**ABSTRACT**

Ionic liquids (ILs) have many properties that make them an attractive candidate for replacing organic solvents in ion-lithium batteries. ILs are highly conductive, have negligible vapor pressure and thermally stable to high temperatures. This work investigates the effect of water on the electrical conductivity of select ILs while monitoring the density and viscosity. ILs readily absorb water and will likely contain water in any practical application. For the ILs investigated, water had no impact on the conductivity up to 1 weight percent water, increased the conductivity as the viscosity dropped according to the expected trend described by the Walden rule. Additional water after 10 weight percent significantly decreased performance.

**OBJECTIVES**

- Study effect of water on conductivity, viscosity and density of ionic liquids (ILs)
- Develop a project that connects STEM research to classroom objectives

**EXPERIMENTAL METHODOLOGY**

- **Ionic Liquids Prepared**
  - 1-ethyl-3-methylimidazolium 2-cyanopyrrolide ([emim][CNpyr])
  - 1-butyl-3-methylimidazolium 2-cyanopyrrolide ([BMMIM][CNpyr])
  - 1-octyl-3-methylimidazolium 2-cyanopyrrolide ([P2228][CNpyr])

- **Density Measurements:** DMA 4500 Anton Paar oscillating U-tube densitometer
  - Uncertainty ±0.01 g/cm³
  - Temperature uncertainty ±0.1 K

- **Viscosity Measurements:** Brookfield DV-III Ultra (cone and plate) rheometer
  - 0.5 to 100 cP: MS 1.6 mm tube
  - 5 to 70 cP: MS 1.8 mm tube

- **Electrical Conductivity Measurements:** Solartron SI 1260 Impedance / Gain-phase analyzer connected to a Solartron 1287 electrochemical interface
  - Uncertainty ±3%
  - Temperature uncertainty ±0.1 K

**RESULTS**

- **Effect of Water on Viscosity and Conductivity at 25 °C**
  - [P2224][CNpyr]
  - [P2228][CNpyr]
  - [emim][CNpyr]

- **Effect of Water on Walden Plot**
  - [P2224][CNpyr]
  - [P2228][CNpyr]
  - [emim][CNpyr]

- **Effect of Water on Density at 25 °C**

**CONCLUSIONS**

- Water had little impact on the conductivity and viscosity of [P2224][CNpyr] and [emim][CNpyr] up to 1 wt% which resulted in little impact on the performance of the IL on the Walden plot.
- [P2228][CNpyr] had an initial increase in viscosity while maintaining the same conductivity, which created a slight increase in performance on the Walden plot.
- The performance of [P2228][CNpyr] on the Walden plot was relatively constant up to 10 wt% water, after which a decrease in performance was observed.

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