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Membrane Distillation for Produced Water Treatment

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Abstract

Large amount of produced water is generated as a waste stream during oil and gas extraction operations. Discharging produced water to the environment is a general practice, which can pollute surface and underground water. Treatment of this water will not only make a harmless product but it also provides a valuable product to consume in different beneficial uses. Various methods are used to treat produced water but they are limited by high treatment cost, high energy requirement, use of hazardous chemicals, large environmental footprints and discharge of secondary waste. Due to its attractive features, Membrane distillation (MD) has been proposed to treat produced water.

In this study, the feasibility of direct contact membrane distillation (DCMD) technology for produced water treatment was investigated. Several techniques were employed to characterize the feed and effluent water including total dissolve solids (TDS), total organic carbon (TOC) and gas chromatography-mass spectroscopy (GC-MS). The membranes were investigated before and after experiments using Scanning Electron Microscope (SEM) coupled with Energy Dispersive X-ray spectroscopy analysis (EDS), Fourier Transform Infrared (FTIR) and Contact angle (CA) measurements. High rejection in term of total dissolved solids and total organic carbon were obtained. More than 99.9% of dissolved solids were retained and up to 93.3% of TOC were rejected. The possible reason of the carbon passage was the presence of volatile organics in the water. The permeate flux increased with feed temperature, which was expected since the driving force of this process is mainly controlled by the temperature difference between feed and permeate sides. It was also found that pre-treatment of produced water using 0.45 µm filter did not have much effect on the performance of the MD. High stability of the polypropylene membranes was observed during the long-term test. A slight gradual reduction of the permeate flux was observed due to fouling. Washing the membrane with de-ionized water was found to be an effective method for cleaning the membrane and restoring the permeate flux indicating the absence of irreversible fouling.