Quantifying the potential of pressure retarded osmosis advanced spacers for reducing specific energy consumption in hybrid desalination

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ABSTRACT

A hypothetical PRO advanced spacer that delivers a 50 % mass transfer enhancement (i.e., 50 % higher Sherwood number) is simulated for a range of feed conditions and membrane properties, to shed insights into the effect of improved PRO spacer on the overall specific energy consumption (SEC) of RO-PRO hybrid desalination. Results show that a large increase in pressure drop in the PRO module has negligible impact on power density (PD) and SEC for RO-PRO. The analysis revealed that the PRO advanced spacer has marginal impact on SEC for a typical current PRO membrane. Even so, the PRO advanced spacer has an important impact in terms of PD, which can increase by 10 %, especially under severe external concentration polarization. The sensitivity analysis demonstrates that the extent of SEC reduction or power density enhancement related to the advanced spacer is most sensitive to the structural parameter. This is because internal concentration polarization is the major cause for osmotic pressure loss in PRO, which limits the potential PRO performance improvements from advanced spacers. Nevertheless, the benefits of PRO advanced spacers can be further exploited through the continuous development of new materials for novel membranes with a reduced structural parameter.

KEYWORDS

Advanced spacer; Concentration polarization; Power density; Pressure retarded osmosis; Specific energy consumption

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