Computational fluid dynamics simulation of forward osmosis (FO) membrane systems: Methodology, state of art, challenges and opportunities

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ABSTRACT
Forward osmosis (FO) has attracted wide research attention owing to its potential application in seawater desalination. In the past decade, the research advancements in FO experimental studies have been accompanied by an increase in computational fluid dynamics (CFD) studies. With advanced CFD techniques, the complex flow patterns related to FO design and different operating conditions are now being studied and some solutions to existing problems are being suggested. Therefore, it is timely to review the CFD methodology, the detailed assumptions made and the mathematical models used for the FO processes. In addition, the problem of verification and validation is discussed in detail, together with the present state of art based on work over the last decade. Many FO CFD works have focused on varying membrane properties and operating conditions, while some have attempted to shed insight into the mechanisms that lead to flux enhancement. Finally, challenges and research opportunities related to FO CFD studies are provided.