PP12 MICROPATTERNED REVERSE OSMOTIC MEMBRANES FOR FOULING CONTROL IN FILTRATION SYSTEMS

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Reverse Osmosis Membrane (ROM) filtration systems are widely utilized in waste-water recovery, seawater desalination, landfill water treatment, etc. During filtration, the system performance is dramatically affected by membrane fouling which causes a significant decrease in permeate flux as well as an increase in the energy input required to operate the system. Design and optimization of ROM filtration systems aim at reducing membrane fouling by studying the coupling between membrane structure, local flow field and foulant adsorption patterns. Yet, current studies focus exclusively on oversimplified steady-state models that ignore any dynamic coupling between the fluid dynamics and the transport through the membrane. In this work, we performed a complete transient simulation study in a virtual framework with computational simulator.

We develop a customized solver (SUMembraneFoam) under the open source finite volume simulator OpenFOAM to solve the transient Navier-Stokes and the Advection-Diffusion-Equations, as well as an adsorption-desorption equation for the foulant accumulation. Three physical quantities are solved in every time step: flow velocity vector, bulk concentration and surface concentration. All quantities are coupled through governing equations and/or boundary conditions. The new open source simulator is able to import/simulate three dimensional structure in different flow regimes (laminar or turbulent). The adsorption-desorption equation used to simulate surface foulant can be easily extended to multiple species in order to model different accumulation physics. The simulation result not only predicts macroscopic quantities (e.g. permeate flux, pressure drop, etc.) but also does show a good agreement with the fouling pattern recorded from experiments. Additionally, the new solver reveals temporal development of foulant accumulation and localized flow field effect. Integrated post-processing analyzer demonstrates how foulant deposition is strongly controlled by the local shear stress on the membrane, and suggest that membrane topology can be modified to control the shear stress distribution and reduce fouling. By applying specially designed microscopic surface patterning, our new design shows the capability of increasing local stress, while limiting the total pressure difference needs to be applied. Fouling is reduced compared with the surface without patterning under the same simulation condition. Preliminary experimental study confirms the efficiency of the micropatterned ROM surfaces and shows the potential of the new design at laboratory scale.