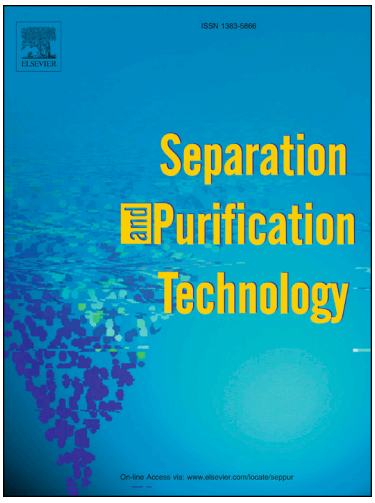

Mixed matrix membranes based on amine and non-amine MIL-53(Al) in Pebax® MH-1657 for CO_2 separation

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Mixed matrix membranes based on amine and non-amine MIL-53(Al) in Pebax® MH-1657 for CO_2 separation

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Abstract

Mixed matrix membranes (MMM) based on poly(ether-b-amide) or Pebax® as the matrix and MIL-53(Al)/NH_2-MIL-53(Al) metal-organic frameworks (MOF) as fillers were prepared by solution casting. The objective of the work was to determine the effect of MOF functionalization and concentration on the permeability and selectivity of different gases (CH_4, N_2, H_2 and CO_2). Scanning electron microscopy (SEM) confirmed that good particle dispersion up to the optimum content was obtained, while Fourier transform infrared spectroscopy (FTIR) confirmed the successful MOF inclusion in MMM. The MMM thermal and mechanical stability were verified by thermogravimetric (TGA) and dynamic mechanical (DMA) analyses, respectively. Finally, the gas separation performances were investigated via single gas and mixed gas permeation tests at 35°C and 10 bar. The results show that CO_2 single gas permeability, as well as CO_2/CH_4 and CO_2/N_2 ideal selectivity, were enhanced by introducing either MIL-53(Al) or NH_2-MIL-53 (Al), while the highest CO_2 permeability (149 Barrer) was obtained at 10 wt.% NH_2-MIL-53 with a 174% improvement over the neat Pebax® value. The highest ideal selectivity for CO_2/CH_4 and CO_2/N_2 was 23.3 (51% increase) and 59.4 (49% increase) also at 10 wt.% MIL-53, respectively. Higher CO_2 permeability and selectivity was attributed to high porosity introduced by the presence of MOF, as well as the selective adsorption of CO_2 on MOF. For mixed gas results, it was found that 20 wt.% NH_2-MIL-53 had significant CO_2/CH_4 separation performance, particularly at low CO_2 volume fraction (20 vol.%) with a separation factor as high as 69.4. Overall, the results showed that MOF surface modification can be necessary under specific conditions.

Keywords: Mixed-matrix membrane; metal-organic framework; gas separation; Pebax; CO_2 separation.