the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Design and Evaluation of Ionic Liquids as Novel Absorbents

Background

There is growing concern among climate scientists that the buildup of greenhouse gases (GHG), particularly carbon dioxide (CO_2), in the atmosphere is affecting the global climate in ways that could have serious consequences. One approach to reducing GHG emissions is to scrub CO_2 from the flue gas of power plants and sequester it in geologic formations. Although it is technically feasible to remove CO_2 from flue gas, current processes are too expensive. New, less expensive processes are needed. This project is investigating the feasibility of using a novel class of compounds – ionic liquids – for the capture of CO_2 from the flue gas from coal and natural gas–fired power plants. The success of ionic liquids technology will be based on increasing the knowledge base on the chemical characteristics of ionic liquids and on the competitiveness of processes which utilize ionic liquid based absorbents for CO_2 capture from flue gas streams compared to commercial amine-based technologies. The successful ionic liquid absorbent will have high CO_2 selectivity and capacity (i.e., a Henry's law constant lower than 10 bar) with a low energy requirement for regeneration (i.e., an enthalpy of absorption less than 60 kJ/mol).

Description

The fundamental factors influencing the absorption of CO_2 and other gases present in flue gas streams will be determined, relevant thermo-physical and phase behavior properties measured, and a preliminary process design for the use of ionic liquids in an absorption separation system developed.

Primary Project Goal

The primary goal of this project is to provide a comprehensive evaluation of the feasibility of using a novel class of compounds – ionic liquids – for the capture of CO_2 from the flue gas of coal- and natural gas-fired power plants.

CONTACTS

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PARTNERS

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PERFORMANCE PERIOD

Start Date	End Date
07/16/04	07/15/07

COMPLETED

COST

Total Project Value
$434,076

DOE/Non-DOE Share
$434,076 / $0

Objectives

The objectives of the project are to:

- Produce a range of ionic liquid sorbents for further evaluation.
- Determine the fundamental factors influencing the absorption of CO_2 and other gases present in flue gas streams.
- Determine relevant thermo-physical and phase behavior properties.
- Develop a preliminary process design that uses ionic liquids in an absorption separation system.

Benefits

If CO_2 capture from flue gas is to become economically feasible, improved capture processes are needed. The use of ionic liquids as CO_2 absorbents holds promise for reducing costs by developing a process with higher CO_2 loading in the circulating liquid and lower heat requirements for regeneration. Both of these effects would lower process costs.

Accomplishments

- Thirty-three ionic liquids were synthesized or acquired. Preliminary tests were performed on all of these compounds, and more extensive tests on those that looked most promising for CO_2 capture. CO_2 solubility was measured in ten of these ionic liquids. Through these efforts, an ionic liquid was developed that has a CO_2 solubility 2.6 times greater than the highest performing ionic liquid available at the start of the project.
- Researchers demonstrated that SO_2 is also extremely soluble in ionic liquids, opening up the possibility of using ionic liquids to remove both SO_2 and CO_2 from flue gas.
- A preliminary systems analysis was conducted and the results used to help identify key physical properties that must be optimized to enable ionic liquids to be cost-competitive for CO_2 capture. It was found that increasing the capacity of the ionic liquids for CO_2 would be important, and that doing so could potentially make ionic liquids more effective than conventional amine solvents.
- The results obtained over the three years of the project suggest that further study is warranted to investigate if ionic liquids may provide a new and better way of performing post-combustion CO_2 capture.