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Dual Amino-Functionalized Imidazolium Ionic liquids for CO_2 capture

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Extended Abstract

Although the amine processes have been used over decades for acid gas removal, the amine absorbents still have various drawbacks such as degradation, corrosion, solvent loss, etc. Ionic liquids have the advantages of low heat capacity, negligible vapor pressure, and so on, and are attracting much attention for replacing amines. Although room temperature ionic liquids (RTILs) could lower the regeneration energy of the absorbent, the CO_2 absorption capacity of RTILs at atmospheric pressure is too low. On the other hand, task-specific ionic liquids (TSILs) have relatively higher absorption capacity than RTILs at atmospheric pressure. One of the TSILs is AAILs (amino acid based ionic liquids). Although AAILs have relatively high absorption capacity, CO_2 absorption rate is slow. [1] As the CO_2 loading increases, the viscosity of AAILs also increases rapidly. In this study, a new ionic liquid composed of imidazole cation with side chain and amino acid anion was synthesized to decrease the viscosity by increasing the intermolecular distance. The synthesized ionic liquid would have relatively higher CO_2 absorption capacity and faster absorption rate as well as lower viscosity than the other AAILs.

1-(2-Aminoethyl)-3-ethylimidazole and 1-(2-aminopropyl)-3-ethylimidazole were selected as cations for synthesis of ionic liquid. The selected imidazole-based materials have long side chains, which can lower the intermolecular interactions, so that it is expected that they will have a relatively low viscosity when absorbing CO_2 than other AAILs. CO_2 absorption capacity also increases due to the presence of amino group of cations.

As the anion, several kinds of amino acids having both carboxylic group and amino group in the molecule were selected. The carboxylic group in the amino acid could lower the regeneration energy of the absorbent and increase the CO_2 absorption capacity because it acts to lower the basicity. The amino acids were chosen to be free of side chains, Lewis acids, hydrogen ions, and ketone groups that could interfere with CO_2 absorption. These functional groups can lead to unnecessary molecular structural modifications or the transfer of electrons from nitrogen to oxygen in amino acids.

In this study, glycine, β-alanine, lysine are selected as anion for synthesis of ionic liquid. Some of the following combinations of ionic liquids were synthesized: 1-(2-aminoethyl)-3-ethylimidazolium glycine ([aeeim][gly]), 1-(2-aminoethyl)-3-ethylimidazolium alanine([aeeim][ala]), 1-(2-aminoethyl)-3-ethylimidazolium lysine ([aeeim][lys]), 1-(3-aminopropyl)-3-ethylimidazolium glycine ([apeim][gly]), 1-(3-aminopropyl)-3-ethylimidazolium alanine ([apeim][ala]), 1-(3-aminopropyl)-3-ethylimidazolium lysine ([apeim][lys]). Metylimidazole or ethylimidazole and bromoethylamine hydrobromide were reacted in ethanol. Then, anion Br was turned into anion OH via the ion change. Finally, anion OH was turned into anion amino acid (glycine, β-alanine, lysine) by a neutralization reaction. [2]-[3]

^{1}H-NMR and ^{13}C-NMR analyses were conducted to identify the chemical structure of synthesized ionic liquids. Cyclic CO_2 absorption test (absorption – desorption – absorption) were conducted. CO_2 absorption abilities of the synthesized ionic liquids were compared with that of aqueous monoethanolamine(MEA) solution. Viscosities of synthesized ionic liquids were also measured.

References

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