

Instytut Inżynierii Chemicznej

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Interphase-engineered Pebax® 1657/Fe₃O₄@ZIF-8 membranes for CO₂/N₂ separation: role of magnetic alignment and humidity

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This study reports the effects of magnetic alignment of the hybrid Fe₃O₄@ZIF-8 filler and operating parameters (humidity, membrane swelling, feed pressure, and long-term stability) on CO₂/N₂ separation in Pebax® 1657 thin-film nanocomposite membranes. The combined effects of filler loading, magnetic alignment, and humidity were systematically analysed to elucidate their influence on the structure and gas transport behaviour of Pebax® 1657. Structural characterization using scanning electron microscopy, differential scanning calorimetry, Fourier-transform infrared spectroscopy, and positron annihilation lifetime spectroscopy revealed that magnetic alignment modifies the microstructure of the Pebax® 1657 matrix, improving the selectivity. Compared with the pristine Pebax® 1657 membrane (CO₂ permeance 7.3 GPU, CO₂/N₂ selectivity 56.9), the incorporation of Fe₃O₄@ZIF-8 and magnetic alignment improves the separation performance under both dry and humid conditions, however with significantly reduced permeance. The optimized membrane containing 4 wt% Fe₃O₄@ZIF-8, fabricated under an external magnetic field, exhibited a CO₂/N₂ selectivity of 117.9 with a CO₂ permeance of 5.7 GPU under humid conditions. The enhanced separation performance is attributed to the reduced aggregation (effect of magnetic orientation) and rigidified polymer regions that preferentially suppress N₂ transport while maintaining CO₂ sorption affinity (effect of filler). Additionally, humidity-assisted transport further enhances CO₂ permeance through plasticization and increased CO₂ solubility in rigidified Pebax® 1657/Fe₃O₄@ZIF-8 matrix.

Metryczka

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