Study of morphology and gas separation properties of polysulfone/titanium dioxide mixed matrix membranes

ABSTRACT

Polysulfone (PSf)-based mixed matrix membranes (MMMs) with the incorporation of titanium dioxide (TiO_2) nanoparticles were prepared. Distribution and agglomeration of TiO_2 in polymer matrix and also surface of membranes were observed by scanning electron microscopy, transmission electron microscopy, and energy dispersive X-ray. Variation in surface roughness of MMMs with different TiO_2 loadings was analyzed by atomic force microscopy. Physical properties of membranes before and after cross-linking were identified through thermal gravimetric analysis. At low TiO_2 loadings (≤3 wt%), both CO_2 and CH_4 permeabilities decreased and consequently gas selectivity improved and reached to 36.5 at 3 bar pressure. Interestingly, PSf/TiO_2 3 wt% membrane did not allow to CH_4 molecules to pass through the membrane and this sample just had CO_2 permeability at 1 bar pressure. Gas permeability increased considerably at high filler contents (≥5 wt%) and CO_2 permeance reached to 37.7 GPU for PSf/TiO_2 7 wt% at 7 bar pressure. It was detected that, critical nanoparticle aggregation has occurred at higher filler loadings (≥5 wt%), which contributed to formation of macrovoids and defects in MMMs. Accordingly, MMMs with higher gas permeance and lower gas selectivity were prepared in higher TiO_2 contents (≥5 wt%).

Keyword: Morphology; Gas separation properties; Polysulfone/titanium dioxide; Mixed matrix membranes (MMMs)