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ANNUAL REPORT - FISCAL YEAR 1996

"POST WATERFLOOD CO₂ MISCIBLE FLOOD
IN LIGHT OIL, FLUVIAL-DOMINATED
DELTAIC RESERVOIR"

DE-FC22-93BC14960

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TEXACO EXPLORATION AND PRODUCTION INC.

AUGUST 15, 1996

AWARD DATE : June 1, 1993.
COMPLETION DATE: December 31, 1997

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U.S. DEPARTMENT OF ENERGY

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Reporting Period: June 1, 1995 - May 31, 1996

U.S./DOE Patent clearance is not required prior to the publication of this document.

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"POST WATERFLOOD CO₂ MISCIBLE FLOOD IN LIGHT OIL FLUVIAL
DOMINATED DELTAIC RESERVOIR"
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Executive Summary

The Port Neches CO₂ flood shown in Figure 1, is a joint operation between the Department of Energy (DOE) and the Texaco Exploration and Production Inc. (TEPI) that has been operating for nearly four years. The project performance during the past year has been adversely affected by several factors including: Water blockage, low residual oil saturation and wellbore mechanical problems.

TEPI attempted to test a new procedure in an new fault block using CO₂ to accelerate primary production in order to improve the primary reserves net present value. the test was abandoned when the discovery well Polk B#39 for the Marg Area 3 was a dry hole. Also, during this period TEPI terminated all new CO₂ purchases from Cardox for economical reasons, while continuing to recycle produced CO₂.

A data base for FDD reservoirs for the Louisiana and Texas Gulf Coast Region was developed by LSU and SAIC. This data base includes reservoir parameters and performance data for reservoirs with significant production and OOIP volumes that are amenable to CO₂ injection. A paper discussing the Port Neches CO₂ project was presented at the 1996 SPE/DOE Symposium on Improved Oil Recovery.

DISCUSSION OF RESULTS - FIELD OPERATIONS.

When miscible CO₂ operations began in 1993, it was estimated that the project will recover 2.2 MMSTB of incremental oil, or 195 of the OOIP. These estimates were based on a reservoir model and other classical reservoir engineering calculations. The flood produced so far 300 MSTB of tertiary oil to date. The production peaked at 500 BOPD in october of 1994 as indicated in Figure 2. this was below the anticipated 800 BOPD rate predicted by the model. It is estimated that the incremental reserves will be reduced by as much as 1.5 MMSTB. The reservoir under-performance is due to several factors: Reservoir characterization, oil saturation, water blockage and mechanical problems. These issues are discussed in more details in the paper presented at the 1996 SPE/DOE Symposium in Tulsa.

Production from the Marg Area 1 has continuously declined from 325 BOPD in June of 1995 to 100 BOPD in May of 1996. This sharp decline is due mainly to lower sweep efficiency caused by water blockage that prevented the CO₂ from contacting oil away from the line between the injection and production wells. This problem was augmented by mechanical failure of gravel-pack screens in two main producers.

Based on the reservoir performance and the amount of remaining recoverable tertiary reserves, TEPI obtained DOE approval to terminate CO₂ purchases from Cardox, while continuing to operate the project with recycled CO₂. Prior to terminating CO₂ operations, TEPI attempted to test a new procedure to accelerate primary production rates using CO₂ injection in an untested fault block. Under miscible conditions, CO₂ dissolves in the reservoir oil displacing its methane, making it highly mobile. Since CO₂ is a highly compressible fluid that dissolves in the reservoir oil at a rate of 4 to 1 when compared to natural gas. This makes the oil highly mobile and capable to flow at a higher rate and pressure. Introducing the CO₂ at the oil-water contact will eliminate the need for any artificial lift of the oil and form a buffer zone between the oil and the water, that reduces the water production. This test was abandoned when the well drilled to the Marg Area 3 was a dry hole.

A new fully compositional reservoir model was developed by EPTD to simulate the reservoir performance including the CO₂ injection phase. The results from this model were used to make decision on reducing the project tertiary reserves and terminate CO₂ purchases earlier than originally planned. Based on the simulation results, a workover was performed on well Kuhn #42 to convert it to CO₂ injector in order to improve the reservoir sweep efficiency. The response from CO₂ injection in Kuhn #42 has not yet been seen in the adjacent wells.

The following is a list of the most recent well tests taken during the month of June 1996 for the producing wells:

producers: Kuhn #15R	82 BOPD,	274 BWPB,	840 PSI,	22 CHOKE.
Injectors: Kuhn #42	784 MCFD,	1188 PSI.		
Stark #10	918 MCFD,	1182 PSI.		
Kuhn #17	131 BWPB,	1300 PSI.		
Marg Area 1H	181 BWPB,	1186 PSI.		

The Notice of Energy RD&D Project, Cost Plan, Milestone plan, Financial Status Report, Summary Report, Federal Transaction report are included in Appendix A.

DISCUSSION OF RESULTS - TECHNOLOGY TRANSFER.

Texaco presented an SPE paper at the SPE/DOE Tenth Annual Symposium on Improved Oil recovery held in Tulsa last April. A copy of the SPE/DOE # 35362 is shown in Appendix B. As technology transfer partners LSU and SAIC also published two reports ranking reservoirs in Texas and Louisiana Gulf Coast that are amenable to CO₂ injection. LSU presented an SPE paper on the subject at the 1996 SPE/DOE Symposium.

**PORT NECHES
MARG AREA 1
FIELD**
1"=600'

ESTAN SCLAVON
A-431

PORT NECHES CO2 PROJECT ALLOCATED PRODUCTION

APPENDIX "A"

U.S. DEPARTMENT OF ENERGY
NOTICE OF ENERGY RD&D PROJECT

1. DOE CONTRACT OR GRANT NUMBER DE-FC22-93BC14960

☐ New contract ☐ Continuation/Revision ^{DE}

2. A. NAME OF PERFORMING ORGANIZATION Texaco E&P Inc.

B. Department or Division Onshore Division

C. Street Address 400 Poydras

City New Orleans State LA. Zip 70130

D. Type of Performing Organization (circle only one two-letter code)

CU-College, university, or trade school

NP-Foundation or laboratory not operated for profit

EG-Electric or gas utility

ST-Regional, state, or local government facility

FF-Federally funded RD&D centers
or laboratory operated for
agency of US government

TA-Trade or professional organization

US-Federal Agency

IN-Private industry

XX-Other

3. PRINCIPAL OR SENIOR INVESTIGATOR

A. Last Bou-Mikael First Sami MI

B. Phone: Commercial (504) 593-4565 FTS

4. DOE SPONSORING OFFICE OR DIVISION Bartlesville Office

5. TITLE OF PROJECT Post Waterflood CO2 Miscible Flood In Light Oil
Fluvial Dominated Deltaic Reservoir

6. DESCRIPTIVE SUMMARY (limit to 200 words)

Please see attached

7. RESPONDENT INFORMATION. List name and address of person filling out this form. Give telephone number and extension where person can be reached. Record the date this form was completed or updated. This information will not be published.

Last Bou-Mikael First Sami MI

Address 400 Poydras

City New Orleans State LA Zip 70130

Phone (504) 593-4565 Date August 15, 1996

Notice of Energy RD & D Project.

The Port Neches CO₂ flood is a joint project between the department of energy (DOE) and Texaco E&P Inc. (TEPI) that has been in operations for nearly 3 years. This project represents a learning step in developing the CO₂ technology. Initially, it was estimated that the project will recover 2.2 MMSTB of incremental oil, or 19% of the OOIP. The project design was based on a reservoir model and other classical reservoir engineering calculations utilizing the OOIP as a basis to estimate the remaining tertiary reserves. The Port Neches flood has produced 300 MSTB of tertiary oil to date. The production peaked at 500 BOPD in October of 1994 as indicated in Fig. 3. This was below the anticipated 800 BOPD rate initially predicted by the model. The reservoir under-performance is attributed to the following reasons: Reservoir characterization, oil saturation, water blockage and wellbore mechanical problems. Detailed information is included in appendix B of this report.

**Milestone Plan
Budget Period 2**

Updated milestone plan submitted with the project continuation application in October 1994:

1- Update the reservoir simulation model	Completed	3/01/96
2- Drill and complete Polk B+39 in area 2	Canceled	
3- Workover Polk B#5	Completed	
4- Begin CO ₂ injection in area 2	Canceled	
5- Submit screening FDD topical report	Completed	4/30/96
6- Present SPE paper on screening	Completed	4/21/96
7- Complete reservoir characterization topical report	-----	12/31/97
8- Submit SPE Paper on reservoir characterization	-----	12/31/97
9- Submit final project topical report	-----	12/31/97
10- DOE cost sharing ends	-----	12/31/97