Self-Cleanable Membranes for Membrane Distillation Treating Geothermal Brines

The desalination of inland brackish groundwater has the potential to provide potable drinking water to residents and industrials in inland arid regions. However, scaling, especially silicate scaling, occurs ubiquitously during the inland brackish groundwater desalination process due to the high concentrations of dissolved silicate salt. In this study, we demonstrated how the residual heat in geothermal brines can be used to drive a membrane distillation (MD) process and produce clean water. Most importantly, we designed and fabricated a new nanocomposite membrane and demonstrated the membrane's self-cleaning capability to mitigate silicate scaling. Specifically, a nanocomposite MD membrane was fabricated by coating the feed side of a porous polypropylene (PP) base membrane with a carbon nanotube (CNT)/poly (vinyl alcohol) (PVA) thin film, resulting a binary surface structure that integrated the hydrophobic properties critical for MD with the hydrophilic and conductive properties of the CNTs. The addition of the CNT layer lead to an increase of membrane flux because of the enhanced heat transport from the bulk feed to the membrane surface, thanks to CNT's high thermal transport properties (2000-6000 W m^{-1} K^{-1} thermal conductivity for CNT vs. 0.6 W m^{-1} K^{-1} for water). In addition, hydroxide ions can be generated along the membrane surface by water electrolysis on the electrically conducting membrane surface by simply applying an electrical potential. The local environment near the membrane-water interface rich in concentrated hydroxide ions can be used to efficiently dissolve silicate scaling that developed during the process of desalinating the geothermal brine, negating the need for chemical cleaning. Three continuously cycles of cleaning were performed, yielding remarkably consistent results and demonstrating the high efficiency of this self-cleaning process.