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Permeate flux enhancement with a helical wired concentric tube in air gap membrane distillation systems

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ABSTRACT

Temperature polarization plays an important role in determining the permeate flux of the membrane distillation in an air gap membrane distillation (AGMD) module. This study aimed to increase the pure water productivity of saline water desalination by applying helical wire on the circumference of a concentric-tube AGMD module to reduce the temperature polarization occurring on the smooth annulus tube of an AGMD module with a normal concentric-tube. Modeling equations of heat and mass transfer in the new design of the AGMD device with helical wire winding on the annulus of a concentric tube have been investigated theoretically and experimentally. The mathematical model proposed in this study was used to correlate a simplified equation for estimating the heat transfer coefficient and to predict the permeate flux accordingly. The effects of various operation parameters, including the feed saline water temperature, feed volumetric flow rate, air gap thickness, and helical wire pitch, on the pure water productivity were also delineated. The permeate flux enhancement for helical wire in the AGMD module could provide the maximum relative increment of up to 31.1%. The temperature polarization coefficient found in this study is ranging from 0.5527 to 0.5451 for different hot feed temperature and flow rate, respectively. An optimal helical wire module was assessed when considering both permeate flux enhancement and energy utilization effectiveness.

Keywords: Helical wired annulus; Desalination; Concentric-tube AGMD; Permeate flux enhancement

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