UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF MoS_2-TiO_2/ PVDF-BASED HOLLOW FIBRE MEMBRANES FOR MEMBRANE DISTILLATION DESALINATION

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ABSTRACT

Membrane distillation (MD) is a hybrid system that combines membrane technology with thermal distillation, which has recently emerged as one of the technologies used for seawater desalination. However, MD faced several limitations that hamper its comprehensive utilization for clean water production, such as low desalination efficiency and temperature polarization. In this study, a series of MoS_2-TiO_2/PVDF membranes were fabricated to improve the performance of MD desalination. The MoS_2-TiO_2 composite was first synthesized using a one-step hydrothermal with different ratios then the fabrication of PVDF-based hollow fibre membrane was fabricated with varied air gap and additional of polyethersulfone (PES) and finally the surface modification of PVDF-based hollow fibre membrane was done where MoS_2-TiO_2 was mixed with trichloro(octadecyl)silane in (OTS) for the dip coating process in the fabrication of MoS_2-TiO_2/PVDF-based membranes. After that that, the XRD, FTIR, TGA, UV-vis, TEM and BET characterization for composite and 5M5T MoS_2-TiO_2 (50 wt% MoS_2 and 50 wt% TiO_2) was chosen for surface modification due to its narrow band gap. After the porosity, contact angle, SEM, and mechanical strength analysis, the PVDF-PES which is the fabricated hollow fibre membrane at a 20 cm air gap with the additional of PES (PP20) was found to have better properties and suitable to be used as support for MD application due to its high porosity and low membrane thickness. It was observed that the contact angle of the MoS_2-TiO_2/PVDF-based membrane increased to 136.8 ± 2.33 ° when the membrane was coated with 0.2% of 5M5T MoS_2-TiO_2 compare to bare PVDF-PES hollow fibre membrane which is 90.6 ± 1.5 °. The MD performances were then investigated via an in-house MD system using highly saline feed water (35g·L^{-1} NaCl) where the hot stream temperature was varied from 50-70 °C. The results indicated that the performances of MoS_2-TiO_2 coated membranes were much better than previously reported membranes due to the high hydrophobicity and porosity that can enhance the overall permeate flux and rejection. The effects of higher temperature hot feed stream temperature were found to be able in increasing the permeate flux where at 50 °C the permeate flux was 2.97 kg·m^{-2}·h^{-1} while at 70 °C, the permeate flux was 23.3 kg·m^{-2}·h^{-1}. The percentage difference for rejection rate for the membranes at various operating temperature was less than 0.1%. The highest permeate flux obtained was 23.3 kg·m^{-2}·h^{-1}, with 99.85% salt rejection at 70 °C for 0.2PP20 membrane. Overall, the results obtained in this work suggest that surface hydrophobicity plays a vital role in membrane distillation performances besides the properties of membrane support.

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