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Understanding the impact of membrane properties and transport phenomena on energetic performance of membrane distillation desalination

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Abstract

Direct contact membrane distillation (DCMD) is a thermal desalination process that is capable of treating high salinity waters using low-grade heat. As a water treatment process, DCMD has several advantages, including the utilization of waste heat (below 100℃), perfect rejection of nonvolatile solutes, low areal footprint, and high scalability. However, the energy efficiency of DCMD is relatively low compared to other work-based and thermal desalination processes. In this study, we aim to quantify how membrane properties and process conditions affect the exergy or second-law efficiency (η_{II}) of a DCMD desalination system with external heat recovery. In particular, we analyze how the membrane permeability coefficient (B) and thermal conduction coefficient ($\overline{K}$) impact MD performance. We show that increasing the B value of a membrane by reducing its thickness, initially leads to an increase in η_{II} before conductive heat loss through the membrane causes η_{II} to fall. For a typical MD membrane with a porosity of 0.90, material