PROJECT facts

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

Carbon Sequestration

4/2008

GEOLOGIC SEQUESTRATION OF CARBON DIOXIDE IN A DEPLETED OIL RESERVOIR: A COMPREHENSIVE MODELING AND SITE MONITORING PROJECT

CONTACTS

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

Andrea McNemar
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-2024
andrea.mcnemar@netl.doe.gov

Gregory J. Elbring
Principal Investigator
Sandia National Laboratory
P.O. Box 5800
Albuquerque, NM 87185
505-844-4904
gjelbri@sandia.gov

Background

The use of carbon dioxide (CO_2) to enhance oil recovery (EOR) is a familiar and frequently used technique in the United States. The oil and gas industry has significant experience with well drilling and injecting CO_2 into oil-bearing formations to enhance production. While using similar techniques as in oil production, this sequestration field test differs in that its purpose is to store rather than recycle the CO_2. However, CO_2 sequestration in oil reservoirs is a complex process spanning a wide range of scientific, technological, economic, safety, and regulatory issues. Detailed understanding of the many interactions is necessary before this option can become a safe and economic sequestration option, and its development requires a focused research and development effort by government and private industry.

Figure 1: Project field site for testing CO2 sequestration in a depleted oil reservoir nearHobbs, New Mexico.

CONTACTS, CONT.

Rajesh Pawar
Principal Investigator
Los Alamos National Laboratory
Los Alamos, NM 87545
505-667-6929
rajesh@lanl.gov

Description

Sandia National Laboratory and Los Alamos National Laboratory, along with New Mexico Tech, Colorado School of Mines, and Kinder Morgan, have partnered with an independent producer, Strata Production Company, to investigate down-hole injection of CO_2 into a depleted oil reservoir, the West Pearl Queen Field in New Mexico.

This project is using a comprehensive suite of computer simulations, laboratory tests, and field measurements to understand, predict, and monitor the geochemical and hydro-geologic processes.

Primary Project Goal

The overall objective of this project is to better understand, predict, and monitor CO2 sequestration in a depleted sandstone oil reservoir. Injection into this reservoir was through an inactive well, while a producing well and two shutoff wells are being used for monitoring.

Objectives

- Characterize the oil reservoir and its storage capacity to sequester CO_2.
- Predict multiphase fluid migration and interactions.
- Deploy and evaluate improved remote geophysical monitoring techniques.
- Conduct computer simulations and lab measurements of fluid flow.
- Assess and predict complex geologic sequestration processes.
- Inject several thousand tons of CO2 into a depleted oil reservoir.

- Establish a pre-injection baseline and assess post-injection reservoir conditions to validate model predictions.

Benefits

Science and technology gaps related to engineering aspects of injecting and sequestering CO_2 into a depleted oil reservoir are being identified in this study. Additional results will provide a better understanding of CO_2/reservoir interactions for improving EOR flooding practices.

Accomplishments

During the early field-site efforts, approximately 2,100 tons of CO_2, equivalent to one day's emissions from an average coal-fired power plant, were injected into the target formation. An extensive three-dimensional geophysical survey was conducted prior to CO_2 injection to provide the best possible subsurface image of the reservoir. The CO_2 entered the reservoir at a rate of about 40 tons/day and a pressure of 1,400 psi, and scientists used highly sensitive equipment to acquire micro-seismic signals to help track the movement of the plume. After the CO_2 was allowed to "soak" into the reservoir rock, a second 3-D seismic survey was taken. These observations tell scientists the fate of the CO_2 plume and will be used to calibrate, modify, and validate modeling and simulation tools. Analysis of the seismic data suggests that most of the injected CO_2 pooled in a relatively small area at the base of the injection well, although post-injection venting has recovered less than half of the injected volume.

Results to date show that geologic and preliminary flow simulation results indicate that the concept and feasibility of injecting CO_2 into a depleted oil reservoir has a level of merit for further field validation. In this particular project effort, the geologic characterization with subsurface data and available analogy to nearby relevant outcrops suggest that the reservoir is not entirely homogeneous. Computer simulations have predicted plume travel times and subsequently suggest that the combined saturation and pressure difference waves generated by injected CO_2 can be monitored through use of appropriate seismic surveys. Simulations of the project effort also provide guidelines for geophysical monitoring (e.g., spacing of sources and receivers). Geochemical experiments with Queen Sandstones have shown a better understanding of the potential for in situ mineralization.

Recent laboratory experiments were performed to determine the effect of CO_2 exposure on sandstone using core samples from the Wet Pearl Queen field. The experimental temperature and pressures mimicked the downhole conditions in the

PARTNERS

Sandia National Laboratory

Los Alamos National Laboratory

New Mexico Tech University

Strata Production Company

Kinder-Morgan CO_2 Company

Colorado School of Mines

PERFORMANCE PERIOD

5/01/2000 to 3/31/2008

COST

Total Project Value
$4,300,000

DOE Share/Non-DOE Share
$4,300,000 / $ 0

reservoir during field experiments, especially during the soak period. Multiple samples were exposed to CO_2 for six months. Analysis of the rock samples (pre- and post-soak) and fluid samples were collected during laboratory experiments to determine whether they show evidence of geochemical interactions due to CO_2 exposure. The preliminary mineral analysis does not show significant geochemical alteration of the reservoir core samples.

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

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www.netl.doe.gov