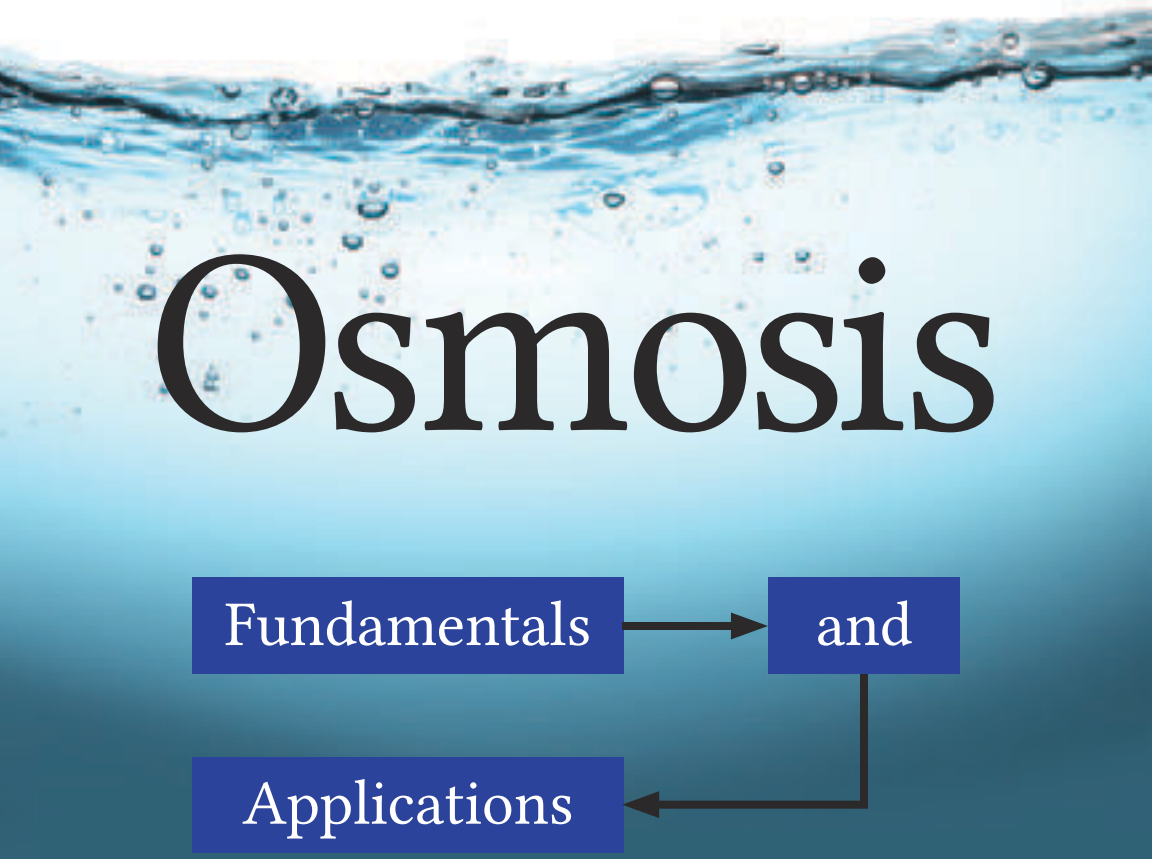
Forward Osmosis



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Fundamentals and Applications

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Preface

The current world population is 7 billion and is expected to reach 9 billion by 2050, creating a significant challenge in meeting the increasing demand for potable water. The fresh water resources have already become limited and the human encroachment on water catchments, unsustainable use of water and human induced climate change is further worsening the water scarcity issues in many parts of the world. To secure sustainable water resources from nonconventional sources, the projection of scientific solutions plays an essential role and has been widely recognised. Reverse osmosis (RO) is one such technology that can play a leading role in resolving water scarcity issues. The state-of-the-art RO technology has significantly improved the scope for the use of saline water and impaired wastewater effluent as an alternate source of water to augment fresh water or to reduce pressure on freshwater resources. The state-of-the-art seawater RO desalination plant now consumes energy by several orders of magnitude lower than the seawater RO about three decades ago. However, the energy required for seawater RO has almost reached a plateau, and any more efforts towards reducing energy consumption requires additional processes thereby increasing the total cost of the final water. Moreover, the law of thermodynamics have set a limit to the theoretical and practical energy for desalination of seawater. Membrane fouling particularly bio-fouling still poses a significant challenge to the RO desalination process further increasing the energy consumption. Therefore, RO still remains energy intensive in nature. Energy is an important component of a desalination plant given its role on global warming and climate change. Therefore, any low energy desalination technologies could make desalination technology more affordable and have a significant impact in meeting the increasing water demand.

Forward osmosis (FO) is now an emerging technology for desalination. The FO process works on the principle of the natural osmotic process, driven by the osmotic gradient between two solutions of different osmolar concentrations when they are separated by a semi-permeable membrane. When a semi-permeable membrane separates saline feed water and the highly concentrated solution (referred to as draw solution or DS), water moves from the saline water (lower solute concentration) to the concentrated DS (higher solute concentration), while retaining the solutes on both sides of the membrane. The main feature of this process is that the water transport across a semi-permeable membrane in the FO process is driven by the osmotic gradient and does not require hydraulic pressure therefore consuming significantly less energy than the RO process where direct hydraulic pressure is required. The other advantage of FO process is the low fouling potential of the process because of the absence of the hydraulic pressure. In

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