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New State Space Modelling Approach and Unknown Input Observer Design for the Assessment of Temperature Polarization Phenomenon in Direct Contact Membrane Distillation

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Abstract: The objective of this paper is three fold. Firstly, a new modeling approach for direct contact membrane distillation (DCMD) is developed. Based on dynamic bi-dimensional configuration, an uncertain non linear state space model that takes into account all the uncertainties generated by discretization errors and plant parameters variation is derived. It is worth noticing that most of the MD configuration processes have been modeled as steady-state one-dimensional systems. Stationary two-dimensional MD models have been considered only in very few studies. The obtained bi-dimensional state space model of DCMD process is also implemented using Matlab and compared with data published in the literature. Secondly, it is theoretically demonstrated that, by measuring only the inlet and outlet temperatures of the DCMD process, one can recover the temperature profile inside the DCMD process using observers. This is an important point, since most of the existing literatures compute the temperature profile by empirical methods without taking into account disceretization errors and uncertainties. Thirdly, a new unknown input observer is developed to estimate temperature polarization inside the membrane. The convergence of the temperature estimation error to zero is theoretically proved and verified by simulation. Of particular interest, the designed observer can be used for the assessment of temperature polarization phenomena and hence preventing some fouling problems.

Keywords: *direct contact membrane distillation; dynamic modeling; heat and mass transfer; unknown input observer; polarization coefficient; fouling.*

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