Quarterly Technical Progress Report - West Hackberry Tertiary Project

**Quarterly Report
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QUARTERLY TECHNICAL PROGRESS REPORT
10/1/97-12/31/97

WEST HACKBERRY TERTIARY PROJECT

Cooperative Agreement No. DE-FC22-93BC14963--18

Amoco Production Company

Date of Report: 1/13/98

Award Date: 9/3/93

Anticipated Completion Date: 9/2/99 (Budget Period 1)

Government Award: \$6,017,500 (Budget Period 1)

Program Manager: Travis Gillham

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Technical Project Officer: Jerry Casteel

Reporting Period: 10/1/97-12/31/97 (17th Quarter of Budget Period 1)

Abstract

The West Hackberry Tertiary Project is a field test of the concept that air injection can generate tertiary oil recovery through the Double Displacement Process. The Double Displacement Process is the gas displacement of a water invaded oil column for the purpose of recovering tertiary oil through gravity drainage. The novel aspect of this project is the use of air as the injection fluid. In Gulf Coast oil reservoirs with pronounced bed dip, reservoir performance has shown that gravity drainage recoveries average 80% to 90% of the original oil in place while water drive recoveries average 50% to 60% of the original oil in place. The target for tertiary oil recovery with the Double Displacement Process is the incremental oil between the 50% to 60% water drive recoveries and the 80% to 90% gravity drainage recoveries. The use of air injection in this process combines the benefits of air's low cost and universal accessibility with the potential for improved oil recovery resulting from spontaneous in situ combustion. If successful, this project will demonstrate that utilizing air injection in the Double Displacement Process will result in an economically viable tertiary process in many Gulf Coast oil reservoirs where other tertiary processes are presently uneconomic. The West Hackberry Tertiary Project receives matching funds from the United States Department of Energy (DOE) as part of the DOE's Class 1 Program for the development of advance recovery technologies in fluvial dominated deltaic reservoirs. In addition, the Petroleum Engineering Department at Louisiana State University (LSU) provides independent study and technology transfer.

Objectives

The goal of the West Hackberry Tertiary Project is to demonstrate the technical and economic feasibility of combining air injection with the Double Displacement Process for tertiary oil recovery. The concept is being field tested in low pressure (300 to 600 pounds per square inch (psi)) reservoirs on the North Flank of the field and high pressure reservoirs (2500 to 3300 psi) on the West Flank of the field.

The low pressure reservoirs on the North Flank of the field are characterized by steep bed dips, large low pressure gas caps, slow water encroachment and thin oil rims. A thin oil rim on a steeply dipping structure occupies a small area. As water encroaches, a producing well will water out while upstructure wells will still reside in the gas cap. Finding an economic method to produce the oil rim represents a considerable challenge. Air injection in this situation can increase oil recovery by: 1)repressurizing the reservoir, 2)pushing the oil rim to downstructure producing wells and 3)effective use of the Double Displacement Process.

The high pressure reservoirs on the West Flank are under active water drive and all producing wells have watered out. Air injection in the high pressure reservoirs is expected to generate tertiary oil recovery through the Double Displacement Process.

Summary of Technical Progress

On the North Flank of West Hackberry Field, air injection has increased oil production in two low pressure reservoirs and air injection has recently been extended to a third low pressure reservoir. On the West Flank, air injection has increased reservoir pressure by 500 psi although it has not yet generated production response. For the fourth quarter of 1997, the following areas are discussed herein: 1)plugging in air injectors, 2)North Flank performance, 3)expansion of the project to the North Flank Cam D reservoir, 4)West Flank performance and 5)technology transfer activities.

1)Plugging in Air Injectors

Plugging in the downhole completions in the air injectors prevented injection during November and steps were taken to alleviate the problem during much of December. A plot of cumulative air injected versus time is included as Figure 1. The plugging material was magnetite, an iron oxide (Fe_3O_4). The source of the magnetite is corrosion in the uncoated steel air injection lines. Currently, two of the four air injectors are totally plugged with magnetite and are shut in.

In December, air injection resumed with injection in the North Flank Bol 3 reservoir in the GLAC No. 245 and with initial injection in the North Flank Cam D reservoir in the CPSB No. 58. To prevent future plugging in air injectors, the following steps have been taken:

- 1)Coated tubing has been installed in three of the four active air injectors.
- 2)The last stage scrubber on the reciprocating compressor has been removed to allow lubricant carryover into the injection lines for the purpose of inhibiting corrosion.
- 3)The injection lines were treated with hydrochloric acid to remove the iron oxide followed by a slug of compressor lubricant to inhibit corrosion.
- 4)High pressure air filters were installed at the wellhead of each air injector. In the two currently active air injectors, the filters have already become plugged with iron oxide and have been changed.

2)North Flank Performance

As a result of magnetite plugging in the air injector, the SL 42 No. 155, no air has been injected in the North Flank Cam C reservoir since July 22, 1997. Oil production has fallen in three of the four producers due to a lack of air injection. In the fourth well, a recent repair to install a gas anchor increased the producing rate. A composite production plot for the four Cam C producing wells is shown on Figure 2. Attempts to re-establish injection by cleaning out the SL 42 No. 155, first with coil tubing and second with a workover rig, have proven unsuccessful. By mid-January, a workover rig was moved back onto the SL 42 No. 155 and the injector will be sidetracked in order to return the well to injection.

The GLAC No. 245 serves as the air injector for the North Flank Bol 3 reservoir. Figure 3 demonstrates that air injection in the GLAC No. 245 has been sufficient to maintain Bol 3 oil production at a relatively stable rate.

With success of air injection in two low pressure North Flank reservoirs, the project has been expanded to a third low pressure North Flank reservoir, the Cam D sand. The Cam D is similar to the North Flank Cam C and Bol 3 reservoirs with low reservoir pressure, steep bed dip, a thin oil rim and a large low pressure gas cap. Air injection began in the Cam D in the CPSB No. 58 in December and increased oil production is expected in the near future.

3)West Flank Performance

The air injector for the high pressure Cam C reservoir on the west flank, the GLD No. 51, became totally plugged with magnetite on October 23, 1997. Attempts to clean out the well with coiled tubing and acid were unsuccessful. One of the options under consideration is to sidetrack the GLD No. 51, complete it as a producing well and convert one of the nearby offset wells to air injection. This would accomplish the combined goals beginning to produce the oil rim while returning the reservoir to air injection. If the sidetrack of the SL 42 No. 155 is successful, the sidetrack of the GLD No. 51 will probably follow shortly thereafter.

4)Technology Transfer Activities

The increase in north flank oil production as a result of air injection has facilitated an increase in technology transfer activities. The following technology transfer events occurred during the fourth quarter or will occur in the near future:

- 1)On October 6, 1997, a paper entitled “Keys to Increasing Production Via Air Injection in Gulf Coast Light Oil Reservoirs” was presented at the SPE Annual Technical Conference and Exhibition in San Antonio, Texas. Over 200 SPE members were in the audience.
- 2)On October 17, 1997, an Amoco geologist presented a paper entitled “Air Injection Enhanced Oil Recovery and 3-D Seismic: Revitalizing an Aging South Louisiana Oil Field” at the Gulf Coast Association of Geological Societies’ (GCAGS) Annual Convention in New Orleans, Louisiana.
- 3)During the last week of October, an article discussing the West Hackberry Air Injection Project was scheduled to appear in the *Enhanced Energy Recovery News*.
- 4)On October 30, 1997, Amoco personnel reviewed the West Hackberry project at a technology transfer event in Houston, Texas, for the Texas Railroad Commission.
- 5)The November, 1997, issue of *World Oil* included an article entitled “A new/economically viable process for the U.S. Gulf Coast” which was co-authored by representatives from Amoco and LSU.

6) On January 23, 1997, a talk entitled “Air Injection: Low Cost IOR for Gulf Coast Reservoirs” will be given at a technology transfer conference in New Orleans sponsored by LSU’s Basin Research Institute.

7) SPE has accepted a proposal for a paper entitled “Low Cost IOR: An Update on the West Hackberry Air Injection Project” to be presented at the SPE/DOE Eleventh Symposium on Improved Oil Recovery in Tulsa, Oklahoma, on April 19-22, 1998. In addition, this paper was also proposed for the SPE Annual Technical Conference and Exhibition that will be held in New Orleans on September 27-30, 1998.

Figures:

- 1) Cumulative Air Injected versus Time
- 2) Composite Production Plot for the North Flank Cam C
- 3) Composite Production Plot for the North Flank Bol 3

SI Metric Conversion Factors

bbl x 1.589 873	E-01 = cubic meters
cubic feet x 2.831 685	E-02 = cubic meters
psi x 6.894 757	E+00 = kPa