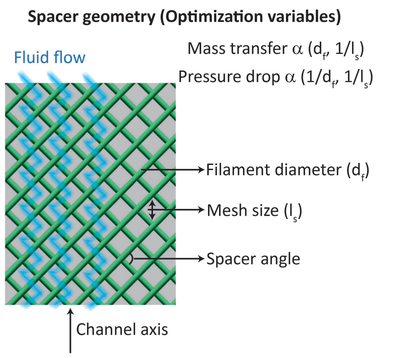


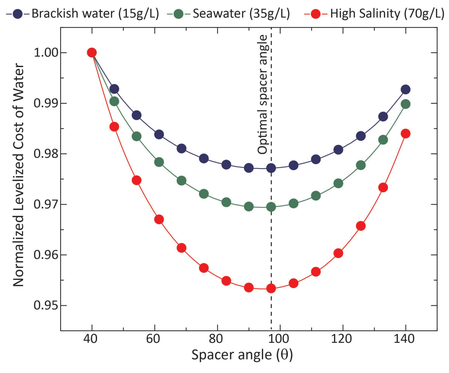


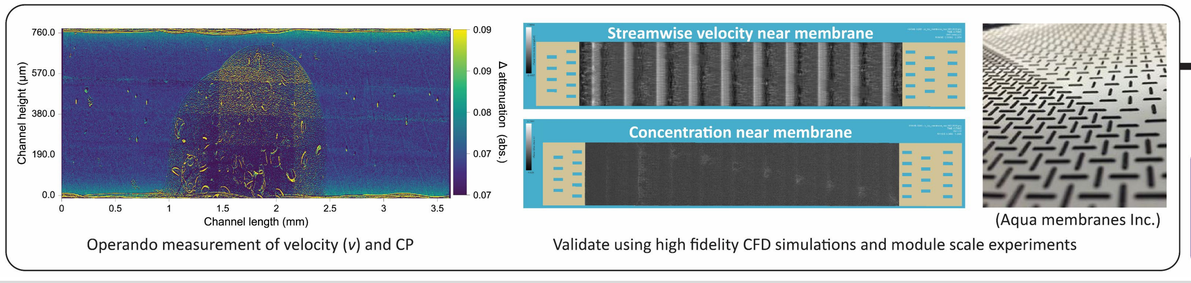
Traditional spacers

3D printed spacers









Operando measurement of velocity (*v*) and CP

Validate using high fidelity CFD simulations and module scale experiments

(Aqua membranes Inc.)

Surrogate models for mass transfer and pressure drop for 3D spacers

Feed water:
1.Brackish
2.Seawater
3.High Salinity

Optimization:
1.No spacer
2.Net-type
3.3D-printed

Cost optimization using **WaterTAP**

Future Work

- Data from CFD simulations and experiments can facilitate the development of surrogate correlations for mass transfer and pressure drop caused by 3D printed spacers
- Incorporating these surrogates into WaterTAP can aid in creating a spacer optimization platform for 3D-printed spacers
- Parameterizing mass transfer and pressure drop will help determine the relative significance of each, as induced by feed spacers
- Mapping state-of-the-art feed spacers onto the parametric space will reveal opportunities for innovation
- Address mineral scaling and pretreatment by integrating chemistry models into the process flowsheet

References

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- Lee, J. Y., et al. (2016). The potential to enhance membrane module design with 3D printing technology. Journal of Membrane Science, 499, 480-490.
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