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Sweeping Gas Membrane Distillation: Numerical simulation of mass and heat transfer in a hollow fiber membrane module

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Abstract

A hollow fiber MD module was tested at various air and brine flow rates and temperatures. A model based on heat and mass transport was developed to predict permeate production rates. The dependence of permeate production rate on brine temperature, air flow rate and brine flow rate was successfully simulated. Numerical simulations support the selection of membrane characteristics and air and brine flow conditions for optimal performance in water desalination. Condensation was predicted to occur on the air side of the membrane due to saturation of the sweeping gas and is accounted for in the model. In the absence of condensation, temperature profiles in the module could not be predicted correctly. The ratio of length to diameter of the membrane module is of particular significance as it dictates the permeation rate for a specific pore size membrane. Small pores require higher aspect ratios than large pores to obtain the same permeate production rate. The membrane module used in this study has an effective pore size of 0.1 μm, which renders membrane transport the dominant source of mass transfer resistance to through-pore water vapor transport. A module with a larger pore size and appropriate aspect ratio should produce permeate at a significantly higher rate.

Keywords
Sweeping Gas Membrane Distillation; Hollow Fiber Membrane; Modeling; Heat and Mass Transfer; Desalination