Subtask 2.20: Bakken CO_2 Storage and Enhanced Recovery Program-Phase II

Award Number: DE-FC26-08NT43291

Prime Performer:
University of North Dakota Energy and Environmental Research Center

Principal Investigator:
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Project Duration:
4/1/2014 – 5/31/2018

Performer Location:
Grand Forks, North Dakota

Field Sites:
Bakken formation, Williston Basin, Montana

Program:
Carbon Transport & Storage

Project Summary:

The Bakken carbon dioxide (CO_2) Storage and Enhanced Recovery program was carried out over two phases. Phase I examined the feasibility of injecting CO_2 into the Bakken Formation for CO_2-enhanced oil recovery (EOR). The Phase I results suggested that a better understanding of the fundamental mechanisms controlling the interactions between CO_2 and Bakken rock, oil, and other reservoir fluids in tight formations is necessary to develop accurate assessments of CO_2 storage and EOR potential. Phase II was conducted to address knowledge gaps from Phase I through a series of laboratory modeling and field-based activities.

Project Outcomes:

In 2017, an injection test was conducted in a vertical well completed in the Middle Member of the Bakken. Approximately 99 tons of CO_2 were injected over 4 days. Reservoir pressure and temperature were monitored during all stages of the test and for 15 days after injection using downhole gauges. Analyses of the preinjection and postinjection oil samples indicated that the composition of the postinjection oil samples had greater amounts of lower-molecular-weight hydrocarbons than the pretest oils. Interpretation of the results from the field test suggest that although matrix injectivity is low, injected CO_2 can penetrate the Middle Bakken to mobilize oil from the matrix. Simulation modeling exercises using the field data indicated that the alternating huff 'n' puff approach showed the best performance in terms of EOR. In the best cases, the alternating huff 'n' puff scheme was predicted to more than double the oil recovery factor of a well. These results support the conclusions of previous Phase I modeling work. The modeling efforts also indicated that the presence of water in a Bakken reservoir can have serious impacts on the EOR and CO_2 storage potential of a well. The Phase II laboratory data and field-testing results were applied to develop a refined methodology for estimating the CO_2 storage potential of a tight oil formation, based on the NETL method developed by Goodman and others (2016). Application of the refined method indicates that the organic-rich Upper and Lower Bakken shales may have two to three times more storage resource on a kg CO_2/m^3 rock basis than the non-shale Middle Bakken. The results of this project provide validation of Phase I laboratory and modeling studies, guidance toward the design and execution of future pilot tests in unconventional tight reservoirs, and insight about how laboratory-, modeling-, and field-based data can yield improved understanding of the potential CO_2 storage resource and EOR opportunities associated with unconventional tight oil reservoirs.

Presentations, Papers, and Publications

Final Report: **Energy & Environmental Research Center (EERC) – U.S. Department of Energy (DOE) Joint Program on Research and Development for Fossil Energy-Related Resources** (May 2018) – Lucia Romuld, John A. Harju, Catherine J. Russell, Ted. R Aulich, Edward N. Steadman