The Simscape Fluids toolbox provides a powerful framework for modeling a wide range of physical systems. However, it currently lacks the ability to model solution and suspension dynamics, particularly for variable-density fluids based on solute concentration, mixing processes, and separation phenomena. The SEA Lab is interested in collaborating with MathWorks to develop a new fluid domain that incorporates these capabilities.

#### **Proposal: Proof of Concept with Desalination (Initial 3-Month Project)**

To ensure feasibility and appropriate scope, the first phase of this project will focus specifically on desalination through reverse osmosis (RO). This will serve as a test case for modeling solute transport and separation, providing an initial foundation for broader solution chemistry modeling.

We envision three key areas of development for this initial phase:

1. New Fluid Domain – A specialized domain based on the isothermal liquid model with an added solute concentration state and parameters for solute mass and particle size.
2. Supporting Simscape Blocks – Key components like a mixing chamber (for blending solutions) and a membrane (for separation processes).
3. Example Project & Documentation – A reverse osmosis desalination model with detailed documentation to facilitate future adoption and expansion.

The SEA Lab will require the most assistance from MathWorksin developing the new fluid domain, as this is an area where we have no prior experience. However, we have some background in developing Simscape blocks and are prepared to take on much of this work with minimal guidance on .ssc syntax and best practices.

#### **Future Expansion: Beyond Desalination**

If this initial effort is successful, there is significant potential to broaden the scope of this tool. Possible future developments include:

1. Changing the Base Domain – While the isothermal liquid model offers simplicity, transitioning to a two-phase fluid model could enable thermal separation methods (e.g., distillation).
2. Multi-Solute Systems – The initial project will focus on a single solute with a single particle size. Future iterations could support multiple solutes, enabling more complex water treatment or chemical processing applications.
3. Modeling Liquid Solutes – Currently, the focus is on solid-particle solutes. Extending the model to liquid-phase solutes could provide more flexibility, particularly in a two-phase system where solutes and solvents may have different boiling points.

#### **Commitment to Open Research**

The SEA Lab is committed to making our tools accessible to other researchers. We typically publish code on GitHub but are open to using MATLAB File Exchange if preferred.

This phased approach ensures that the initial project remains focused and achievable, while laying the groundwork for a versatile and extensible solution in the future.