Synthesis and Characterization of an Extractant [Bmim]PF$_6$ for Lithium Ion

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With the rapid increasing demand of metal lithium and its compounds in science and technology, studies on lithium recovery though lithium ion extraction from salt lake brines are blooming because more than 60 percent of the global total lithium resources are located in salt lakes (Wang, 1999; Zhang and Guo, 2001). Although solvent extraction as one of the effective approaches, the traditional extractant for lithium ion recovery from salt lake brines is scarce for its serious environmental pollution of their high volatility and soluble loss. Compared with the traditional volatile organic solvent, imidazolium-based ionic liquid is a new type of green extractants for its superb extractive properties and environmentally friendly (Rogers and Seddon, 2003). Hence, it is meaningful to develop a more effective synthesis approach and study the relevant physicochemical properties of imidazolium-based ionic liquid.

In this paper, a green extractant of [Bmim]PF$_6$ (1-butyl-3-methylimidazolium hexafluorophosphate) was synthesized with the ultrasonic-assisted method under a high purity nitrogen environment (Zhang et al., 2006). Factors affecting the yield of intermediate [Bmim]Br including reaction time, frequency, the mole ratio of reactants and those of target product [Bmim]PF$_6$ including reactive time and solvent volume were systematically investigated, parts of the results were shown in Figures 1 and 2. The physicochemical structure of the final product were also characterized by FT-IR and UV, and the results demonstrated that the synthetic method is feasible. The infrared spectrum and UV spectrum of [Bmim]PF$_6$ were illustrated in Figures 3 and 4.

In addition, the physicochemical properties including the content of water, density, refractive index of [Bmim] PF$_6$ at room temperature and atmospheric pressure were also determined by using karr Fischer moisture meter (V20), densitometer (DMA 4500M) and automatic

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refractometer (Abbemat 550). Density, refractive index and moisture data of [Bmim]PF₆ at different temperatures were presented in Figure 5. Results illustrated in Figure 5 show that density and refractive index of [Bmim]PF₆ are shown an inverse relationship with temperature, and both density and refractive index of [Bmim]PF₆ appear a good linear downward trend as the temperature increases.

Furthermore, different extractive system for lithium ion recovery from high Mg/Li salt lake brine was investigated to verify the extraction capability of [Bmim]PF₆. From the results that showed in Figure 6, we can deduced that the ionic liquid [Bmim]PF₆ added extractive system shows better extraction performance for lithium recovery as compared with the traditional extraction system, especially separation factor of Li and Mg for the extraction system of (IL + T + F) were reach to 42.98, which achieved a higher separation of lithium and magnesium for high Mg/Li salt lake brine.

Key words: [Bmim]PF₆; ultrasonic-assisted; density; refractive index

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References


