Thermophysical Properties of Amino Acid Salt Solutions for Carbon Capture Applications

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Absorption utilising amine solvents is currently the most mature approach to post-combustion carbon capture. Unfortunately, aqueous amine solutions present certain problems including degradation, toxicity and corrosivity. Aqueous amino acid salt solutions are proposed as potential alternatives to amine solvents in these applications. Amino acids are organic compounds containing at least one amino group and a carboxylic functional group. Research suggests that amino acid salt solutions have properties that make them suitable alternatives to amine solvents, with beneficial properties such as resistance to degradation, low volatility, low toxicity and minimal corrosivity. For this work, the potassium salts of three amino acids (glycine, proline, and arginine) have been investigated. The properties studied in this work are vapour liquid equilibrium (VLE), density, and viscosity of the CO_2-free and loaded amino acid salt solutions.

A bespoke semi-analytical VLE apparatus was designed and used to measure the solubility of CO_2 in the amino acid salt solutions. The previously-evacuated VLE cell was initially partially filled with the degassed solvent. CO_2 was then admitted in stages from a calibrated and thermostated reservoir. The pressure and temperature in both the VLE cell and the reservoir were continuously monitored so that the amount of CO_2 transferred could be evaluated. A small head-space correction was applied to allow the amount of CO_2 actually dissolved to be determined. The apparatus was validated by means of measurements on a 30 mass% aqueous ethanolamine solution and the results were found to be in good agreement with the literature. The results for CO_2 solubility in the amino acid salt solutions are presented in comparison with a thermodynamic model based on chemical equilibria and an activity-coefficient model.

An oscillating tube densimeter with high-pressure capability was used to determine the density of the amino acid salt solutions with and without dissolved CO_2. The viscosity of the same solutions was determined using a combination of techniques, including capillary viscometry and measurements with a rotational Couette viscometer. Correlations of the low-pressure density and viscosity as function of temperature and CO_2 loading will be presented.

The amino acid salt solutions were prepared gravimetrically using solid amino acids and a premixed aqueous KOH solution. Three solution molalities were investigated for each amino acid salt, with a temperature range between (313 and 393) K. The viscosity measurements were limited to $T \leq 333$ K due to the loaded solvent degassing at higher temperatures.