

The Evaporation Study of 1-ethyl-3-methylimidazolium chloride

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Abstract : The ionic liquids (ILs) based on imidazolium cation are well known nowadays. The changing anions and substituents in imidazolium ring may lead to different physical and chemical properties of ILs. It is important that such ILs with halogen as anion are characterized by a low thermal stability. The data about thermal stability of 1-ethyl-3-methylimidazolium chloride are ambiguous. In the works of last years, thermal stability of this IL was investigated by thermogravimetric analysis and obtained results are contradictory. Moreover, in the last study, it was shown that the observed temperature of the beginning of decomposition significantly depends on the experimental conditions, for example, the heating rate of the sample. The vapor pressure of this IL is not presented at the literature. In this study, the vapor pressure of 1-ethyl-3-methylimidazolium chloride was obtained by Knudsen effusion mass-spectrometry (KEMS). The samples of [EMIm]Cl (purity > 98%) were supplied by Sigma-Aldrich and were additionally dried at dynamic vacuum ($T = 60\text{ }^{\circ}\text{C}$). Preliminary procedures with IL were derived into glove box. The evaporation studies of [EMIm]Cl were carried out by KEMS with using original research equipment based on commercial MI1201 magnetic mass spectrometer. The stainless steel effusion cell had an effective evaporation/effusion area ratio of more than 6000. The cell temperature, measured by a Pt/Pt-Rh (10%) thermocouple, was controlled by a Termodat 128K5 device with an accuracy of $\pm 1\text{ K}$. In first step of this study, the optimal temperature of experiment and heating rate of samples were customized: 449 K and 5 K/min, respectively. In these conditions the sample is decomposed, but the experimental measurements of the vapor pressures are possible. The thermodynamic activity of [EMIm]Cl is close to 1 and products of decomposition don't affect it at firstly 50 hours of experiment. Therefore, it lets to determine the saturated vapor pressure of IL. The electronic ionization mass-spectra shows that the decomposition of [EMIm]Cl proceeds with two ways. Nonetheless, the MALDI mass spectra of the starting sample and residue in the cell were similar. It means that the main decomposition products are gaseous under experimental conditions. This result allows us to obtain information about the kinetics of [EMIm]Cl decomposition. Thus, the original KEMS-based procedure made it possible to determine the IL vapor pressure under decomposition conditions. Also, the loss of sample mass due to the evaporation was obtained.

Keywords : ionic liquids, Knudsen effusion mass spectrometry, thermal stability, vapor pressure

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