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Theoretical modeling and experimental validation of transport and separation properties of carbon nanotube electrospun membrane distillation

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Abstract

Developing a high flux and selective membrane is required to make membrane distillation (MD) a more attractive desalination process. Amongst other characteristics membrane hydrophobicity is significantly important to get high vapor transport and low wettability. In this study, a laboratory fabricated carbon nanotubes (CNTs) composite electrospun (E-CNT) membrane was tested and has showed a higher permeate flux compared to poly(vinylidene fluoride-co-hexafluoropropylene) (PH) electrospun membrane (E-PH membrane) in a direct contact MD (DCMD) configuration. Only 1% and 2% of CNTs incorporation resulted in an enhanced permeate flux with lower sensitivity to feed salinity while treating a 35 and 70 g/L NaCl solutions. Experimental results and the mechanisms of E-CNT membrane were validated by a proposed new step-modeling approach. The increased vapor transport in E-CNT membranes could not be elucidated by an enhancement of mass transfer only at a given physico-chemical properties. However, the theoretical modeling approach considering the heat and mass transfers simultaneously enabled to explain successfully the enhanced flux in the DCMD process using E-CNT membranes. This indicates that both mass and heat transfers improved by CNTs are attributed to the enhanced vapor transport in the E-CNT membrane.