PROJECT facts

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

Carbon Sequestration

08/2007

CO_2 Removal From Flue Gas Using Microporous Metal Organic Frameworks

CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4867
sean.plasynski@netl.doe.gov

David Lang
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4881
david.lang@netl.doe.gov

Richard Willis
Principal Investigator
UOP LLC
50 East Algonquin Rd.
Des Plaines, IL 60017
847-391-3190
richard.willis@uop.com

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 asscociated 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 adorption 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

The scope of this project is to develop a MOF-based CO_2 removal process and design a pilot study to evaluate the performance and economics of the process in a commercial power plant. 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 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 objective of this project is to develop a low cost novel sorbent and the process around it to capture CO_2 from coal-based power plant flue gas in a cost-effective manner.

PARTNERS

UOP LLC
Vanderbilt University
University of Edinburgh

PROJECT DURATION

04/01/07 to 03/31/10

COST

Total Project Value
$2,802,200

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

ADDRESS

National Energy Technology Laboratory

1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5892

2175 University Avenue South
Suite 201
Fairbanks, AK 99709
907-452-2559

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

One West Third Street,
Suite 1400
Tulsa, OK 74103-3519
918-699-2000

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Objectives

- Phase I – Evaluate known MOF materials and enable down-selection to <10 candidate materials for further development based on CO_2 capacity and hydrothermal stability.
- Phase II – Further develop and test up to 10 MOF materials and demonstrate one or more MOF materials with improved performance and stability that are suitable for optimization and scaleup in Phase III.
- Phase III – Demonstrate one or more MOF materials that meet performance targets and have sufficient stability to carry into pilot testing.

Benefits

Current CO_2 capture technology imposes a significant cost burden on delivering electricity. The proposed technology has the potential to change the CO_2 capture economics, enabling practical CO_2 sequestration and accelerating the widespread use of CO_2 capture in the power-generation industry.

Accomplishments

This is a new project. During the first quarter, significant progress was made on the synthesis of MOF materials, as more than 10 materials were successfully prepared. The materials were 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.