Modeling and Optimization of Multi-Stage Vacuum Membrane Distillation (VMD) for Draw Solute Separation in FO process

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Forward osmosis (FO) process has been actively studied for desalination since it is known to require less energy for water permeation than other membrane processes. However, once pure water is penetrated from seawater into draw solution, it should be separated from draw solution again for producing potable water as well as draw solute recovery. Thus, selection of draw solute separation is highly important in respect to performance and energy requirement. In the present work, vacuum membrane distillation (VMD) is investigated for draw solute separation. When a volatile substance is used for draw solute, it requires much less energy than seawater separation by VMD because its vapor pressure is much higher than water's. Despite the previous statement, VMD still needs considerable amounts of energy for pre-heating, condensation, and a vacuum pump. For the performance and energy evaluation, models are developed for FO and VMD module. Furthermore, to minimize the whole required energy, VMD process is considered in forms of multi-stage and its operating conditions are optimized independently in each stage using the developed model.