Supported Ionic Liquid Membranes for Paraffin/Olefin Separation

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The separation of olefins and paraffins is one of the most energy intensive separations in the chemical industry and it makes up the largest cost in the production of olefins. Currently, this separation is done in large-scale centralized plants using cryogenic distillation. However, cryogenic distillation is prohibitively expensive for small scale operation and this limits the ability to convert paraffins to olefins at or near the wellhead using current technology due to the relatively small amounts at each location. This limitation motivates the use membranes to perform the separation since membranes have a small footprint, are modular in design, and do not have the large capital and energy cost associated with distillation. Ionic liquids with dissolved transition metal salts such as silver have been shown to increase the solubility of olefins, but not paraffins, due to reversible complex formation between olefin and transition metal ion. Due to the negligible volatility of ionic liquids and high olefin solubility through the use of dissolved metal salts, ionic liquids make an excellent solvent choice for supported liquid membranes for paraffin/olefin separation. We present a study of the pure gas permeability and solubility of propane and propylene in two imidazolium ionic liquids containing the bis(trifluoromethanesulfonyl)amide anion using a time-lag method and gravimetric method, respectively. Further the effect of adding silver salts to the ionic liquids to increase the permeability of propylene (and therefore the propylene/propane permeability selectivity) is examined in terms of solubility selectivity and diffusivity selectivity to determine the factors that affect the permeability selectivity upon addition of silver salt. Further we determined the viscosity of these ionic liquid/silver salt systems to explain the observed trends in diffusion coefficients. The breakdown of permeability into its solubility and diffusivity components is necessary to develop structure-property relationships and guide future research.