the ENERGY lab

PROJECT FACTS

Carbon Sequestration

The Coal-Seq III Consortium: Advancing the Science of CO_2 Sequestration in Coal Seam and Gas Shale Reservoirs

Description

Through its core research and development (R&D) program administered by the National Energy Technology Laboratory (NETL), the U.S. Department of Energy (DOE) emphasizes monitoring, verification, and accounting (MVA), as well as computer simulation, of possible carbon dioxide (CO_2) leakage at CO_2 sequestration sites, along with risk assessment of those sites. As a part of these efforts, Advanced Resources International, Inc. (ARI) has been leading the Coal-Seq industry/government R&D collaborative project since 2000, with cooperating industry partners BP America, BG Group, and Sasol Petroleum International, among others. The primary goal of the project was to understand the technical/economic feasibility and application potential of carbon sequestration in coal seams.

Coal-Seq Consortia I & II were widely successful in furthering an understanding of the mechanisms controlling CO_2 extended coal bed methane recovery (ECBM) as a byproduct of CO_2 storage in deep, unmineable coal seams. By studying the only long-term, multi-well ECBM projects that exist in the world today (the Allison and Tiffany units in the San Juan Basin), Coal-Seq identified numerous important sub-surface reservoir mechanisms, performed laboratory research to verify and validate gas storage mechanisms in these reservoirs, developed a screening model to assess CO_2 sequestration potential in other promising coal basins of the United States, and established a better predictive capability for such projects to promote investment in them.

Now Coal-Seq III, a new three-year consortium phase of this project— performed by ARI in partnership with Southern Illinois University, Oklahoma State University, and Higgs-Palmer Technologies — will develop and test three advanced geochemical and geomechanical modules that will increase the accuracy of simulating CO_2 behavior in coals and shales, and couple these with flow simulation. The project also will address coal storage factors such as coal failure and permeability enhancement, matrix swelling and shrinking, and competition with water as an adsorbed phase on coals, as well as other aspects of CO_2 sequestration.

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COST

Total Project Value
$2,139,015

DOE/Non-DOE Share
$1,000,000 / $1,139,015

PARTNERS

Advanced Resources International, Inc (performer)
BG Group (sponsor)
BP America (sponsor)
Higgs-Palmer Technologies (performer)
Illinois Clean Coal Institute (sponsor)
National Energy Technology Laboratory (sponsor)
New York State Energy Research and Development Authority (sponsored)
Oklahoma State University (performer)
Sasol Petroleum International (sponsor)
Southern Illinois University (performer)
U.S. Department of Energy (sponsor)

U.S. DEPARTMENT OF ENERGY

Primary Project Goal

The primary project goal of Coal-Seq III is to develop a set of robust mathematical modules to accurately predict how coal and shale permeability and injectivity change with CO_2 injection. These modules will correctly account for multi-component (methane-CO_2-nitrogen-water) matrix shrinkage/swelling; coal-weakening; competitive adsorption; bi-direction diffusion; and system pressure, volume, and temperature (PVT) behavior.

Accomplishments

This project was awarded on October 1, 2009. To accomplish its primary goal, the project team established the following tactical objectives:

- Use coal samples to perform CO_2 core-flood experiments in the laboratory, observing and measuring any changes in mechanical properties ("weakening") in the presence of high-pressure CO_2.
- Investigate coal shrinkage during production and coal swelling during CO_2 injection, using laboratory core flood experiments conducted at in-situ pressures and stresses.
- Develop improved algorithms and adsorption models to facilitate realistic simulation of CO_2 sequestration in wet coal seams and shale gas reservoirs.
- Set forth quantitative formulations that rigorously account for coal permeability changes during CO_2 injection and storage, and incorporate these formulations within simulation codes and modules to deliver an advanced and benchmarked model.
- Validate the theoretical and experimental results with data from large-scale field projects.
- Explore the feasibility of storing CO_2 in gas shale reservoirs, using advanced shale completion techniques (horizontal wells and multistage, massive hydraulic fracture simulations); and undertake a detailed modeling effort to explore the feasibility of this concept, using "real-world" datasets.
- Using these newly generated simulation modules, assess the CO_2 storage potential of the San Juan Basin's Fruitland Coal as well as the Marcellus and Utica shales of the Appalachian Basin.
- Disseminate the project findings to industry, regional sequestration partnership working groups, and the scientific/engineering communities via publications and presentations.
- Foster international collaboration on CO_2 sequestration in coal seams and shale reservoirs via the Coal-Seq website (www.coal-seq.com) and Coal-Seq forums.

Benefits

The knowledge gained from this project will benefit the energy industry by providing verifiable and valid storage mechanisms in coal reservoirs, as well as a new source of clean gas supply. The ability to take advantage of these opportunities will be facilitated by the development of valid geochemical and geomechanical predictive modules for coal seam and methane behavior under CO_2 sequestration as described above.

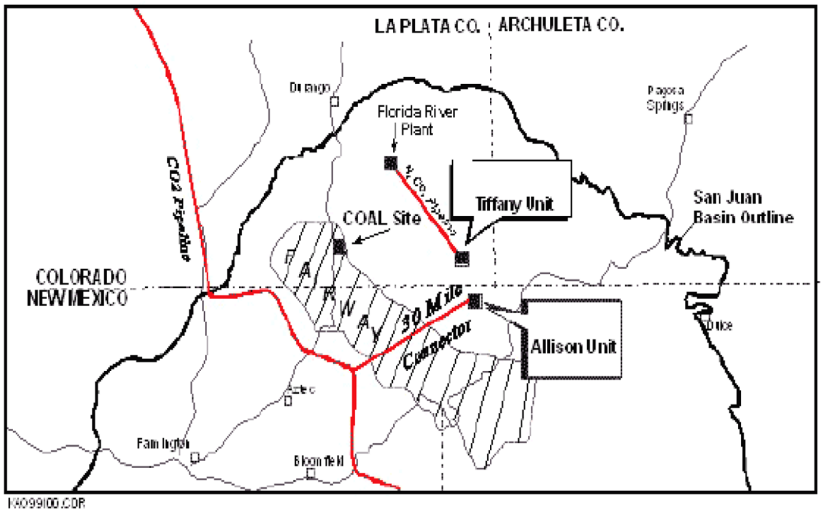

Figure 1: Location of the Tiffany and Allison units on the Colorado-New Mexico border.

Figure 2: CO_2 injector well at the Allison Unit.