the ENERGY lab

PROJECT FACTS

Carbon Sequestration

SO_2-Resistent Immobilized Amine Sorbents for CO_2 Capture

Background

Increased attention is being placed on research into technologies that capture and store carbon dioxide (CO_2). Carbon capture and storage (CCS) technologies offer great potential for reducing CO_2 emissions and, in turn, mitigating global climate change without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCS specialties that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) has selected 43 projects to receive more than $12.7 million in funding, the majority of which is provided by the American Recovery and Reinvestment Act (ARRA) of 2009, to conduct geologic sequestration training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects will include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term CO_2 storage; and CO_2 capture.

Project Description

DOE is partnering with the University of Akron (Akron) to conduct research and training to develop an effective solid amine sorbent for large scale CO_2 capture from power plant flue gas. Sorbent materials developed by Akron consist of immobilized carbon and hydrogen structures (paraffin) distributed inside of the amine pores and aromatic amines located on the external surface and the pore mouth of the sorbent. The immobilized paraffinic amines have been shown to display excellent CO_2 capture capacity by adsorbing CO_2 at temperatures below 55 °C and releasing it at temperatures between 80-120 °C. This effort will focus on increasing scientific understanding of the chemical and physical principles affecting amines deposited on a series of porous solids that generally have large pore space, high surface area, and/or high thermal conductivity. The proposed dual amines structure are expected to capture sulfur dioxide (SO_2) on the pore mouth and particle surface, thus addressing the typical challenges associated with power plant flue gas SO_2 removal (desulfurization FGD).

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PARTNERS

None

PROJECT DURATION

Start Date
12/01/2009

End Date
11/30/2012

COST

Total Project Value
$386,052

DOE/Non-DOE Share
$300,000/$86,052

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

The project will investigate scientific concepts regarding CO_2 flue gas capture using amine sorbents including:

- Effects of the amine and adsorbed CO_2 species on the CO_2 adsorption capacity of the sorbent.
- Effects of SO_2 on CO_2 adsorption capacity of the solid amine sorbent.
- Thermal stability and long term CO_2 adsorption/regeneration capacity as well as the kinetics associated with CO_2 adsorption and desorption.
- Kinetics of CO_2 absorption and desorption.

Goals/Objectives

The primary objective of the project is to develop an efficient and low-cost CO_2 capture solid sorbent which is highly resistant to SO_2 and thermal degradation. Results from characterization and sorbent performance will provide the database needed for fine-tuning the basicity, dispersion, and distribution of immobilized amines on a series of porous solids. The proposed concept for this project can be further extended to the preparation of highly poison-resistant basic catalysts for organic synthesis.

Benefits

This project will provide greater insight into the development of higher efficiency and lower cost CO_2 flue gas capture technologies. The capture of CO_2 from large point-sources is an essential step toward developing large-scale CCS operations. Furthermore, this project will contribute key innovative concepts to the development of CO_2 capture technologies, including the use of PEG (polyethylene glycol) as a template to control the pore size of sorbent particles, and the use of a covalent bond linker to bind the sorbent structure (Figure 1).

It is expected that the low cost of raw materials for the synthesis of these dual-amine sorbents could lead to a breakthrough in technology for the effective capture of CO_2 from flue gas of coal-fired power plants. The added benefit of this ARRA funded opportunity is that college students participating in this effort will learn how to use basic chemistry and chemical engineering principles to deal with critical issues in sorbent preparation, performance evaluation, and characterization.

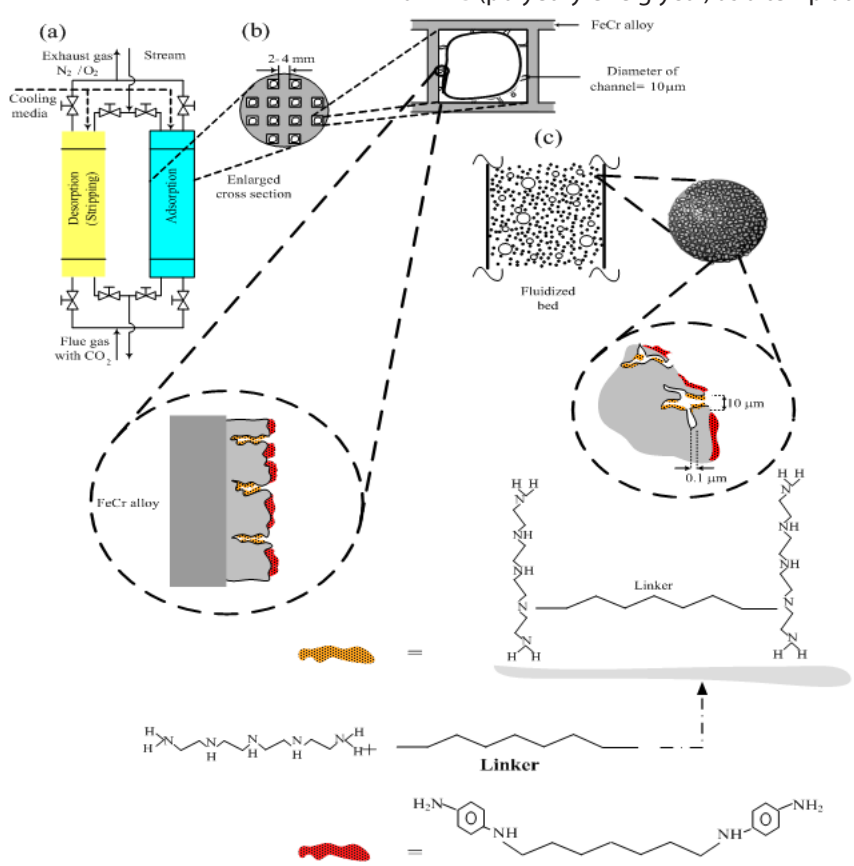

Figure 1: Schematic of proposed amine absorbent concept by the University of Akron. The proposed sorbent particles consist of immobilized paraffinic amines distributed inside amine pore spaces, and aromatic amines on the external pore surface.