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A numerical study on the effects of operational parameters and membrane characteristics on the performance of vacuum membrane distillation (VMD)

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ABSTRACT

Recently, the seawater desalination process has gained widespread attention due to lack of drinking water. Among several membrane distillation methods for desalination, vacuum membrane distillation (VMD) is one of the emerging technologies that has mostly focused. In this study, an integrated heat and mass transfer model for the VMD process is established and the simulation results are validated with experimental data available in the literature. The numerical model is solved using in-house coding in Mathcad. The effect of some influential process parameters like feed circulation velocity, feed temperature, salinity, and heat transfer coefficient (HTC) on VMD flux is investigated. Moreover, the influence of some membrane characteristics like membrane porosity, membrane pore size and membrane thickness on permeate flux is also considered. Furthermore, the effect of some operating parameters on temperature polarization is also presented in this paper. Results of the numerical model indicated that the VMD flux enhanced with an increase in velocity, feed temperature, membrane porosity, membrane pore size, and HTC, whereas permeate flux declined with an increase in salt concentration, vacuum pressure, and membrane thickness. The maximum increase in permeate flux was 21.62 kg/m^{2}h by increasing feed temperature from 35°C to 65°C at a constant feed velocity of 1.0 m/s. Additionally, it was confirmed that an optimum value of the membrane parameter is preferable for a substantial improvement in overall VMD performance.

Keywords: Heat transfer; Mass transfer; Membrane distillation; Permeate flux; Temperature polarization; Vacuum membrane distillation; VMD

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