SUMMARY ANNUAL REPORT (9/3/96-9/2/97)

WEST HACKBERRY TERTIARY PROJECT

Cooperative Agreement No. DE-FC22-93BC14963

Amoco Production Company

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Date of Report: 9/21/97
Principal Investigator: Travis H. Gillham
Reporting Period: 9/3/96-9/2/97 (4th Year of Budget Period 1)
DISCLAIMER

Portions of this document may be illegible electronic image products. Images are produced from the best available original document.
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 Double Displacement Process is the gas displacement of a water invaded oil column for the purpose of recovering oil through gravity drainage. The novel aspect of this project is the use of air as the injection fluid. The target reservoirs for the project are in the Oligocene Age sands located on the west and north flanks of West Hackberry Field in Cameron Parish, Louisiana. If successful, this project will demonstrate that the use of air injection in the Double Displacement Process can economically recover oil in reservoirs where tertiary oil recovery is presently uneconomic.

Summary of Progress

By the end of the fourth year of Budget Period 1, air injection has been under way at West Hackberry since November of 1994 on the west flank and since July of 1996 on the north flank. During the past year, the most noteworthy events were: 1) increased oil production in low pressure reservoirs on the north flank, 2) demonstrated economic viability of air injection in low pressure reservoirs, 3) increased west flank reservoir pressure as a result of air injection and 4) intensified program of technology transfer activities. A discussion of the areas of progress follows.

1) Increased Oil Production in Low Pressure Reservoirs on the North Flank
On the north flank of West Hackberry, air is injected in two low pressure reservoirs (300-600 pounds per square inch (psi)), the Cam C-1,2,3 and the Bol-3. The reservoirs are characterized by low reservoir pressure, steep bed dip, large low pressure gas caps, thin oil rims and slow water encroachment. Air injection began in the Cam C-1,2,3 in July of 1996. Oil production increased within the first 30 days of initial injection and continues to produce oil at rates well in excess of the pre-injection rates. The project was successfully expanded to a second north flank reservoir, the Bol-3, in December of 1996. The Bol-3 has also seen an increase in oil production as a result of air injection. From July of 1996 to July of 1997, air injection generated 58,500 barrels of incremental oil production in the two north flank reservoirs. This increase in oil production is 61% more oil than the pre-injection rate of decline. As of July of 1997, the two north flank reservoirs were producing 390 barrels of oil per day (BOPD) compared to the 230 BOPD that would have been expected from the normal decline. Air injection both increased oil producing rates and decreased the percentage of water present in the produced liquids.

2) Demonstrated the Economic Viability of Air Injection in Low Pressure Reservoirs
West Hackberry performance can be used to demonstrate the profitability of air injection in low pressure reservoirs. An economic analysis was performed for the time period from July of 1996 to July of 1997. In the West Hackberry project, it is difficult to separate the costs associated with low pressure air injection from the cost associated with high pressure air injection. To simplify the analysis, a price quote was obtained for purchasing
compressed air from a contract compression company. This quote was used in the economic analysis as indicative of the cost for acquiring compressed air for injection. For the period from July of 1996 to July of 1997, the costs for purchasing the compressed air, investments required investments to install the project (downstream of the compressors), operating costs and repair well expense would have totaled $532,000. The 58,500 barrels of incremental oil would have generated $853,000 in before tax cash after leasehold royalty and state severance tax. Subtracting the $532,000 of costs from the $853,000 in before tax cash receipts yields a before tax positive incremental cash flow of $321,000 for the period from July of 1996 to July of 1997. This economic analysis demonstrates that low pressure air injection in a Gulf Coast salt dome field can be profitable and can even achieve a positive full cycle cash flow in less than a year.

3) Increased West Flank Reservoir Pressure as a Result of Air Injection
On the west flank of West Hackberry, two higher pressure (2500-3300 psi) fault blocks, Fault Blocks II and IV, were originally targeted for air injection. In Fault Block IV, a total of 1522 million standard cubic feet (MMSCF) of air had been injected into the Gulf Land D No. 51 through August 1, 1997. Although no evidence of production response or nitrogen breakthrough has occurred in Fault Block IV, reservoir pressure has increased an average of 500 psi since the start of air injection. Production response is expected in Fault Block IV during the next year of air injection.

Fault Block II saw premature nitrogen breakthrough during the first six months of injection. As a result of premature nitrogen breakthrough, operating strategy has been to concentrate west flank air injection capacity on Fault Block IV and to discontinue injection in Fault Block II.

4) Intensified Program of Technology Transfer Activities
The increased oil production on the north flank has facilitated a more intense program of technology transfer activities for 1997. The following technology transfer activities have occurred or will occur in the near future:


b) On August 23, 1997, the West Hackberry Air Injection Project received the “Best of the Gulf Coast Award” in the Best Advanced Recovery Project division from the Texas Independent Producers and Royalty Owners Association.

c) On September 16, 1997, representatives from Louisiana State University (LSU), Amoco, DOE and the Petroleum Technology Transfer Council (PTTC) presented a technology transfer workshop at LSU in Baton Rouge, Louisiana, which used the West Hackberry Air Injection Project as a case study.

d) On September 17, 1997, Amoco personnel gave a presentation on the West Hackberry project to a combined meeting of the Society of Petroleum Engineers’ (SPE) Westside and South Louisiana Study Groups in Houston, Texas.

e) On October 6, 1997, Amoco personnel will present a paper entitled “Keys to Increasing Production Via Air Injection in Gulf Coast Light Oil Reservoirs” at the SPE Annual Technical Conference and Exhibition in San Antonio, Texas.

g) During the last week of October, an article discussing the West Hackberry Air Injection Project will appear in the "Enhanced Energy Recovery News."

h) On October 30, 1997, an Amoco personnel will make a technology transfer presentation concerning West Hackberry air injection for the Texas Railroad Commission in Houston, Texas.

i) The November, 1997, issue of "World Oil" will contain an article discussing the West Hackberry Air Injection Project co-authored by Amoco and LSU personnel.

j) An abstract has been submitted to SPE for a paper entitled "Low Cost IOR: An Update on the West Hackberry Air Injection Project." If accepted, this paper will be presented at the SPE/DOE Eleventh Symposium on Improved Oil Recovery in Tulsa, Oklahoma, on April 19-22, 1998.

**Significant Accomplishments**

1) West flank reservoir pressure has increased by 500 psi.
2) On the north flank of West Hackberry, air injection was successfully expanded to a second low pressure reservoir. Oil production in the two north flank air injection reservoirs has increased by 58,500 barrels or 61% more than the normal decline for the time period from July of 1996 to July of 1997.
3) An economic analysis of air injection in the low pressure north flank reservoirs demonstrates that air injection in low pressure reservoirs can be economically viable at current oil prices.

**Significance to EOR Research Plan**

With the increase in oil production on the north flank, the West Hackberry Tertiary Project is the first project to demonstrate that air injection can both increase oil recovery and be economically viable when applied to low pressure Gulf Coast oil reservoirs. Although these events are significant, the goals of the project are to demonstrate that air injection can be used to economically generate tertiary oil recovery in both high pressure reservoirs with strong water drive and low pressure reservoirs with little water influx. With this in mind, the upcoming twelve months will be of critical interest as additional operating experience will be gained in the low pressure reservoirs on the north flank while awaiting initial production response in the high pressure reservoirs on the west flank.
Future Research Plans

For the upcoming year, air injection will continue to be split between the high pressure reservoir on the west flank and the low pressure reservoirs on the north flank. In addition to the ongoing injection in the two low pressure reservoirs, air injection will be extended to a third low pressure reservoir on the north flank during the fourth quarter of 1997. The overall project strategy for the next 12 months is to maximize production in the low pressure reservoirs while continuing sufficient injection in the high pressure reservoirs to see production response. As additional operating experience is obtained, an ongoing program of technology transfer will pass this experience on to the domestic oil industry.