

# **Review of analytical and numerical modeling for pressure retarded osmosis membrane systems**

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## **ABSTRACT**

Over the past two decades, pressure retarded osmosis (PRO) has attracted attention owing to its capability to harvest energy from salinity difference. However, more efforts for optimizing PRO processes using simulation models are only seen since 2010s. These main simulation models can be categorized into analytical and numerical (i.e., CFD) models. Mathematical simulation of a complex PRO process is important as it allows user to gain knowledge required for an efficient system analysis and improvement. Furthermore, an advancement in computer simulation could lead to breakthrough ideas of the PRO technology. Despite this, there is no constructive review highlighting the applicability and shortfalls of these two models. The present paper not only provides a critical review of the methodology and assumptions of the mathematical model, but also includes the current state of the art of the modeling application. Areas for further research prospects are suggested. Furthermore, a multi-scale modeling approach that integrates both CFD model at sub-millimeter scale and system-level model (analytical) at meter scale to describe the PRO full-scale performance is proposed.

## **KEYWORDS**

Analytical model; Computational Fluid Dynamics (CFD); Methodology; Pressure retarded osmosis; Scale-up

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