IMPROVED OIL RECOVERY
IN FLUVIAL DOMINATED DELTAIC RESERVOIRS OF KANSAS - NEAR-TERM

Cooperative Agreement Number DE-FC22-93BC14957

The University of Kansas Center for Research, Inc.

April 15, 1995

Budget Period #1 Duration from 06/18/93 - 03/31/95
Budget Period #2 Duration from 04/01/95 - 12/31/98

DOE Award $2,007,446

Program Manager
Don W. Green
University of Kansas
Lawrence, Kansas

Principal Investigators
Don W. Green
G. Paul Willhite

Co-Investigators
A. Walton, L. Schoeling, R. Reynolds, M. Michnick, L. Watney

DOE Project Officer
Rhonda P. Lindsey
Bartlesville Project Office

Reporting Period 02/01/95 - 04/01/95
(7th Quarterly Report)

"U.S./DOE PATENT CLEARANCE IS NOT REQUIRED PRIOR TO PUBLICATION OF THIS DOCUMENT"

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
Objectives

The objective of this project is to address waterflood problems of the type found in Cherokee Group reservoirs in southeastern Kansas and in Morrow sandstone reservoirs in southwestern Kansas. Two demonstration sites operated by different independent oil operators are involved in the project. The Nelson Lease (an existing waterflood) is located in Allen County, Kansas in the N.E. Savonburg Field and is operated by James E. Russell Petroleum, Inc. The Stewart Field (on latter stage of primary production) is located in Finney County, Kansas and is operated by Sharon Resources, Inc.

General topics to be addressed will be 1) reservoir management and performance evaluation, 2) waterflood optimization, and 3) the demonstration of recovery processes involving off-the-shelf technologies which can be used to enhance waterflood recovery, increase reserves, and reduce the abandonment rate of these reservoir types.

The reservoir management portion of the project will involve performance evaluation and will include such work as 1) reservoir characterization and the development of a reservoir database, 2) identification of operational problems, 3) identification of near wellbore problems, 4) identification of unrecovered mobile oil and estimation of recovery factors, and 5) identification of the most efficient and economical recovery process.

The waterflood optimization portion of the project involves only the Nelson Lease. It will be based on the performance evaluation and will involve 1) design and implementation of a water cleanup system for the waterflood, 2) application of well remedial work such as polymer gel treatments to improve vertical sweep efficiency, and 3) changes in waterflood patterns to increase sweep efficiency.

Finally, it is planned to implement an improved recovery process, possibly polymer augmented waterflooding on both field demonstration sites.

Summary of Technical Progress

Savonburg Field Project

Task 1.1 - Engineering and Geological Analysis.

Summary of work in last quarter

Colored cross-sections were continually revised in Stratamodel throughout the field. In some instances, perforations have been added.

Information for the continuation application for the Stewart Field project was prepared and submitted to request funding to continue the Stewart Field project in Budget Period 2. Based upon a favorable evaluation of the continuation application the project is authorized to proceed into Budget Period 2 (covering period from 04/01/95 through 12/31/98).

Summary of planned work for next quarter

All work associated with this task has been completed.
Task 1.2 - Water Plant Development

Summary of work in last quarter

The air flotation unit is working successfully. The removal of suspended oil and solids has been successful, however the dissolved barium has caused a problem by the formation of a barium sulfate scale. The resulting scale is more difficult to remove due to the absence of oil and other solids which in the past made the scale soft and removable. Progress is being made in reducing the barium content of the produced water before combination with make-up water. Cleanup of injection wells has indicated no appreciable deposits in the injection wellbores from the injected brine.

Summary of planned work for next quarter

The waterplant will be continually monitored and optimized as problems arise. We believe the greatest opportunity lies in the area of metering, monitoring, and controlling the water streams leading into and out of the flotation unit. It has been difficult to maintain constant flotation efficiency at the unit. This is caused by a variation in the percentage of produced and make-up water that is being treated over time. When this mix changes, the constituents of the combined water stream also change, necessitating a variation in the chemical treatment. This problem could be solved by automatically monitoring the water mix and adjusting the chemical feed accordingly. This development would certainly make the technology useable by most operators and applicable over a wide range of conditions.

Task 1.3 - Pattern Changes and Wellbore Cleanup

Summary of work in last quarter

The 1-inch tubing and packer were pulled and replaced on KW-51. A larger pumping unit was installed on Well No. H-13 after pulling and servicing. Well No. H-20 was pulled, the pump rebuilt, and the 1-inch pump string replaced. The pump was then set 50 feet deeper. H-30 was also pulled and repaired.

Well No. RW-7 was placed back on injection after a pressure fall-off test and delta-temperature survey were conducted and the offset producing wells tested. Well No. K-39 was shut down as uneconomic.

Summary of planned work for next quarter

We will convert three of the producing wells to injection wells. Also we will clean appropriate wells for better injectivity into the B3 zone.
Task 1.4 - Field Operations

Summary of work in last quarter

Normal field operations have included: 1) monitoring wells on a daily basis, 2) repairing waterplant, piping, and wells as required, 3) collecting daily rate and pressure data, and 4) solving any other daily field operational problem that might occur.

<table>
<thead>
<tr>
<th>Month</th>
<th>Oil Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 1993</td>
<td>26.4 B/D</td>
</tr>
<tr>
<td>November 1993</td>
<td>30.7 B/D</td>
</tr>
<tr>
<td>December 1993</td>
<td>32.0 B/D</td>
</tr>
<tr>
<td>January 1994</td>
<td>30.8 B/D</td>
</tr>
<tr>
<td>February 1994</td>
<td>30.9 B/D</td>
</tr>
<tr>
<td>March 1994</td>
<td>30.3 B/D</td>
</tr>
<tr>
<td>April 1994</td>
<td>29.1 B/D</td>
</tr>
<tr>
<td>May 1994</td>
<td>28.5 B/D</td>
</tr>
<tr>
<td>June 1994</td>
<td>30.3 B/D</td>
</tr>
<tr>
<td>July 1994</td>
<td>28.9 B/D</td>
</tr>
<tr>
<td>August 1994</td>
<td>24.6 B/D</td>
</tr>
<tr>
<td>October 1994</td>
<td>23.0 B/D</td>
</tr>
<tr>
<td>November 1994</td>
<td>25.7 B/D</td>
</tr>
<tr>
<td>December 1994</td>
<td>27.8 B/D</td>
</tr>
<tr>
<td>January 1995</td>
<td>27.0 B/D</td>
</tr>
<tr>
<td>February 1995</td>
<td>25.3 B/D</td>
</tr>
<tr>
<td>March 1995</td>
<td>22.4 B/D</td>
</tr>
<tr>
<td>April 1995</td>
<td>22.4 B/D</td>
</tr>
</tbody>
</table>

Summary of planned work for next quarter

Continue Field Operations
Stewart Field Project

Task I.1 - Geological and Engineering Analysis

Summary of work in last quarter

Information for the continuation application for the Stewart Field project was prepared and submitted to request funding to continue the Stewart Field project in Budget Period 2. Based upon a favorable evaluation of the continuation application the project is authorized to proceed into Budget Period 2 (covering period from 04/01/95 through 12/31/98).

Summary of planned work for next quarter

All work associated with this task has been completed.

Task I.2 - Laboratory Testing

Summary of work in last quarter

All work associated with this task has been completed.

Task I.3 - Unitization

Summary of work in last quarter

North American Resources Company (NARCO) has purchased 100% of the working interest in the Stewart Field from the other operators, which resolves the unitization issue. NARCO is currently in the process of acquiring agreements with the royalty interest owners in the field and filing for a hearing with the Kansas Corporation Commission, which will finalize unitization of the Stewart Field.

Summary of planned work for next quarter

All work associated with this task has been completed.