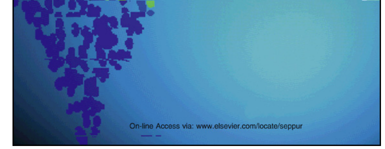

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High-flux polysulfone mixed matrix hollow fiber membrane incorporating mesoporous titania nanotubes for gas separation

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Abstract

In this study, the gas separation performance of polysulfone (PSF) hollow fiber mixed matrix membranes (MMMs) incorporated with nanotubes derived from titania were investigated. Titania nanotubes (TNTs) were synthesized via facile hydrothermal method of different reaction times: 10 h and 48 h. Transmission electron microscopy (TEM), X-ray diffraction (XRD), and BET analysis were conducted to scrutinize the structural morphology of the as-synthesized TNTs. TNTs produced under prolonged reaction exhibited larger tube diameters, but have rather smaller pores. No functionalizations or modifications were made regarding the surface chemistry of the TNTs prior to blending with the spinning dope. Defect-free membranes were attained up to 0.6 wt% addition of TNT_{10}. The measured permeances for all gases tested were profoundly increased with the addition of TNTs. PSF-TNT_{10} 0.4 wt% MMM recorded the highest permeance enhancement (about 150%), with H_2, CO_2, O_2 permeance of 269 GPU, 120 GPU, and 26 GPU, respectively, with O_2/N_2, H_2/CH_4, CO_2/CH_4, and CO_2/N_2 selectivity remained higher than the neat membrane. TNT_{48} MMM demonstrated relatively lower fluxes but higher selectivity which ascribed to its smaller internal tube diameter endowing better size-exclusion capability. The TNTs formation mechanisms were discussed to justify the evolution of gas separation performance of TNT-incorporated MMMs. In light of the findings, hydrothermal method can be regarded as a versatile technique for producing TNTs of different morphologies simply by manipulating its reaction parameters. On top of that, TNTs being a low cost material, it holds enormous potential to be widely exploited in gas separation applications.

Keywords: Titania nanotube; synthesis mechanisms; hollow fiber; mixed matrix membrane; gas separation.