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Mini Review on the Effects of Concentration Polarization in Forward Osmosis and Pressure-retarded Osmosis Processes

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Extended Abstract

Discharge of water from the boundary layer of the thin film composite membrane can unbalance the concentration of solution at the membrane–feed interface and the bulk solution. This phenomenon is known as concentration polarization, and is common in pressure-driven membrane processes, particularly in reverse osmosis (RO) and nanofiltration (NF), but also in emerging forward osmosis (FO) and pressure retarded osmosis (PRO) processes. There are two types of concentration polarization, external (ECP) and internal (ICP). The effect of concentration polarization is always to decrease the membrane productivity (water flux) and selectivity (salt rejection); in other words, it undermines membrane performance regardless of the process. The ECP can occur at both interfaces of a membrane and can be dilutive or concentrative. However, it can be mitigated by promoting turbulence at a fluid-membrane interface. On the other hand, the ICP, which also can be dilutive or concentrative, occurs within a porous sublayer of the membrane. Therefore, the ICP is unavoidable because it is not possible to induce turbulence within the porous sublayer. The ICP is unique to the FO and PRO processes because of the opposite direction of solute and water fluxes. Although it is not possible to eliminate the effects of ICP in FO and PRO processes, it possible to partly reduce its negative effects by optimizing the membrane structure. In turn, this requires an understanding of the mass transfer processes taking place in FO and PRO membranes. In this mini-review, we will examine basic transport equations pertinent to FO and PRO processes and link them to the phenomena of ECP and ICP, and the membrane performance.

Keywords: Mass transfer, FO, PRO, membrane, ICP and ECP

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