Open-source CFD model for optimization of forward osmosis and reverse osmosis membrane modules - DTU Orbit (08/11/2017)

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Osmotic membrane separation processes are based on using semi-permeable membranes to remove solutes from a given feed solution. This can happen either as Reverse Osmosis (RO) where a hydraulic pressure is applied to drive separation across the membrane, or as Forward Osmosis (FO) where osmotic pressure difference between a feed solution and a draw solution is used to drive the separation process. In both systems, concentration polarization in the vicinity of membrane surfaces are one of the major concerns in terms of separation efficiency, as this phenomenon effectively reduces the driving forces for the separation processes. In this work we present an optimized computational fluid dynamics (CFD) model capable of efficiently running steady-state and transient simulations of both RO and FO at low computational cost.Use of the model is demonstrated for FO by showing how it can provide theoretical insight into the flow phenomena present in the commonly used lab-scale membrane module CF042. We demonstrate how the model can be used to investigate the way in which various flow and geometry parameters influence module performance. Our results indicate that varying the inlet angles, or the number of inlets, have very little influence on the total mass transfer across the membrane. The model can also be used for investigating mass-transfer for various spacer types, densities and configurations and this is demonstrated in an "analysis of how spacer geometry affects "dead volumes" with low flow in the module.The open source CFD code is provided free-of-charge, so that it might be readily used by the membrane community in prototyping their own custom-designed membrane chambers/modules, or characterize existing chambers/modules. With the optimized solver code presented here simulations in geometries containing millions of cells will converge within 24 h using just a single CPU.

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