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CO₂ HUFF-n-PUFF PROCESS
IN A LIGHT OIL
SHALLOW SHELF CARBONATE RESERVOIR

(No. DE-FC22-94BC14986)

QUARTERLY TECHNICAL PROGRESS REPORT

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OBJECTIVES

The principal objective of the Central Vacuum Unit (CVU) CO₂ Huff-n-Puff (H-n-P) project is to determine the feasibility and practicality of the technology in a waterflooded shallow shelf carbonate environment. The results of parametric simulation of the CO₂ H-n-P process, coupled with the CVU reservoir characterization components will determine if this process is technically and economically feasible for field implementation. The technology transfer objective of the project is to disseminate the knowledge gained through an innovative plan in support of the Department of Energy's (DOE) objective of increasing domestic oil production and deferring the abandonment of shallow shelf carbonate (SSC) reservoirs. Tasks associated with this objective are carried out in what is considered a timely effort for near-term goals.

BACKGROUND

Texaco Exploration and Production Inc.'s. (TEPI) mid-term plans are to implement a full-scale miscible CO₂ project in the CVU. The current market precludes acceleration of such capital intensive projects in many cases. This is a common finding throughout the Permian Basin SSC reservoirs. In theory, it is believed that the "immiscible" CO₂ H-n-P process might bridge these longer-term "miscible" projects with near-term results. A successful implementation would result in near-term production, or revenue, to help offset cash outlays during the initial startup of a miscible flood. The DOE partnership provides some relief to the associated R & D risks, allowing TEPI to evaluate a proven Gulf-coast sandstone technology in a waterflooded carbonate environment. Numerous sites exist for widespread replication of this technology following a successful field demonstration.

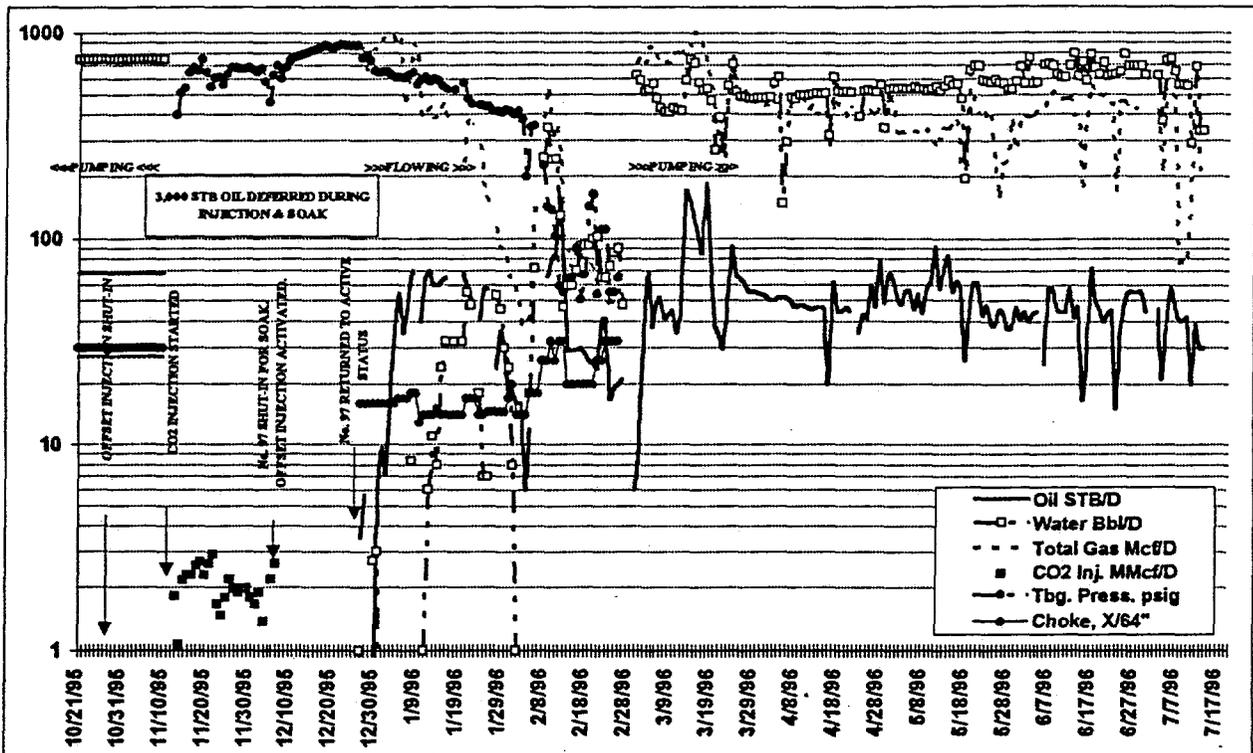
TEPI concluded all of the Tasks associated with the First Budget Period by October, 1995. The DOE approved the TEPI continuation application. Budget Period No. 2 is in progress. Initial injection of CO₂ began in November, and after a short shut-in period for the soak, the well was returned to production in late December, 1995. Monitoring the results of this first demonstration continued throughout the period covered by this report.

SUMMARY of TECHNICAL PROGRESS

FIELD DEMONSTRATION:

Results/Continued Monitoring. CVU No. 97 was returned to active status under flowing conditions on December 27, 1995. Flowing tubing pressure averaged 631 psig with choke settings between 13/64 in. and 18/64 in. Initially, production averaged 901 Mscf/Day. Gas production cannot exceed 1,000 Mscf/D due to disposal limitations. No appreciable water production was seen initially. As expected, the water production slowly returned to the pre-demonstration rates. Compositional analyses of the gas stream shows that early gas rates were at 94 mole-% CO₂. Current production has been very steady around 70 mole-% CO₂. Liquid hydrocarbon production was initially too small to measure and began increasing on the third day. Samples are being collected and retained. The fluid was initially a transparent straw color (41°API), suggesting that lighter hydrocarbons are being effected (or paraffins & asphaltenes are

being left behind). The well is currently producing the field normal 38°API crude. The well had achieved a 70 BOPD rate by the tenth net day of flow-back (average pre-demonstration was 68 BOPD). Production has been quite volatile. The well initially flowed on various choke settings, but eventually loaded up. An ESP was run into the wellbore in early March, 1996. Following some minor operational problems, the well peaked at 184 BOPD. However, production has declined rather sharply following this peak. Approximately 100% of the injected CO₂ volume has been produced. The well continues to produce rather high gas volumes, therefore, the accuracy of either the test volumes, laboratory analysis, or a combination of both are suspect. One notable benefit to date is a reduced volume of water production which has a strong impact on lifting costs. The field demonstration history through mid-July, 1996 has been provided in the following graph.



It is noteworthy to point out that although production expectations have not been achieved at this specific test site, there was a period that favorably experienced reduced operating expenses. During the injection, soak and flowing periods there were no electrical costs. Electrical load was also significantly reduced during the initial pumping period when water rates were 33% below pre-demonstration levels. Although there are a few signs of paraffin buildup and scaling, the lower than forecast oil production result is felt to be due to a lack of gas trapping in the matrix since 100% of the injected CO₂ volume is forecast to be recovered. The metered gas volumes shown in the chart above are in question since early May. The metering accuracy is being evaluated.

SITE-SPECIFIC SIMULATION:

History Match. A need for model refinement has been demonstrated by the differences between predictions and early results (injection rates, pressures, & production). Monitoring of the CVU field demonstration continues. Enough data has now been gathered for a meaningful attempt at history matching. The mechanisms investigated during the parametric simulation exercise will be incorporated as warranted. The history matching exercise will be initiated during July, 1996. Pursuit of a second demonstration site will be weighed with findings developed during the history matching.

Assuming a successful demonstration, the development of guidelines for the cost-effective selection of candidate sites, along with estimation of recovery potential, will be pursued. The economics of the process, if positive, will also be provided.

REFERENCES/PUBLICATIONS

The Petroleum Recovery Research Center continues to provide updates on the project in its quarterly newsletter. In addition, the Petroleum Technology Transfer Counsel, a joint venture between the Independent Producers Association of America (IPAA) and DOE is providing complete quarterly and annual Technical Reports on an Industry Bulletin Board called GO-TECH. This will allow a more timely dissemination of information to interested parties.

The Joint Project Advisory Team (JPAT) met during the month of June. This group is composed of the 21 partners holding ownership in the Central Vacuum Unit, TEPI principal investigators, the New Mexico Petroleum Recovery Institute and the DOE. The JPAT representatives were brought up-to-date on the field demonstration and discussed related issues.

Two industry presentations are scheduled. The first presentation will be in Roswell, New Mexico. The date is tentatively set for August 22-23, 1996. This first presentation will be at a workshop called Integration of Advanced Geoscience & Engineering Techniques of Class II DOE projects. The second presentation will be at the New Mexico Petroleum Recovery Research Center in Socorro, New Mexico. The date is tentatively set for October 23-24, 1996. This second presentation is part of a CO₂ Oil Recovery Forum.

No formal abstracts have been submitted or accepted during the second quarter 1996.