Amine Functionalized Supported Ionic Liquid Membranes (SILMs) for CO2/N2 Separation

Antoine Chamoun-Farah[1, S], Austin N. Keller[1], Mariam Y. Balogun[1], Louise M. Cañada[1], Joan F. Brennecke[1, C] and Benny D. Freeman[1]

[1]*McKetta Department of Chemical Engineering, The University of Texas at Austin, Austin, TX, U.S.A.*
jfb@che.utexas.edu

Supported ionic liquid membranes (SILMs), containing aprotic heterocyclic anion ionic liquids (AHA ILs) in an inorganic inert support, exhibit excellent CO_2/N_2 permselectivity, reaching as high as 640 at 35 °C and 0.03 bar CO_2, conditions similar to post-combustion carbon capture (PCCC) from a natural gas power plant. A Fickian model fit to the experimental data estimates CO_2 permeability at direct air capture (DAC) pressure conditions of 10,400 barrer and a CO_2-N_2 permselectivity of 4,000 for the best performing IL, triethyl(octyl)phosphonium 4-bromopyrazolide ($[P_{2228}][4\text{-BrPyra}]$). The effect of cation size on permeance is studied for the [2-CNPyr]-anion, and it was determined that the smaller $[P_{2228}]^+$ cation outperformed the trihexyl(tetradecyl)phosphonium ($[P_{66614}]^+$) cation because its ILs had a higher carrier concentration and reacted with CO_2 more readily. The most important criterion for high selectivity is a large equilibrium constant for binding between the IL and CO_2, which results in high CO_2 solubility. ILs with smaller molar volumes and without any fluoroalkyl chains enhance N_2 rejection. Low viscosity and high IL molar density also enhance CO_2/N_2 permselectivity and CO_2 permeance. In addition, preliminary humidified mixed-gas results, down to 400 ppm CO_2 (balanced N_2) will be presented for phosphonium-based ionic liquids with AHAs.