Solubility of the Noble Gases Argon, Krypton, and Xenon in Ionic Liquids

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The primary motivation of the work is to understand the underlying driving force for solubilization of sparingly soluble gases in Ionic Liquids (ILs). Understanding whether the absorption is controlled by enthalpic interactions or entropic interactions can provide insight into ways of controlling the gas solubility in ILs. The solubility of noble gases, including argon, krypton, and xenon were measured in different ILs with varying size and functionality. The ILs investigated include a series of imidazolium-based ILs and a phosphonium-based IL: trihexyl(tetradecyl)phosphonium bis(trifluoromethylsulfony)amide, $[P_{66614}][Tf_2N]$. The associated Henry's law constants are reported for all systems, as well as enthalpies and entropies of absorption for systems where multiple isotherms are available. Xenon is the most soluble gas with Henry's law constants ranging from 10-100 bar while argon is the least soluble gas studied, with the Henry's law constants on the order of 10^3 bar. The uncertainties in the measurements of argon, krypton, and xenon solubilities are less than 1%, with lower than 3% deviation in the Henry's law constants from the associated smoothing curves. The solubility of xenon increases as the temperature decreases, and all three gas solubilities increase as the alkyl chain length on the imidazolium increases, which indicate a strong correlation between the noble gas solubility and the IL molar volume. A general volume dependence of the noble gas solubility in ILs is obtained.