Abstract Submitted
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Dimensional analysis of membrane distillation flux through fibrous membranes MEAGAN MAUTER, Carnegie Mellon University — We developed a dimensional-analysis-based empirical modeling method for membrane distillation (MD) flux that is adaptable for novel membrane structures. The method makes fewer simplifying assumptions about membrane pore geometry than existing theoretical (i.e. mechanistic) models, and allows selection of simple, easily-measureable membrane characteristics as structural parameters. Furthermore, the model does not require estimation of membrane surface temperatures; it accounts for convective heat transfer to the membrane surface without iterative fitting of mass and heat transfer equations. The Buckingham-Pi dimensional analysis method is tested for direct contact membrane distillation (DCMD) using non-woven/fibrous structures as the model membrane material. Twelve easily-measured variables to describe DCMD operating conditions, fluid properties, membrane structures, and flux were identified and combined into eight dimensionless parameters. These parameters were regressed using experimentally-collected data for multiple electrospun membrane types and DCMD system conditions, achieving R^2 values >95%. We found that vapor flux through isotropic fibrous membranes can be estimated using only membrane thickness, solid fraction, and fiber diameter as structural parameters. Buckingham-Pi model DCMD flux predictions compare favorably with previously-developed empirical and theoretical models, and suggest this simple yet theoretically-grounded empirical modeling method can be used practically for predicting MD vapor flux from membrane structural parameters.

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