Pure and Mixed Gas Solubilities in Tunable Ionic Liquids

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We are interested in how ionic liquids (ILs) can be tuned for specific and selective gas separations, in addition to their use as solvents for reactions involving permanent gases like O_2. Selection of different combinations of anions and cations allow the IL to be tuned for specific purposes. Thus, one goal of this work is to measure the solubility of gases in various ILs in order to understand the relationship between IL structure and gas solubility. We are also interested in how the presence of CO_2 affects the solubility of other gases in ILs. CO_2 is quite soluble in ILs; however, reactive gases such as O_2 are only sparingly soluble. The presence of CO_2 may enhance the solubility of the sparingly soluble gases like O_2 in ILs but experimental data is scarce. Consequently, another goal of this work is to measure the solubility of O_2 in CO_2/IL mixtures.

The pure gas solubilities were measured in various imidazolium- and pyridinium-based ILs making use of both physical and chemical absorption. CO_2 solubility was found to be the greatest in all ILs. Physical absorption of gas increased with increased IL fluorination, though chemical absorption by ILs containing amine, acetate and other functional groups was found to be superior to physical absorption. Therefore, we will show that we are able to measure the gas solubility in various ILs using both physical and chemical absorption. The mixed gas solubility of CO_2/O_2 was measured in 1-hexyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([hmim][Tf_2N]). The solubility of O_2 increased substantially compared to its respective pure gas solubility at all pressures. Thus, we show that CO_2 does, indeed, enhance the solubility of O_2 even at low pressures in [hmim][Tf_2N].