Comparison of energy-efficient configurations of direct-contact membrane distillation for brackish water desalination

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Received 23 June 2018; Accepted 20 November 2018

ABSTRACT

Membrane distillation (MD) uses thermal energy to purify brackish and seawater. The MD-required specific energy is almost ten folds of that required by the conventional thermal and membrane desalination processes. Herein, the performance of the direct-contact membrane distillation (DCMD) unit for the desalination of brackish water was empirically evaluated. The recovery ratio and the thermal efficiency of the unit were found to be very low compared with conventional desalination processes. Different configurations designed to maximize the process performance were thus proposed and investigated theoretically. The investigation involved simulations using a validated DCMD model. The configuration based on permeate-heat recovery offered the maximal gain output ratio (GOR) of up to five when an MD system with a large surface area of 10 m² was used. On the other hand, the configuration based on brine recycling outperformed that based on permeate recovery when the surface area of the MD system was less than 6 m². Although the cascade configuration with permeate recovery produced the highest GOR, this design suffers from a greater specific capital investment due to the larger number of MD units.

Keywords: Water desalination; Membrane distillation; Brine recycling; Multistage; Energy efficiency