PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

4/2008

CARBON DIOXIDE SEPARATION WITH NOVEL MICROPOROUS METAL ORGANIC FRAMEWORKS

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Background

UOP LLC, in collaboration with Vanderbilt University and the University of Edinburgh, is working to develop novel microporous metal organic frameworks (MOFs) and an associated process for the removal of CO_2 from coal-fired power plant flue gas. This innovative project will exploit the latest discoveries in an extraordinary class of materials (MOFs) having extremely high adsorption capacities. MOFs have previously exhibited exceptional adsorption capacity for methane, hydrogen, and other gases. MOFs are hybrid organic/inorganic structures – essentially scaffolds made up of metal hubs linked together with struts of organic compounds, a structure designed to maximize surface area. MOF sorption properties can be readily tailored by modifying either the organic linker and/or the metal hub.

Description

During Phase I, UOP will use its combinatorial chemistry capabilities to systematically synthesize a wide range of state-of-the-art MOFs and related materials. UOP will screen the materials for hydrothermal stability and characterize materials of particular interest. Detailed isotherm data will be collected in the low-pressure regime in order to establish a consistent, relevant baseline for subsequent development and optimization. The results of the baseline studies will be used to guide the ongoing synthesis, screening,

PARTNERS

UOP LLC

Vanderbilt University

University of Edinburgh

and measurement of new MOFs. In Phase II, up to 10 candidates will be selected for optimization, based on Phase I results. The effects of water on CO_2 adsorption will be measured in parallel with the development and validation of material scale-up and forming procedures. During Phase III, one or two of the best materials will be selected for final optimization and scale-up to pilot-scale quantities. The effects of contaminants on the performance of scaled-up, formed materials will be optimized and detailed kinetic and equilibrium data will be collected. These data will be incorporated into a process design and process economic analysis, leading to the design of a pilot study.

Primary Project Goal

The primary goal of this project is to develop a low-cost, novel sorbent and associated process to remove CO_2 from coal-fueled power plant flue gas in a cost effective manner.

Objectives

The objective of this project is to develop a low-cost novel sorbent and an associated process that demonstrates:

- High adsorption capacity
- High selectivity
- Good adsorption/desorption rates
- Ease of regeneration

- Hydrothermal and contaminant stability

- Potential to meet or exceed DOE's post-combustion CO_2 capture targets of 90% CO_2 capture at less than 20% increase in the cost of energy services by 2012

Benefits

Although oil production in the United States has been gradually declining, the nation has huge reserves of coal. Unfortunately, when coal is burned, it releases more CO_2 per unit of heat than any other fossil fuel, and anthropogenic CO_2 is believed to be contributing to global warming and climate change. Successful completion of this program could lead to a low-cost, novel sorbent to remove CO_2 from flue gas in electric power plants. The captured CO_2 could then be sequestered to prevent its emission to the atmosphere. This would enable the use of our coal reserves as an energy source without contributing to global warming, while simultaneously creating jobs and reducing our dependence on imported oil.

Accomplishments

- More than 23 different MOF materials have been prepared toward a goal of up to 50 materials.

- Prepared materials have been characterized by conventional techniques such as x-ray diffraction, thermal gravimetric analysis, and high-resolution electron microscopy to ultimately enhance the understanding of relationships among material properties and CO_2 capture performance.

- Initial CO_2 adsorption measurements have been carried out at Vanderbilt University and the University of Edinburgh.

PERFORMANCE PERIOD

4/01/2007 to 3/31/2010

COST

Total Project Value
$2,802,200

DOE/Non-DOE Share
$2,230,672 / $571,528

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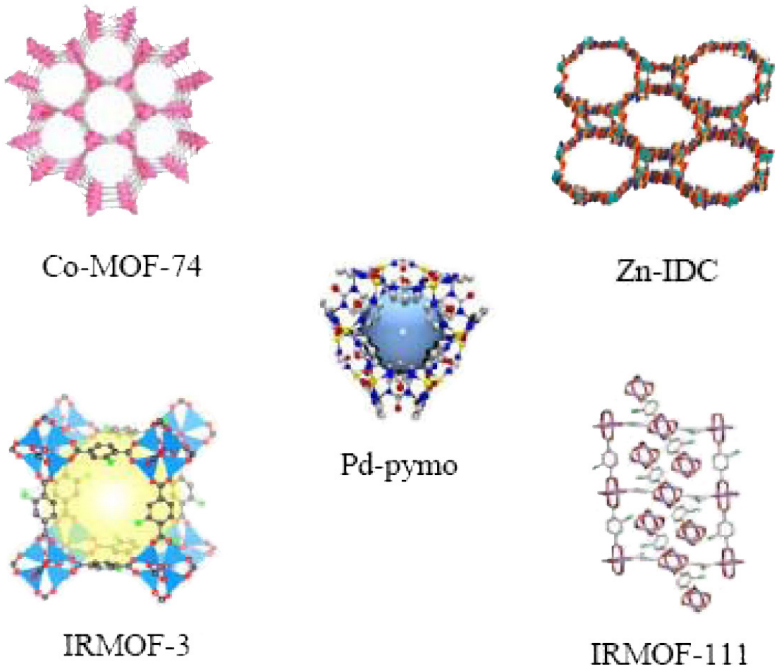

Examples of several MOFs under investigation.