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Review of modeling methodologies and state-of-the-art for osmotically assisted reverse osmosis membrane systems

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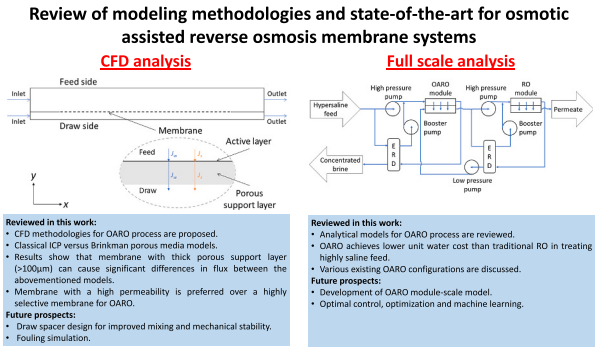
HIGHLIGHTS

- State-of-the-art modeling methodologies for OARO are reviewed.
- CFD for simulating OARO is demonstrated using the classical and porous media models.
- Porous media model is most applicable for a system with a thick membrane.
- Role of mathematical model for OARO module-scale and optimization is highlighted.
- Role of CFD for design of OARO draw spacer and fouling is emphasized.

GRAPHICAL ABSTRACT



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ABSTRACT

Osmotically assisted reverse osmosis (OARO) has been proposed as an innovative solution to recover more water from hypersaline water, surpassing the traditional RO method which is limited by the maximum pressure that the membrane can withstand. An accurate mathematical model is required to elucidate the mechanism of concentration polarization build-up at the inside and outside of the membrane so that these insights can be applied to design an efficient OARO system. This paper reviews state-of-the-art modeling methodologies for OARO using analytical and CFD models. While analytical models have been extensively employed for the design of OARO, the progress of computational models (i.e., CFD) still falls behind. Therefore, CFD methodologies for simulating OARO are demonstrated in this review using the classical and Brinkman porous media models. The sensitivity analysis demonstrates that the Brinkman porous media model is the most applicable for systems with low flux and a thick membrane porous layer. Lastly, future research directions related to OARO modeling are recommended.

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