

# Designing Ionic Liquids for CO<sub>2</sub> Separations

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## Abstract

Ionic liquids 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<sub>2</sub>, O<sub>2</sub>, CH<sub>4</sub> and other gases. However, when CO<sub>2</sub> partial pressures are low, the incorporation of functional groups to chemically react with the CO<sub>2</sub> can dramatically increase capacity, while maintaining or even enhancing selectivity. We will demonstrate five major advances in the development of ILs for CO<sub>2</sub> capture applications. First, we will show how the reaction stoichiometry can be doubled over conventional aqueous amine solutions to reach one mole of CO<sub>2</sub> 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<sub>2</sub>, 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 show the advantage of phosphonium cations over their imidazolium counterparts. Fourth, we will elucidate the role water plays in both the reaction chemistry and the viscosity. Finally, we will discuss the role that the cation plays in the reaction chemistry.