Separation of water/methanol vapour from hydrogen and carbon dioxide gas at high temperature through polyimide membranes

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Abstract:

Carbon dioxide hydrogenation is currently a promising way to produce the future fuel methanol from greenhouse gas, stabilize carbon dioxide level in the atmosphere and assist in the transition to hydrogen economy. Liquid methanol can be utilized as hydrogen carrier for energy storage and transportation due to its high volumetric energy density. However, industrial uptake of this process suffers from high costs due to low carbon conversion and product yield. Methanol production from carbon dioxide is limited by the thermodynamic equilibrium and to overcome this issue membrane reactor technology will be deployed, which removes product(s) from the reacting system. Glassy amorphous polyimides have attracted much attention of membrane industry for decades due to their good thermochemical stability, high gas permeability, structure tunability and high intrinsic permselectivity. In this research, the permeability of methanol and water vapor through polybenzimidazole (PBI), Matrimid®5218 and 6FDA-durene were investigated in temperature range from 100°C to 200°C under pressurized conditions, to evaluate their potential in a membrane reactor configuration The results were then compared with rubbery polymers such as polydimethylsiloxane (PDMS). It was observed that water and methanol vapor permeability through the three polyimides were much higher than hydrogen and carbon dioxide. However, it was also observed that water vapor permeability in the three polyimides reduced with vapour activity while the methanol permeability remained constant within the tested activity range.

Keywords: PBI; Matrimid®5218; 6FDA-durene; vapour separation; carbon dioxide; hydrogen.