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Effect of Defects on Selectivity Parameters of SAPO

In natural gas processing, CO_2 is separated from CH_4 because it is corrosive and decreases the net energy content. SAPO-34 zeolite membranes can provide a less energy-intensive alternative to current, inefficient processes. This study determines defect flux through SAPO-34 zeolite membranes, using i-C_4H_{10} (i-butane: a molecule too large to fit through zeolite pores). An understanding of (a) the contribution of defect flow to overall flow and (b) the defect transport mechanism is important to predict and improve membrane performance. Mixtures of CO_2 with CH_4, and with i-C_4H_{10}, were passed through the membrane, and flow rate and molar concentration were measured in the resulting permeate and retentate streams. Individual gas permeances were calculated and the selectivity of a defect-free membrane was estimated by calculating the CH_4 flux through defects from the i-butane flux (assuming Knudsen transport). The calculated selectivity of a 'defect-free membrane' was very similar to the measured selectivity, indicating that defect flux contribution to overall flux and selectivity is minimal. The low i-butane permeance indicates that the quality of membranes is high. The drop in i-butane permeance with an increase in temperature indicates that defect transport is not exclusively described by Knudsen diffusion and that surface diffusion plays a significant role. However, calculations based on Knudsen transport provide a reasonable estimate and show that CH_4 flux through defects is likely negligible and that the majority of CH_4 permeates through zeolite pores. This study demonstrates the membranes' superior separation qualities and confirms their potential for commercial natural gas processing.