Integration of the fouling description into models of osmotically driven membrane processes

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Summary

The osmotic separation processes as forward (FO) and pressure retarded (PRO) osmosis can be significantly affected by membrane fouling due to the accumulation of deposited suspended particles, colloids, organic macromolecules, inorganic solutes, microorganisms, etc. in a mass transfer boundary layer adjacent to the membrane surface. Dissolved molecules accumulating at the surface reduce the solvent (here water) activity and this reduces the solvent flow through the membrane. Question arises how can be modelled the mass transfer through a fouling layer and how can it involved in the description of the osmotically driven membrane processes as FO and PRO processes. Recently Tow and Lienhard [1] developed a mass transfer rate equation for quantifying porous foulant accumulation on semipermeable membranes in terms of two parameters that capture both osmotic and hydraulic causes of flux decline. Applying the salt transfer rate given for every single mass transfer layer [2], including that for the fouling layer [1], the overall salt flux, and the water flux, as well, will be defined which involves the effect of five transfer layers, namely selective and sponge layers, external boundary layers and the fouling layer. Accordingly, the effect of the fouling on the membrane performance can be predicted by a relatively simple manner. Two operating modes will be discussed in this presentation: (i) the feed is facing the selective membrane layer (FO process) and (ii) the draw solution is facing the selective layer (PRO mode). The fouling layer is building up on the feed-facing side during FO process, while on the sponge side during PRO process. This latter case can cause additional problem because the foulant can accumulate in the sponge layer as well inducing its increasing resistance. The model results will then be compared with experimental data.

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Literature

[1] Tow, E.W., Lienhard, V.J.H. Quantifying osmotic membrane fouling to enable comparison across diverse processes. *J. Membr. Sci*., 511, 92-107 (2016)

[2] Nagy, E. A general, resistance-in-series, salt- and water flux models for forward osmosis and pressure retarded osmosis for energy generation, *J. Membr. Sci*., 460, 71-81 (2014)