the ENERGY lab

PROJECT FACTS

ICCS – Area 2

Recovery Act: Carbon Dioxide-Water Emulsion for Enhanced Oil Recovery and Permanent Sequestration of Carbon Dioxide

Background

The U.S. Department of Energy (DOE) distributed a portion of American Recovery and Reinvestment Act (ARRA) funds to advance technologies for chemical conversion of carbon dioxide (CO_2) captured from industrial sources. The focus of the research projects is permanent sequestration of CO_2 through mineralization or development of processes that beneficially use CO_2 to produce fuels or chemical products. These are pilot-scale, field-testing projects for which laboratory-scale research has been completed and the results used to perform a detailed systems and economic analysis. One such process uses CO_2 for enhanced oil recovery (EOR).

Worldwide demand for oil continues to rise while production levels continue to decrease. New technologies that can recover additional oil from known reservoirs could help address this problem. The National Energy Technology Laboratory (NETL) partnered with the University of Massachusetts Lowell (UMass Lowell) to investigate the feasibility of pilot-scale testing of their CO_2 emulsion process for EOR.

Project Description

UMass Lowell planned to demonstrate an innovative system that beneficially used CO_2 to extract additional crude oil through EOR, ultimately mineralizing and permanently sequestering CO_2 in the reservoir. The CO_2 was to be separated, pressurized, and emulsified in water. The resulting emulsion was then to be injected into an oil formation for EOR and to enhance mineralization for permanent sequestration of CO_2.

UMass Lowell, in collaboration with Jordan Development Company, LLC and Core Energy, LLC, conducted development work to refine and scale-up the emulsion-producing equipment by providing preliminary and detailed design specifications. The research team planned to separate CO_2 from natural gas wells in Michigan's Otsego County and inject it into a nearby semi-depleted oil reservoir for EOR and permanent sequestration. The separated CO_2 was to be liquefied under pressure and emulsified in water using ultrafine particles as emulsion stabilizers. The emulsion would then be injected into the oil formation, where it would dislocate the residual heavy crude oil from the rock granule surfaces, reduce its viscosity, and increase its mobility. The advancing emulsion front was to provide viscosity control and drive the reduced-viscosity oil toward the production wells.

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PARTNERS

Jordan Development Company, LLC
Core Energy, LLC

PROJECT DURATION

Start Date
01/15/2010

End Date
12/31/2011

PROJECT COST

ARRA Funded

Total Project Value
$716,207

DOE/Non-DOE Share
$572,891 / $143,316

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

The plan for Phase II included construction of the pilot-scale equipment and necessary infrastructure to transport CO_2 to the site, produce the emulsions, and commence EOR and operations to mineralize and sequester CO_2. The team also planned for monitoring and testing; however, this project was not selected for continuation to Phase II.

Goals/Objectives

The overall objective of this project was to develop and test an innovative emulsion system that utilized CO_2 both to extract crude oil from semi-depleted oil wells and to permanently sequester and mineralize the CO_2 in the reservoir. Specific goals included performing laboratory-scale refinements on existing procedures for producing liquid-CO_2-in-water and water-in-liquid-CO_2 emulsions using hydrophilic fine particles; designing the modifications needed for emulsion injection for the CO_2 flooding system in Otsego County; designing monitoring and verification systems to measure potential leakage of CO_2 after emulsion injection; designing a production protocol to assess EOR with emulsion injection compared to present recovery with net CO_2 flooding; and designing core sampling protocols for assessing the fate of injected emulsion. Phase II objectives were to deploy the emulsion injection system at the Otsego County oil field, operate it for a four-year period, and evaluate the performance of the process.

Accomplishments

UMass Lowell developed this new technology while conducting research for DOE on geologic sequestration of CO_2. During this project, the team constructed a particle stabilization formation apparatus and demonstrated emulsion formation. The team completed Phase I and began characterization of the site for scale-up; however, this project was not selected for continuation to Phase II. Currently, the project is in closeout, and awaiting submission and acceptance of the final technical report.

Benefits

A process to use waste CO_2 for EOR that simultaneously facilitates long-term CO_2 sequestration would allow the United States to increase the supply of domestic fuels while decreasing the negative environmental effects of excess CO_2 in the atmosphere. Phase I of this project led to a better understanding of the CO_2 emulsion process and may be used to advance technologies needed for carbon sequestration.

Laboratory-scale testing showed that the CO_2 emulsion process enhanced oil recovery by 60 percent for crude oil from the sand (left) compared to a conventional oil recovery method (right).