PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Sequestration

04/2003

NETL

Geologic Sequestration of CO_2 in a Depleted Oil Reservoir: A Comprehensive Modeling and Site Monitoring Project

Background

Carbon dioxide (CO_2) injection into geologic formations is a promising strategy for the long-term sequestration of anthropogenic CO_2. This technique is likely to be needed to sustain the U.S.'s fossil fuel-based economy and to maintain our high standard of living. Subsurface injection of CO_2 into depleted oil reservoirs has the potential to be both cost effective and environmentally safe. 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 R&D effort by government and private industry.

Significant R&D gaps related to the sequestration of CO_2 in depleted oil reservoirs include the need to understand coupled physicochemical processes involving CO_2, water, oil, and reservoir rock; better estimates of the capacity of reservoirs for long-term sequestration; the ultimate fate of injected CO_2 (compared to short-term enhanced oil recovery); and improved remote (geophysical) monitoring technologies for accurately determining the dispersion of injected CO_2. 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 downhole 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 hydrogeologic processes involved.

The following components are involved: geologic flow/reaction modeling; injection of CO_2 into a depleted oil-producing reservoir; geophysical monitoring of the advancing CO_2 plume; and laboratory experiments to measure reservoir changes due to CO_2 flooding. The models and data are being used to predict storage capacity and physical and chemical changes in reservoir properties, such as fluid composition, porosity, permeability, and phase relations. Science and technology gaps related to sequestration of CO_2 in depleted oil reservoirs will be identified as a result of this study.

Primary Project Goal

The overall objective of this project is to better understand, predict, and monitor CO_2 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.

CONTACT POINTS

Scott M. Klara
Sequestration Product Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-4864
scott.klara@netl.doe.gov

Charles W. Byrer
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-4547
charles.byrer@netl.doe.gov

Norman R. Warpinski
Project Manager
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185
505-844-3640
nrwarpi@sandia.gov

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

Department of Energy · United States of America

Geologic Sequestration of CO_2 in a Depleted Oil Reservoir: A Comprehensive Modeling and Site Monitoring Project

PARTNERS

Sandia National Laboratories

Los Alamos National Laboratory

New Mexico Tech University

Strata Production Company

Kinder-Morgan CO_2 Company

Colorado School of Mines

TOTAL ESTIMATED COST

Total Project Value	$4,830,000
DOE	$3,930,000
Non-DOE Share	$ 900,000

CUSTOMER SERVICE

800-553-7681

WEBSITE

www.netl.doe.gov

Objectives

- Characterize the oil reservoir and its capacity to sequester CO_2 .
- Predict multiphase fluid migration and interactions.
- Deploy and evaluate improved remote geophysical monitoring techniques.
- Measure CO_2/reservoir reactions.
- Conduct computer simulations and lab measurements of fluid flow .
- Assess and predict complex geologic sequestration processes.
- Inject several thousand tons of CO_2 into a depleted oil reservoir .
- Establish pre-injection baseline and assess post-injection reservoir conditions to validate model predictions.

Accomplishments

Current geologic and preliminary flow simulation results indicated the feasibility of CO_2 injection into a depleted oil reservoir. Simulations have predicted plume travel times and suggest that the combined saturation and pressure difference waves generated by injected CO_2 can be monitored through use of seismic surveys. Simulations also provide guidelines for geophysical monitoring (e.g., spacing of sources and receivers). Geochemical experiments with Queen Sandstones have been initiated to understand the potential for in situ mineralization. These experiments show that carbonate cements dissolve over time.

Approximately 2,100 tonnes of CO_2, equivalent to one day's emissions from an average coal-fired power plant, have been injected into the formation. An extensive three-dimensional geophysical survey was conducted prior to CO_2 injection to provide the best possible subsurface image of the reservoir. As the CO_2 entered the reservoir at a rate of about 40 tons/day and a pressure of 1,400 psi, scientists used highly sensitive equipment to acquire microseismic signals to help track the movement of the plume. After the CO_2 has been allowed to "soak" into the reservoir rock, a second 3-D seismic survey will be taken. These observations will begin to tell scientists the fate of the CO_2 plume and will be used to calibrate, modify, and validate modeling and simulation tools.

Benefits

This project takes advantage of unique test opportunities for a pilot scale field experiment in a pressure-depleted oil reservoir to predict and monitor the migration and ultimate fate of injected CO_2. The models and data developed will be used to predict storage capacity and physical and chemical changes in reservoir properties, such as fluid composition, porosity, permeability, and phase relations. Science and technology gaps related to engineering aspects of CO_2 sequestration will be identified in this study. In addition, a better understanding of CO_2/reservoir interactions will improve enhanced oil recovery (EOR) flooding practices.