

The Solubility of Nitrogen in Ionic Liquids

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Accurate measurements of nitrogen solubility are especially important for the design of carbon capture processes. However, much of the literature currently available on sparingly soluble gases in ionic liquids is limited to low pressures and is hindered by high uncertainties. We present the solubility of nitrogen in ionic liquids with imidazolium, ammonium, pyrrolidinium, and phosphonium cations paired with bis(trifluoromethylsulfonyl)imide (TFSI), dicyanamide (DCA), methylsulfonate (MeSO₃), tetrafluoroborate (BF₄), and triflate (TfO) anions at 23 °C, 40 °C, and 60 °C and pressures up to 140 bar measured gravimetrically. Nitrogen solubility increases with increasing cation alkyl chain length when paired with the same anion. The nitrogen solubility in ionic liquids containing a common 1-ethyl-3-methyl-imidazolium cation follows the trend [BF₄] < [DCA] < [MeSO₃] < [TfO] < [TFSI]. Solubility is directly related to ionic liquid molar volume across all ionic liquids studied. When two ionic liquids with similar molar volume, but different cation structure are compared, the solubility in the cyclic pyrrolidinium ionic liquid is lower than in the tetraalkylammonium ionic liquid. The absorption of nitrogen in alkylmethylimidazolium ionic liquids does not show temperature dependence, suggesting that nitrogen dissolution in these ionic liquids is entirely entropically driven.