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Techno-economic and environmental analysis of an integrated solar vacuum membrane distillation system for the treatment of reverse osmosis desalination brine

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ABSTRACT

Reverse osmosis (RO) desalination is widely used for drinking water production, because of its relatively low energy consumption. However, RO is limited in recovery ratio due to the osmotic pressure which increases with salinity. It results with high rejected brine volume inducing negative environmental impact. The aim of this work is to investigate the possibility of using solar vacuum membrane distillation (VMD) in an integrated RO desalination process in order to reduce brine discharge volume and increase RO global recovery ratio. A small RO desalination unit operated by solar energy in a real site in the Algerian desert is considered for the feasibility study. The obtained results proved that important permeate fluxes can be reached with RO coupled with VMD as the water recovery increased from 37% to nearly 87.5%. Brine volume can so be reduced by a factor of 5 and the global water production is more than doubled. A sensitivity analysis was also carried out to study the effects of operating conditions on the desalination system performance in terms of feed water temperature, vacuum pressure and solar collector efficiency. Finally, an economic study was performed to estimate the cost of water produced from the three possible configurations: the RO alone, the VMD alone and the RO-VMD combined system.

Keywords: Reverse osmosis desalination; Brine disposal; Vacuum membrane distillation; Solar energy; Economic study; Sensitivity analysis

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