

Qualitative and quantitative analysis of intercalated and exfoliated silicate layers in asymmetric polyethersulfone/cloisite15A® mixed matrix membrane for CO₂/CH₄ separation

Abstract

In this study, flat sheet asymmetric MMMs were prepared from polyethersulfone (PES) containing 1 (PES/C15A1) and 5 wt% (PES/C15A5) loading of Cloisite15A® via phase inversion to investigate the effect of dispersion of silicate layers on the properties and performance of the MMMs for CO₂/CH₄ separation. The MMMs were characterized by means of WAXD, TEM, tensile test and pure gas permeation measurement. Partial intercalated and exfoliated silicate layers for MMM with 1 wt% loading contributed to the enhancement of the membrane morphological and mechanical properties. The increase tortuosity in PES/C15A1 reduced the CH₄ permeance with a significant enhancement for the CO₂/CH₄ selectivity from 22.57 to 46.89. In addition, high degree of intercalation and exfoliation of silicate layers was also corroborated by particle size measurement (PSM), particle density measurement (PDM) and free-path spacing measurement (FPSM) with the increase in aspect ratio, dispersed single silicate layers, density and formation of several tactoid classes for PES/C15A1. The properties and performance of the MMMs, determined by qualitative and quantitative measurements for PES/C15A1 was higher compared to PES/C15A5; therefore, the extent of the silicate layers dispersion has a significant role in the fabrication of asymmetric MMMs.