High Pressure Density Measurements of 1-Ethyl-3-Methylimidazolium Ethylsulfate

Ismail Kula, Javid Safarovb,c, Jürgen Nockeb, Astan Shahverdiyevc, Egon Hasselb

a) Department of Chemistry, Department of Biochemistry, Widener University, One University Place, Chester, PA 19013, USA.
b) Institute of Technical Thermodynamics, University of Rostock, Albert-Einstein-Str. 2, D-18059 Rostock, Germany.

Ionic liquids (ILs) are salts that are liquid at room temperature. They are non-flammable, thermally stable, and have very small vapor pressures. They are also characterized as promising solvents for clean processes and green chemistry. ILs are promising ideal systems which can be used for different purposes in chemistry: catalysis, separation processes and electrochemistry.

There have been intensive studies of thermophysical investigations of ILs in the literature since the last two-three decades. Our research group has also intensively investigated the thermophysical properties of various ILs. In this work, we studied the \( p,T \) properties of 1-Ethyl-3-methylimidazolium ethylsulfate \([\text{EMIM}][\text{EtSO}_4]\) at \( T = (283.15 \text{ to } 413.15) \text{ K} \) and at pressures \( p = (0.101 \text{ to } 140) \text{ MPa} \), using a new modernized high pressure – high temperature Anton-Paar DMA HPM vibrating tube densimeter.

Densities of \([\text{EMIM}][\text{EtSO}_4]\) at ambient pressure and at temperatures \( T = (283.15 \text{ to } 363.15) \text{ K} \) were also measured using Anton-Paar DMA 5000 vibrating tube densimeter for comparison with the existing literature data. The density measurements is predicted to be equivalent to the reproducibility of the density measurements, i.e. \( \Delta \rho/\rho = \pm(0.01 \text{ to } 0.08) \text{ %} \).

The measured densities as a function of pressure and temperature were fitted to an empirical equation of state, which fits the experimental results of density of \([\text{EMIM}][\text{EtSO}_4]\). This equation was used for the calculation of thermal properties of the ionic liquid (IL), such as isothermal compressibility, isobaric thermal expansibility, differences in isobaric and isochoric heat capacities, thermal pressure coefficient and internal pressure as a function of pressure and temperature. Internal pressure and the temperature coefficient of internal pressure data were used to make conclusions on the molecular characteristics of the IL.