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Characteristics analysis of a combined system of vacuum membrane distillation and mechanical vapor recompression

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ABSTRACT

Vacuum membrane distillation (VMD) is the efficient method to evaporate freshwater from aqueous solution. However, energy requirement in the distillation process still remains as the biggest obstacle. In this paper, a new combined system with VMD and mechanical vapor recompression subsystems coupled for the concentration of sodium chloride solution is proposed, to reduce the energy consumption of evaporation by recovering latent heat from the compression process. In light of the thermal processes included, mathematical models were established based on the mass and energy balance equations. The influences of the operating parameters on temperature and concentration polarization effects are investigated. The mechanisms of influencing compressor power from the appointed key factors such as, temperature polarization effect, concentration polarization effect and boiling point elevation (BPE) and so on, at various operating conditions are revealed. The simulation results present that the power consumption of compressor can be reduced appropriately through weakening the impacts of temperature and concentration polarization effects and BPE on distillation process by adjusting operating conditions. Moreover, the specific thermal energy consumption is found to be 85 kWh/m^3, which is about 39.3% lower than that of the solar powered membrane distillation system.

Keywords: Vacuum membrane distillation; Mechanical vapor recompression; Temperature polarization effect; Concentration polarization effect; Boiling point elevation; Compressor power

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