the ENERGY lab

PROJECT FACTS

Carbon Sequestration

High Fidelity Computational Analysis of CO_2 Sorption at Pore Scales in Coal Seams

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

The DOE is partnering with the University of Texas at El-Paso (UTEP) to devise a new mathematical model for understanding CO_2 sorption mechanisms in coal seams. The work by UTEP will focus on devising a new mathematical model utilizing variational techniques for pore size and geometry in order to understand CO_2 transport and sorption within a coal bed. The project will focus also on techniques to predict the amount of free-phase CO_2 sequestered in pores due to capillary effects, and describe the interaction between fluid phases and the wide variety of statistical pore shapes that are modeled in the pore-pore throat model.

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

Justin Glier
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-5255
justin.glier@netl.doe.gov

Vinod Kumar
Principal Investigator
University of Texas at El-Paso
500 West University Avenue
El Paso, Texas 79968
304-285-5255
vkumar@utep.edu

PARTNERS

Oak Ridge National Laboratory
Shell Oil Company

PROJECT DURATION

Start Date

12/01/2009

End Date

11/30/2012

COST

Total Project Value

$288,858

DOE/Non-DOE Share

$288,858/$0

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

The project model is specifically geared for both single- and multi-phase flow in porous media, typical of storage formations for geologic storage of CO_2. First, UTEP will develop a novel computational technique to estimate hydraulic conductance in pore space. Thin section images, micro-CT scanning, simulations of depositional processes, and application of a previously developed hydraulic conductance technique will be performed on a representative sample of a formation type being considered for CO_2 injection. Results from this step will be used to develop a pore network simulation of CO_2 transport, as well as for the trapping and reaction phenomena typical of geologic storage of CO_2. The simulation results will be validated by experimental data provided from a study by Oak Ridge National Laboratory (ORNL). Once the initial pore network simulation can be refined, UTEP will develop an iteratively coupled numerical algorithm to solve multiscale phenomena and predict the effects of storage mechanisms and efficiency on a three-phase (water-CO_2-oil) geologic storage system at the reservoir scale. Project research will be conducted primarily by graduate students.

Goals/Objectives

The goal of the project is to develop a mathematical pore-network simulation based on coupled variational techniques in order to describe the migration and free-phase trapping kinetics of CO_2 in porous rock in the subsurface, and to provide support for one graduate and one undergraduate student from UTEP to participate in cutting-edge CCS research Specific project objectives include:

- Developing a computational technique to estimate hydraulic conductance in pores.
- Constructing and simulating a multiphase system with regular and irregular geometries.
- Applying hydraulic conductance findings into the TOUGH2 Reservoir Simulator.

Benefits

The long-term benefit of this project is to advance the fundamental understanding of CO_2 storage and mobility in the presence of oil/natural gas and water/water vapor in geological environments, as well as to quantify interactions within various porous geological materials including coals, shales, and sandstones. Furthermore, the proposed research will create opportunities for preparing outstanding underrepresented minority students to join the CCS workforce as first-class scientists and engineers.