Investigation of Water Flux and Pressure Losses in Osmotically Driven Membrane Systems Using Computational Fluid Dynamics Modelling

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Abstract

Forward osmosis (FO) and pressure retarded osmosis (PRO) are two processes of growing interest due to their applications in water purification, power generation and energy recovery. By reducing hydrodynamic losses within membranes and maximizing the experienced osmotic pressure difference between streams, FO and PRO can be used to recover water and/or generate energy with greater efficiency. These losses come from the formation of an internal concentration polarization (ICP) gradient that forms within the support layer of the membrane, an external concentration polarization (ECP) gradient that forms in the feed and draw channels, and increased pressure losses due to the inclusion of spacer meshing. Modelling techniques, such as computational fluid dynamics (CFD), are important tools to simulate operation and analyze results for process improvement. The objective of this work is to develop a model using the OpenFOAM software package that can be applied to full scale FO and PRO modules. OpenFOAM uses finite volume method (FVM) and PISO & PIMPLE algorithms to solve the governing equations of these processes. An OpenFOAM solver designed for osmotic processes will provide a flexible tool that will be useful for the study of new module configurations to compare flux and pressure losses to current designs. This poster discusses FO and PRO operation, pressure and water flux losses, modelling techniques, and research goals. After presenting a background about the processes, specifics about how OpenFOAM can be used to solve the governing equations of these processes will be illustrated. How the water flux across membrane boundary is calculated and how the algorithms work will be of particular interest.