Department of Chemical Engineering Seminar Series

Using Ionic Liquids for Post-Combustion Carbon Capture

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Monday, April 27, 2015
Lecture: 4:00-5:00 p.m.
Physics Astronomy Building (PAA) A118
Reception at 3:30 p.m. PAA A118

Abstract

Ionic liquids (ILs) present intriguing possibilities for removal of carbon dioxide from a wide variety of different gas mixtures, including post-combustion flue gas, pre-combustion gases, air, and raw natural gas streams. Even by physical absorption, many ILs provide sufficient selectivity over N_2, O_2, CH_4 and other gases. However, when CO_2 partial pressures are low, the incorporation of functional groups to chemically react with the CO_2 can dramatically increase capacity, while maintaining or even enhancing selectivity. We will demonstrate several major advances in the development of ILs for CO_2 capture applications. First, we will show how the reaction stoichiometry can be doubled over conventional aqueous amine solutions to reach one mole of CO_2 per mole of IL by incorporating the amine on the anion. Second, we will show how we have been able to virtually eliminate any viscosity increase upon complexation of the IL with CO_2, by using aprotic heterocyclic anions (AHA ILs) that eliminate the pervasive hydrogen bonding and salt bridge formation that is the origin of the viscosity increase. Third, we will describe the discovery of AHA ILs whose melting points when reacted with CO_2 are more than 100 °C below the melting point of the unreacted material. These materials allow one to dramatically reduce the energy required for CO_2 release and regeneration of the absorption material because a significant amount of the energy needed for the regeneration comes from the heat of fusion as the material releases CO_2 and turns from liquid to solid.

Speaker Biography

Joan F. Brennecke is the Keating-Crawford Professor of Chemical Engineering at the University of Notre Dame and was the founding Director of the Center for Sustainable Energy at Notre Dame. She joined Notre Dame after completing her Ph.D. and M.S. (1989 and 1987) degrees at the University of Illinois at Urbana-Champaign and her B. S. at the University of Texas at Austin (1984).

Her research interests are primarily in the development of less environmentally harmful solvents. These include supercritical fluids and ionic liquids. In developing these solvents, Dr. Brennecke's primary interests are in the measurement and modeling of thermodynamics, thermophysical properties, phase behavior and separations. Major awards include the 2001 Ipatieff Prize from the American Chemical Society, the 2006 Professional Progress Award from the American Institute of Chemical Engineers, the J. M. Prausnitz Award at the Eleventh International Conference on Properties and Phase Equilibria in Greece in May, 2007, the 2008 Stieglitz Award from the American Chemical Society, the 2009 E. O. Lawrence Award from the U.S. Department of Energy, and the 2014 E. V. Murphree Award in Industrial and Engineering Chemistry from the American Chemical Society. She serves as Editor-in-Chief of the Journal of Chemical & Engineering Data. Her 130+ research publications have garnered over 12,000 citations. She was inducted into the National Academy of Engineering in 2012.