

**QUARTERLY TECHNICAL PROGRESS REPORT  
FOR THE PERIOD ENDING SEPTEMBER 30, 2002**

**TITLE: FIELD DEMONSTRATION OF CARBON DIOXIDE MISCIBLE FLOODING  
IN THE LANSING-KANSAS CITY FORMATION, CENTRAL KANSAS**

**DOE Contract No. DE-AC26-00BC15124**

**Contractor:** University of Kansas Center for Research, Inc.  
2385 Irving Hill Road  
Lawrence, KS 66044

**DOE Program:** Class II Revisited - Field Demonstrations

**Award Date:** March 8, 2000

**Total Project Budget:** \$5,388,683

**DOE Cost Amount:** \$1,892,094

**Program Period:** March 8, 2000 – March 7, 2009 (BP1 03/00-05/03, BP2 05/03-03/08, BP3 03/08-03/09)

**Reporting Period:** July 1, 2002 – September 30, 2002

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**ABSTRACT:**

Progress is reported for the period from July 1, 2002 to September 30, 2002. On September 27, 2002 the US DOE approved the proposed modified plan to flood a 10+-acre pattern. MV Energy has received informal notification that GE Capital will approve sale of the portion of the Colliver lease involved in the pilot. Murfin Drilling Company is seeking local small independent partners for the pilot and has received commitment from White Eagle Energy and John O. Farmer Oil Company to date. A Contract was signed between the Kansas Department of Commerce & Housing and Murfin formalizing the KSDOC&H contribution of \$88,000 to the pilot project. This money will be used for well rework and testing. The results of this small flood will be used to evaluate the viability of performing a larger-scale demonstration and will be used by the partners to decide their role in a larger-scale demonstration. The 10+-acre pattern requires the least up-front expense to all parties to obtain the data required to accurately assess the viability and economics of CO2 flooding in the L-KC and of a larger-scale demonstration. Proposed modifications to the project plan were reviewed in the previous quarterly technical progress report.

## TABLE OF CONTENTS

TITLE PAGE .....	1
DISCLAIMER .....	2
ABSTRACT .....	2
TABLE OF CONTENTS .....	3
LIST OF TABLES .....	3
LIST OF FIGURES .....	3
INTRODUCTION .....	5
EXECUTIVE SUMMARY .....	5
RESULTS AND DISCUSSION .....	5
TASK 3.2 ECONOMIC AND RECOVERY ANALYSIS OF PILOT .....	5
TASK 7.0 PROJECT MANAGEMENT .....	6
TASK 8.0 TECHNOLOGY TRANSFER .....	7
CONCLUSIONS .....	7

## LIST OF TABLES

Table 1. Approximate schedule of tasks for step implementation .....	7
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## LIST OF FIGURES

Figure 1. Proposed 10+-acre Pilot Pattern .....	5
Figure 2. Comparison of Predicted Oil Recovery for 10+ acre Pilot .....	6

## **INTRODUCTION**

**Objectives** - The objective of this Class II Revisited project is to demonstrate the viability of carbon dioxide miscible flooding in the Lansing-Kansas City formation on the Central Kansas Uplift and to obtain data concerning reservoir properties, flood performance, and operating costs and methods to aid operators in future floods. The project addresses the producibility problem that these Class II shallow-shelf carbonate reservoirs have been depleted by effective waterflooding leaving significant trapped oil reserves. The objective is to be addressed by performing a CO<sub>2</sub> miscible flood in a 10-acre (4.05 ha) pilot in a representative oomoldic limestone reservoir in the Hall-Gurney Field, Russell County, Kansas. At the demonstration site, the Kansas team will characterize the reservoir geologic and engineering properties, model the flood using reservoir simulation, design and construct facilities and remediate existing wells, implement the planned flood, and monitor the flood process. The results of this project will be disseminated through various technology transfer activities.

### **Project Task Overview -**

**Activities in Budget Period 1 (03/00-05/03)** involve reservoir characterization, modeling, and assessment:

- Task 1.1- Acquisition and consolidation of data into a web-based accessible database
- Task 1.2 - Geologic, petrophysical, and engineering reservoir characterization at the proposed demonstration site to understand the reservoir system
- Task 1.3 - Develop descriptive and numerical models of the reservoir
- Task 1.4 - Multiphase numerical flow simulation of oil recovery and prediction of the optimum location for a new injector well based on the numerical reservoir model
- Task 2.1 - Drilling, sponge coring, logging and testing a new CO<sub>2</sub> injection well to obtain better reservoir data
- Task 2.2 - Measurement of residual oil and advanced rock properties for improved reservoir characterization and to address decisions concerning the resource base
- Task 2.3 – Remediate and test wells and patterns, re-pressure pilot area by water injection and evaluate interwell properties, perform initial CO<sub>2</sub> injection to test for premature breakthrough
- Task 3.1 - Advanced flow simulation based on the data provided by the improved characterization
- Task 3.2 - Assessment of the condition of existing wellbores, and evaluation of the economics of carbon dioxide flooding based on the improved reservoir characterization, advanced flow simulation, and engineering analyses
- Task 4.1 – Review of Budget Period 1 activities and assessment of flood implementation

**Activities in Budget Period 2 (05/03-03/08)** involve implementation and monitoring of the flood:

- Task 5.4 - Implement CO<sub>2</sub> flood operations
- Task 5.5 - Analyze CO<sub>2</sub> flooding progress - carbon dioxide injection will be terminated at the end of Budget Period 2 and the project will be converted to continuous water injection.

**Activities in Budget Period 3 (03/08-03/09)** will involve post-CO<sub>2</sub> flood monitoring:

- Task 6.1 – Collection and analysis of post-CO<sub>2</sub> production and injection data

**Activities that occur over all budget periods include:**

- Task 7.0 – Management of geologic, engineering, and operations activities
- Task 8.0 – Technology transfer and fulfillment of reporting requirements

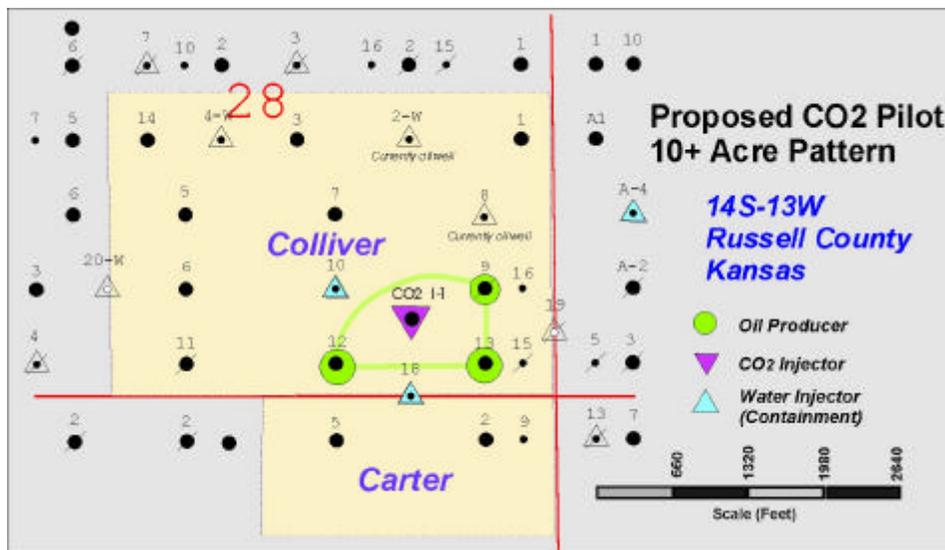
## EXECUTIVE SUMMARY:

Progress is reported for the period from July 1, 2002 to September 30, 2002. On September 27, 2002 the US DOE approved the proposed modified plan to flood a 10+-acre pattern. MV Energy has received informal notification that GE Capital will approve sale of the portion of the Colliver lease involved in the pilot. Murfin Drilling Company is seeking local small independent partners for the pilot and has received commitment from White Eagle Energy and John O. Farmer Oil Company to date. A Contract was signed between the Kansas Department of Commerce & Housing and Murfin formalizing the KSDOC&H contribution of \$88,000 to the pilot project. This money will be used for well rework and testing. The results of this small flood will be used to evaluate the viability of performing a larger-scale demonstration and will be used by the partners to decide their role in a larger-scale demonstration. The 10+-acre pattern requires the least up-front expense to all parties to obtain the data required to accurately assess the viability and economics of CO<sub>2</sub> flooding in the L-KC and of a larger-scale demonstration. Proposed modifications to the project plan were reviewed in the previous quarterly technical progress report.

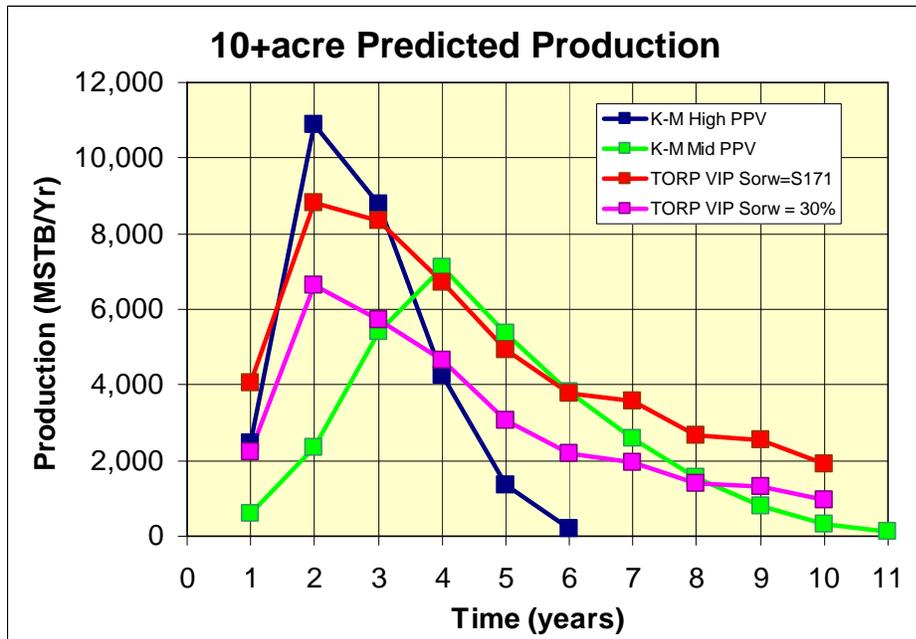
## RESULTS AND DISCUSSION:

### TASK 3.2 ECONOMIC AND RECOVERY ANALYSIS OF PILOT

The 10+-acre flood pattern is shown in Figure 1. Minimum predicted recovery ranges down to 22,300 BO assuming Sorw is 30% in all layers. Maximum recovery reaches as high as 47,000 BO assuming Sorw is 40% in some layers as predicted by VIP simulations. Transpetco Eng./Kinder-Morgan predicted recoveries are approximately 27,000-28,000 BO based on displacement calculations and fractional pattern modeling (Figure 2). Recovery in the economic models is cut-off after the first year the flood exhibits negative cash flow.



**Figure 1.** Proposed 10+ acre pilot with WAG injection in CO<sub>2</sub>#1, water injection in #10 and #18, and production from #9, #12, and #13.



**Figure 2.** Comparison of predicted oil recovery for 10+ acre pilot for various models.

## TASK 7.0 PROJECT MANAGEMENT

Table 1 presents the approximate schedule of tasks for step implementation of the 10+-acre pilot. Data and models are being analyzed to establish the model-predicted pressure response of the injection and establish criteria for go-no go decisions concerning calculated reservoir properties.

Slight modification were made to the proposed 10+ acre pilot plan and the modified plan submitted to USDOE on August 30, 2002. On September 27, 2002 the USDOE approved the 10+-acre modified plan for the CO<sub>2</sub> demonstration.

A meeting was held on September 17, 2002 at the offices of the NPTO in Tulsa, OK the following personnel were present: TORP) Paul Willhite; KGS) Alan Byrnes, Saibal Bhattacharya; DOE) Daniel Ferguson, Paul West, Gary Walker. Topics covered included: CO<sub>2</sub> demonstration project status, PUMP project status, review of CO<sub>2</sub> 10+-acre pilot proposal. Paul West is now the USDOE Project Manager for this project.

James Daniels with Murfin Drilling Company (Murfin), has been coordinating the discussions concerning purchase of the pilot area from MV Energy LLC and GE Capital approval of the sale. Murfin and MV Energy have received informal notice that GE Capital will approve the sale. Murfin has approached small independent operators in the area to be partners in the pilot flood. Several operators have indicated interest. White Eagle Energy and John O. Farmer Oil Company have indicated that they will participate. An executive summary of the pilot economics has been sent to interested parties.

A Contract was signed between the Kansas Department of Commerce & Housing and Murfin formalizing the contribution of \$88,000 to the pilot project. This money will be used for well rework and testing.

The US Energy Partners Ethanol plant completed the CO2 liquification facility in August and began shipping food-grade CO2 in September. USEP is still committed to supplying CO2 to the demonstration project.

**Table 1. Approximate Schedule of Tasks for Step Implementation of 10+ Acre Pilot**

Task Number	Task Description (Go/No-go decisions at completion of Tasks 1, 3, 5, 7, 9, 11)	Month													
		1	2	3	4	5	6	7							
		Week													
		0	1	2	3	4	5	6	7	8	12	16	20	21	28
1	Finalize arrangements for CO2 supply and delivery to site	█													
2	Identify a compatible water supply and filtration system for injectivity tests into CO2#1 and upgrade wellhead. Assumes cost of new well - if existing then cost decreases. Install line for inject.		█	█											
3	Conduct water injectivity tests in CO2#1, evaluating rate and pressure. Determine the distribution of water injection rate across the reservoir interval. Acidize well if necessary to obtain injectivity into desired reservoir zones			█	█										
4	If distribution of injected water is adequate in CO2#1, recomplete Colliver #12 into the C zone and leave the well open				█	█									
5	Verify connectivity between Colliver #12 and CO2#1 by observing pressure response in Colliver #12 while injecting into CO2#1						█								
6	Complete Colliver #9 into the C zone by washing down well.							█							
7	Verify connectivity between Colliver #9 and CO2#1 by observing pressure response in Colliver #16 while injecting into CO2#1								█						
8	Revise reservoir models as necessary to conform to pressure and injectivity distributions. Check economics of CO2 flood with revised reservoir and economic models						█	█							
9	Pressure-up test pattern and confirm pressure&connectivity between CO2#1 and Colliver #12, #9 are adequate for project. (~3-4 months water injection)								█	█	█	█			
10	Assuming pressure-up is adequate, install CO2 injection and production surface facilities													█	
11	Inject CO2 to confirm no early breakthrough (est. ~2-4 months)														█
12	After confirming there is no early CO2 breakthrough in Colliver #12 & #16, recomplete Colliver #10 and #13. Proceed with CO2														█

**TASK 8.0 TECHNOLOGY TRANSFER**

Both the Kansas Geological Survey and Tertiary Oil Recovery Project sent representatives and had booths at the Kansas Independent Oil and Gas Association Annual Meeting, August 18-19, Wichita, KS. Project status was presented in one-on-one discussions with operators.

**CONCLUSIONS**

USDOE approval of the 10+ acre pilot allows this pilot plan to proceed. MV Energy has obtained informal approval from GE Capital for sale of the pilot area and Murfin has obtained small independent working interest partners in the pilot. Formal contracts and initial implementation of the plan are expected in the next quarter.