Thermophysical Properties of Ionic Liquids and Compressed Gas Mixtures: Experiment and Modeling

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Thermodynamic and transport properties of ionic liquids (ILs) and compressed gases are needed for proper design of a wide variety of engineering applications. Here, we present experimental measuring techniques and results for thermophysical properties including solubility, density, viscosity and thermal conductivity of ILs with gases such as hydrofluorocarbons (HFCs, e.g., R-32, R-125, R-134a), CO_2, NH_3, etc. at elevated temperatures and/or pressures (up to 398.15 K and 20 MPa). The investigated binary mixtures comprise imidazolium-based ILs and several gases with varying structure, polarity, and solvation potential. Large deviations from ideal solution behavior are observed for many of the properties. For instance, linear composition-based mixing rules of the pure component properties underpredict the mixture thermal conductivity by up to 30%. Similarly, investigated mixtures exhibit often large negative excess molar volumes (up to -14 cm^3/mol) and negative "excess" viscosities (up to -11 cP). The accuracy of several models in correlating the density and viscosity of the mixtures is assessed. Utilized models include a volume-translated Peng-Robinson equation of state for the molar volumes and an extension of an Eyring-NRTL model for viscosities. The ramifications of approximations of the mixture properties on engineering unit design are illustrated.