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The Effects of Operating Conditions on Gas Transport Mechanisms through SAPO-34 Zeolite Membranes

The demand for energy-efficient gas separation technologies has resulted in increased interest in SAPO-34 zeolite membranes. SAPO-34 is a crystalline molecular sieve with 0.38nm pores that can be grown as thin continuous layers on the inside of porous ceramic tubes to form a membrane. This study investigated the effects of operating conditions on gas transport through SAPO-34 zeolite membranes to determine the quality of the membranes, characterize transport mechanisms, and to evaluate separations of gas mixtures that are of commercial interest.

SAPO-34 zeolite membranes were used to separate gas mixtures at different operating conditions in a custom-built gas separation apparatus. The permeating gas was analyzed by the gas chromatograph. The permeances (flux normalized for pressure) and selectivities (ratio of gas permeances) were measured at different feed gas compositions, temperatures, and pressures to determine membrane quality, identify defects, and develop a model for gas transport.

Results indicate that the membranes are high quality with few defects and primarily separate by adsorption mechanisms and differences in molecular size. Decreased dependencies on operating conditions when compared to previous studies show that SAPO-34 membranes are suitable for operation under a wide range of conditions.

Notably, the results demonstrate that the newly synthesized SAPO-34 zeolite membranes are suitable for a variety of commercial gas separations, including natural gas purification, hydrogen purification, biomass gasification, and carbon sequestration. The use of SAPO-34 zeolite membranes in these commercial processes would allow for more energy-efficient and cost-effective separations when compared to conventional amine scrubber techniques.