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Performance of treated and untreated asymmetric polysulfone hollow fiber membrane in series and cascade module configurations for CO_2/CH_4 gas separation system

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Abstract

This study investigates the effects of one-, two- and three-stage membrane system configurations in series arrangement for the CO_2/CH_4 separation for both untreated and treated membranes. Asymmetric polysulfone hollow fiber membranes were fabricated from 33 wt.% of polysulfone polymer using dry/wet phase inversion process. The produced membranes were characterized by pure gas permeation experiments, Differential Scanning Calorimetry (DSC), Scanning Electron Microscopy (SEM), density measurement and Thermogravimetric Analysis (TGA). For both untreated and treated membranes, the pressure-normalized flux of CO_2 decreased with increasing of the membrane stages. In addition, the selectivities of asymmetric hollow fiber membrane showed a more constant trend with feed pressure. Treated membrane exhibited lower pressure-normalized flux than untreated membranes due to skin layer densification which increased the transport resistance, thus lead to the reduction in pressure-normalized fluxes. Among all the three configurations studied, two-stage membrane configuration showed the most constant trend in term of selectivity. However, three-stage cascade configuration produced the highest CO_2/CH_4 selectivity especially when tested at low feed pressure range. Effect of stage cut on feed pressure showed an increasing trend with increasing of CO_2 and CH_4 feed pressure for all configurations. This is due to the increase of the permeation driving force, which caused the passage of larger amounts of more permeable gas through the membrane. This study showed that, three-stage cascade configuration exhibited the smallest stage cut values thus produced higher purity of CO_2 in permeate stream.

Keywords: Hollow fiber; Gas separation system; Membrane configuration; Membrane performance; Polysulfone

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