

CO₂ Sequestration Validation Test in a Deep Oil Field in the Williston Basin

CO₂, Oil Fields, and Sequestration

Oil is typically extracted from underground reservoirs in three phases: primary, secondary, and tertiary (or enhanced) recovery. Typically, during the primary phase, natural pressures within the reservoir drive the oil to the well, and pumps bring the oil to the surface. On average, primary recovery produces 10% to 15% of the oil. Injecting water into the formation (secondary recovery) helps recover another 10% to 20%. Enhanced oil recovery (EOR) methods, including CO₂ EOR, have the potential to recover an additional 10%–20% of the oil in the reservoir (Figures 1 and 2). Most of the CO₂ currently used in EOR operations is produced from geologic formations. Because most of the CO₂ from EOR operations remains in permanent storage underground at the end of the EOR operation, replacing the geologic CO₂ used today in EOR with anthropogenic CO₂ (CO₂ from human activities) would reduce anthropogenic emissions by putting the human-produced CO₂ into long-term storage in depleted oil reservoirs underground. At the same time, the oil revenue generated through the anthropogenic CO₂ EOR could provide economic incentive to undertake these types of sequestration projects. The wide implementation of this value-added strategy for sequestering anthropogenic CO₂ could be an effective hedge against climate change.

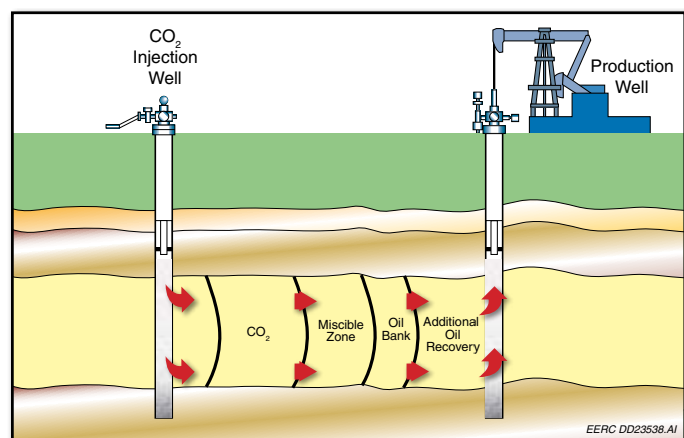


Figure 1. Each day, 1.75 billion cubic feet of CO₂, most of it from natural geologic sources, is transported through 3500 miles of pipeline to the more than 4600 injection wells involved in the 80 active CO₂ EOR operations in North America. EOR operations typically leave 90% of the CO₂ in permanent storage in the depleted oil reservoir.¹

What Is “Value-Added”?

The term value-added is used to describe the economic value of an action or product that has been increased through a change in process or practice. Operations that use CO₂ to enhance the production of oil or natural gas can also add value by using the oil or natural gas reservoir as a storage site for the CO₂. The sale of the additional oil or natural gas can provide the economic return needed to provide incentive for companies to undertake value-added sequestration projects under today’s market conditions.

Williston Basin Field Validation Test

The Energy & Environmental Research Center’s Plains CO₂ Reduction (PCOR) Partnership will be conducting a multiyear field validation test of CO₂ sequestration in an oil field in the North Dakota portion of the Williston Basin (Figure 3). A preliminary analysis indicates that



Figure 2. CO₂ EOR operations have been proven effective in prolonging the life of oil fields in areas from West Texas to the northern Great Plains.

a significant number of deep oil fields in the Williston Basin may hold promise for CO₂ EOR operations that will permanently sequester CO₂. The knowledge gained through pioneering CO₂ EOR/CO₂ geologic sequestration projects in deep reservoirs in the Williston Basin could facilitate expansion of CO₂ EOR projects in deeper oil fields globally.



Figure 3. Location of the Williston Basin in the PCOR Partnership Region.

The Williston Basin Field Validation Test will be conducted in an oil reservoir nearly 2 miles below the earth's surface, making it the deepest CO₂-based EOR project in North America.² As a result, this project will provide valuable information that will help customize operations for CO₂ EOR and CO₂ sequestration under geologic conditions of high pressure and temperature elsewhere in the basin and in the world. The Williston Basin Field Validation Test is among the four field validation tests currently under way in the PCOR Partnership region in the northern Great Plains of North America and one of the nearly three dozen field demonstrations under the U.S. Department of Energy National Energy Technology Laboratory's Regional Carbon Sequestration Partnership Program.

Test Goals and Approach

The overall goal of the Williston Basin Field Validation Test is to develop the practical knowledge necessary to undertake CO₂ EOR and CO₂ geologic sequestration in deep oil reservoirs. Specifically, the test is designed to determine the following:

- The effect of the naturally high-pressure and high-temperature conditions in a deep oil reservoir on the ability to conduct EOR using CO₂.

- The effect of the naturally high-pressure and high-temperature conditions in a deep oil reservoir on the volume of CO₂ that could be left in permanent storage in the reservoir.
- The applicability of adapting the existing methodologies for CO₂ EOR and CO₂ sequestration that have been developed for use at relatively shallow depths for use in deeper zones.
- The effects of the conditions in the deep reservoir on the economics of the EOR and sequestration operations.

Test Operation

Since the spring of 2007, the PCOR Partnership team has been gathering detailed information on the geological and engineering characteristics of candidate oil fields in the Williston Basin. Once this geological characterization is completed and after close consultation with the operators of the candidate oil fields, a test site will be chosen, and a CO₂ injection plan will be developed and finalized. This plan will include a customized approach for monitoring the fate of CO₂ at the site.

CO₂ injection is scheduled to begin in late 2008. The monitoring activities will be conducted before, during, and after the CO₂ injection to verify and validate the effectiveness of both the EOR and sequestration components of the test, as well as to ensure the protection of potable groundwater resources in the test area.

Project Deliverables

The project is designed to result in two key deliverables:

- A technical report that summarizes test results and findings, including overall performance and a statement of CO₂ storage capacity.
- A best practices manual for use in CO₂ sequestration projects in deep oil reservoirs and value-added projects in oil fields that combine EOR with the sequestration of CO₂.

References and Notes

1. Melzer, L.S., 2007, An oil industry perspective on carbon capture and storage (CCS): Presented at the PCOR Partnership 2007 Annual Meeting, Grand Forks, North Dakota, October.
2. Jerrell, P.M., Fox, C.E., Stein, M.H., and Webb, S.L., 2002, Practical aspects of CO₂ flooding: Richardson, Texas, Society of Petroleum Engineers, Inc., p. 8.

The Plains CO₂ Reduction (PCOR) Partnership is a group of public and private sector stakeholders working together to better understand the technical and economic feasibility of sequestering CO₂ emissions from stationary sources in the central interior of North America. The PCOR Partnership is managed by the Energy & Environmental Research Center (EERC) at the University of North Dakota and is one of seven regional partnerships under the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Initiative. To learn more, contact:

Edward N. Steadman, Senior Research Advisor, (701) 777-5279; esteadman@undeerc.org
John A. Harju, Associate Director for Research, (701) 777-5157; jharju@undeerc.org

Visit the PCOR Partnership Web site at www.undeerc.org/PCOR. New members are welcome.

Sponsored in Part by the
U.S. Department of Energy

