

## Future of the osmotic processes

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### ABSTRACT

Osmotic processes are widely utilized in water–ion separation applications. These include purification of low salinity water, desalination of brackish and seawater and reclamation of wastewater. The advantage of application of pressure driven membrane separation processes is obvious when comparing energy requirements of membrane processes with other desalination technologies. It is possible that future improvement of water permeability of current reverse osmosis (RO) membranes could bring some additional reduction of energy use of membrane desalination. However, for seawater desalination, any significant future reduction of energy requirement is limited by osmotic pressure of the concentrate and apparent coupling of water and salt transport. For current commercial RO membranes the increase of water permeability is associated with increase of salt transport and increased permeate salinity. The nominal salt rejection of commercial seawater membranes is about 99.85%. In order to maintain the same permeate salinity at lower feed pressure, membranes with higher water permeability have to maintain the same salt transport rate, which translates to a proportionally reduced salt passage, i.e. increased salt rejection. It is not very likely that current membrane manufacturing methods could bring additional improvement of salt rejection, which is today frequently above 99.9% for the flat sheet membranes. A new osmotic process that could bring a meaningful reduction of energy of seawater desalination is forward osmosis (FO). FO requires low pressure for recirculation of seawater and draw solution, but does not require high feed pressure to generate sufficient net driving pressure (NDP) to drive water through the membrane. FO utilizes osmotic pressure gradient to extract low salinity water from seawater. Under conditions of availability of low temperature waste heat, FO could desalt seawater at energy requirement less than 50% of the energy required by the current RO seawater desalination technology. The major obstacle for commercial implementation of FO to water desalination is lack of suitable commercially available membranes. The same obstacle, unavailability of suitable membranes, is facing another promising osmotic process: pressure retarded osmosis (PRO). Potentially, PRO could be a significant source of renewable energy, utilizing low salinity–high salinity water mixing energy to generate hydraulic gradient that would drive turbine and generate electric power. Detailed energy generating system configurations have been developed for PRO by S. Loeb and others in the past. However, due to difficulty of manufacturing of suitable membranes, the PRO technology verification experiments have been limited to laboratory conditions only. This paper includes information on current status of reverse osmosis as applied to desalination and wastewater treatment. Process configurations and areas of potential future improvement are discussed. Forward osmosis and pressure retarded osmosis process configurations and projected operating parameters of commercial systems are presented. Performance and configuration requirements of suitable membranes for FO and PRO are discussed.

*Keywords:* Reverse osmosis; Membranes; Osmotic process

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