PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

08/2002

PHYSICS AND CHEMISTRY OF COAL-SEAM CO_2 SEQUESTRATION & COALBED METHANE PRODUCTION

PRIMARY PARTNERS

National Energy Technology Laboratory
Pennsylvania State University
University of Pittsburgh
University of Oklahoma
University of Southern Illinois
CSIRO
Netherlands Institute of Applied Geoscience TNO
Illinois State Geological Survey

DOE FUNDING PROFILE

Prior FY's	$257,000
FY2002	$441,207
Future FY	TBA

TOTAL ESTIMATED COST

DOE	$698,207

CUSTOMER SERVICE

800-553-7681

WEBSITE

www.netl.doe.gov

Background

Recently, the concept and practice of carbon management via the sequestration of carbon dioxide by coal seams and the concurrent production of coalbed methane (CBM) have increased in potential significance. The injection of CO_2 into deep, unmineable, gassy coal seams may substantially increase CH_4 (methane) production above the level achievable by standard depressurization methods. Water continues to play a key role in CBM production, yet explanations in the coal literature of how water does this on a molecular scale are presently undeveloped. Thus, a fundamental understanding of the mechanism(s) by which sorbed water influences, or can influence, coalbed methane production, with and without CO_2 sequestration is necessary.

Additionally, research is being conducted to obtain information useful for assessing the technical feasibility of CO_2 sequestration in coal-seams. Areas of interest include estimation of the capacity of a coal-seam to adsorb CO_2 (*adsorption isotherm*), the validity of inter-lab comparisons of isotherm data (*inter-lab precision*), and the stability of the CO_2 saturated phase once formed—especially with respect to how it might be affected by changes in the post-sequestration environment (*environmental effects*). The affects of temperature, pressure, and coal rank on the ability of coal to adsorb CO_2 have been investigated.

Primary Project Goal

The goals of the research are to ultimately provide guidelines for drilling of new CBM production wells and enable field engineers to determine if cases of poor CO_2 sequestration and/or low methane productivity can be attributed to non-ideal coalbed temperatures/depths or, perhaps, to other factors.

Objectives

- Determine the temperature dependence of CO_2 sequestration and methane production.
- Determine adsorption isotherms for pure gases in a static system for coals of NETL interest.
- Develop a flow system to generate adsorption isotherms via numerical techniques established for data analysis.

Physics and Chemistry of Coal-Seam CO_2 Sequestration & Coalbed Methane Production

CONTACT POINTS

Curt White

Carbon Sequestration Science Focus Area Leader
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-5808
curt.white@netl.doe.gov

Accomplishments

Advanced CO_2/CH_4 Concepts (CO_2 sequestration & CBM production): A method for simultaneously accounting for heats of CO_2 and CH_4 sorption/desorption, moles of CO_2 and CH_4 sorbed/desorbed, extents of dehydration, and sample temperature was developed and a manuscript was prepared and accepted for presentation at various conferences. Mathematical methods for resolving complex calorimetric thermograms were developed. Accordingly, an apparent correlation between hypothetical extents of coal dehydration and predicted relative viscosities of water in the narrow capillaries, mesopores, and micropores of coal was discovered.

CO_2 Sorption, Transport, & Environmental Chemistry (CO_2 Sequestration): A static system for the measurement of adsorption isotherms was assembled, pressure-tested, and successfully employed to generate data along with a derived equation used to separate the actual surface adsorption from the effects of coal swelling on the isotherm shape. The extent of actual physical adsorption was determined, the heats of adsorption were calculated, and the values were found to agree within 10% of each other. NETL has developed a new theory that allows one to obtain information on coal swelling from the experimentally derived adsorption isotherm.

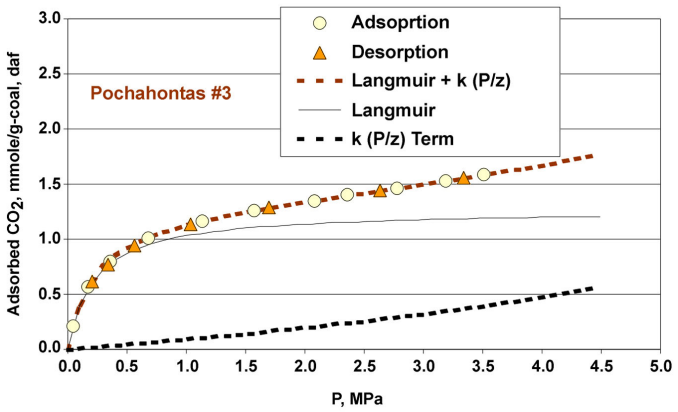
Benefits

This project will provide guidelines for both efficient sequestration of carbon dioxide in coal seams and enhanced methane production. Through an understanding of the fundamental chemistry involved in the CO_2 adsorption/CH_4 desorption process, it will be possible to select optimum conditions for CO_2-enhanced coalbed methane production/sequestration. The project has resulted in development of a new theory of coal swelling and how the CO_2 adsorption process affects swelling. The new theory allows one to obtain information on coal swelling from simple adsorption isotherm measurements. The enhanced methane production associated with CO_2 sequestration will help to defray sequestration costs. Additionally, by capturing carbon dioxide and sequestering it, harmful emissions into the atmosphere are prevented that may further increase global warming.

NETL's New Theory on Coal Swelling

Adsorption Isotherms Appear to Be Combinations of a **Surface Adsorption Term** and a **Constant Term**

$$n_{exp} = n_{ads} + k(P/z)$$



Proj186.pmd