

Calorimetric Measurements of Heat of Absorption of Carbon Dioxide in a Series of Anion-Functionalized Ionic Liquids

Marjorie Massel^S and Joan F. Brennecke^C

University of Notre Dame, Department of Chemical and Biomolecular Engineering, Notre Dame, IN, U.S.A.

jfb@nd.edu

Technologies for the removal of carbon dioxide from post-combustion flue gas have an essential role to play in slowing down or even reversing global climate change. The challenge is to design a capture unit that will absorb carbon dioxide efficiently while minimizing the parasitic energy and environmental impact. Ionic liquids are often presented as promising solvents for this application. They have numerous advantages over aqueous amine solutions, such as high stability and low volatility. In particular, we have developed a series of ionic liquids based on aprotic heterocyclic anions. They have high CO₂ capacity, as high as one mole of CO₂ per mole of ionic liquid, and do not significantly increase in viscosity when they react with CO₂. The cost of the capture unit is mainly dictated by the cost of regeneration of the solvent, which is in turn determined by the heat of reaction and absorption of carbon dioxide in the ionic liquid. While heats of absorption can be estimated from CO₂ uptake at multiple isotherms, our efforts have concentrated on producing direct and accurate measurements by calorimetry. In this work, enthalpies of absorption were measured for a series of anion-functionalized ionic liquids that chemically complex with carbon dioxide. The ionic liquids have been designed with various functional groups, such as trifluoromethyl-, cyano- and nitro-, to weaken the heats of reaction to various extents. A Setaram microDSC III calorimeter with modified cells and injection system was used to measure the heat released upon reaction and absorption of carbon dioxide. The modifications of the calorimeter have allowed more accurate measurements. We compare the results for the different anion-functionalized ionic liquids with theoretical calculations and, when available, the values estimated from CO₂ uptake isotherms.