

DOE/BC/14957-26
(OSTI ID: 14186)

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

Quarterly Technical Progress Report
October 1, 1998-December 31, 1998

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Report Issue Date: January 15, 1999

Performed Under Contract No. DE-FC22-93BC14957

University of Kansas
Lawrence, Kansas

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November 1999

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

Cooperative Agreement Number DE-FC22-93BC14957-28

The University of Kansas Center for Research, Inc.

January 15, 1999

Budget Period #1 Duration from 06/18/93 - 03/31/95

Budget Period #2 Duration from 04/01/95 - 09/30/99

DOE Award \$ 2,007,446

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Reporting Period 10/01/98 - 12/31/98
(22nd Quarterly Report)

"U.S./DOE PATENT CLEARANCE IS NOT REQUIRED
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14186

Objectives

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

General topics to be addressed are 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.

In the Stewart Project, the reservoir management portion of the project conducted during Budget Period 1 involved performance evaluation. This included 1) reservoir characterization and the development of a reservoir database, 2) volumetric analysis to evaluate production performance, 3) reservoir modeling, 4) laboratory work, 5) identification of operational problems, 6) identification of unrecovered mobile oil and estimation of recovery factors, and 7) identification of the most efficient and economical recovery process.

To accomplish these objectives the initial budget period was subdivided into three major tasks. The tasks were 1) geological and engineering analysis, 2) laboratory testing, and 3) unitization. Due to the presence of different operators within the field, it was necessary to unitize the field in order to demonstrate a field-wide improved recovery process. This work was completed and the project moved into Budget Period 2.

Budget Period 2 objectives consisted of the design, construction, and operation of a field-wide waterflood utilizing state-of-the-art, off-the-shelf technologies in an attempt to optimize secondary oil recovery. To accomplish these objectives the second budget period was subdivided into five major tasks. The tasks were 1) design and construction of a waterflood plant, 2) design and construction of a water injection system, 3) design and construction of tank battery consolidation and gathering system, 4) initiation of waterflood operations and reservoir management, and 5) technology transfer. Tasks 1-3 have been completed and water injection began in October 1995.

In the Savonburg Project, the reservoir management portion involves performance evaluation. This work included 1) reservoir characterization and the development of a reservoir database, 2) identification of operational problems, 3) identification of near wellbore problems such as plugging caused from poor water quality, 4) identification of unrecovered mobile oil and estimation of recovery factors, and 5) preliminary identification of the most efficient and economical recovery process i.e., polymer augmented waterflooding or infill drilling (vertical or horizontal wells).

To accomplish this work the initial budget period was subdivided into four major tasks. The tasks included 1) geological and engineering analysis, 2) waterplant optimization, 3) wellbore cleanup and pattern changes, and 4) field operations. This work was completed and the project has moved into Budget Period 2.

The Budget Period 2 objectives consisted of continual optimization of this mature waterflood in an attempt to optimize secondary and tertiary oil recovery. To accomplish these objectives the second budget period is subdivided into six major tasks. The tasks were 1) waterplant development, 2) profile modification treatments, 3) pattern changes, new wells and wellbore cleanups, 4) reservoir development (polymer flooding), 5) field operations, and 6) technology transfer.

Summary of Technical Progress

Stewart Field Project

Task II.1 - Design/Construct Waterflood Plant

Summary of work in last quarter

Tested new water supply zones in Sherman #5, waiting for chemical evaluation of water quality.

Summary of planned work for next quarter

Field work for project completed effective December 31, 1998.

Task II.2 - Design/Construct Injection System

Summary of work in last quarter

None.

Summary of planned work for next quarter

Field work for project completed effective December 31, 1998.

Task II.3 - Design/Construct Battery Consolidation and Gathering System

Summary of work in last quarter

Installed free water knockout at the plant to increase fluid handling capabilities.

Summary of planned work for next quarter

Field work for project completed effective December 31, 1998.

Task II.4 - Waterflood Operations and Reservoir Management

Summary of work in last quarter

Ongoing pump changes and speeding up pumping units were performed during the quarter on several wells. These changes are made as a result of the well testing program that identifies wells with production problems, rising fluid levels, abnormal production trends and low pump efficiencies. The changes that were made are a continued effort to maximize oil production and keep all the wells near a pumped off condition. A progressive gravity pump was installed on the Bulger 7-8 to increase fluid production.

The Meyer 10-6 that was drilled last quarter continues to be a good producer, currently producing 170 BOPD and 21 BWPD. Originally this well was drilled to be an injector, but with its high production rates, we are evaluating converting the Meyer 10-1 instead.

Continued to monitor production and injection rates, water supply volumes, and injection pressures. Continued the ongoing testing of producing wells with test trailers and fluid level instruments. Ongoing allocation of the injection volumes in the injection wells were performed based on response in producers and injectors. Cumulative water injection through December is 7,626,528 bbls. Oil production has continued to increase and as of December 31, 1998 total incremental waterflood response is approximately 2900 BOPD. Total field production is approximately 3150 BOPD and 3950 BWPD. Total incremental waterflood production through December 1998 is 1,552,441 BO. **Figure 1** is a plot showing average daily totals for injection and production data by month for the field since the initiation of the waterflood.

Summary of planned work for next quarter

Field work for project completed effective December 31, 1998.

Task II.5 - Technology Transfer

Summary of work in last quarter

Continued to publicize information on the success of the Stewart Field waterflood. Operators throughout the region continue to visit the field to view the state-of-the-art waterflood installation and computerized monitoring system. A presentation on the project was presented at the Tertiary Oil Recovery Project's Advisory Board meeting on October 30, 1998.

Summary of planned work for next quarter

Continue to publicize information on the success of the Stewart Field waterflood. Presentations and/or papers on the Stewart Field project are scheduled for the North American Prospect Expo (NAPE) in Houston, TX on January 27-28, the Society of Independent Earth Scientists (SIPES) 1999 annual convention and seminar in Wichita, KS on March 10-12, and the Tertiary Oil Recovery Project's 13th Oil Recovery Conference in Wichita, KS on March 17-18.

Stewart Waterflood Average Daily Totals

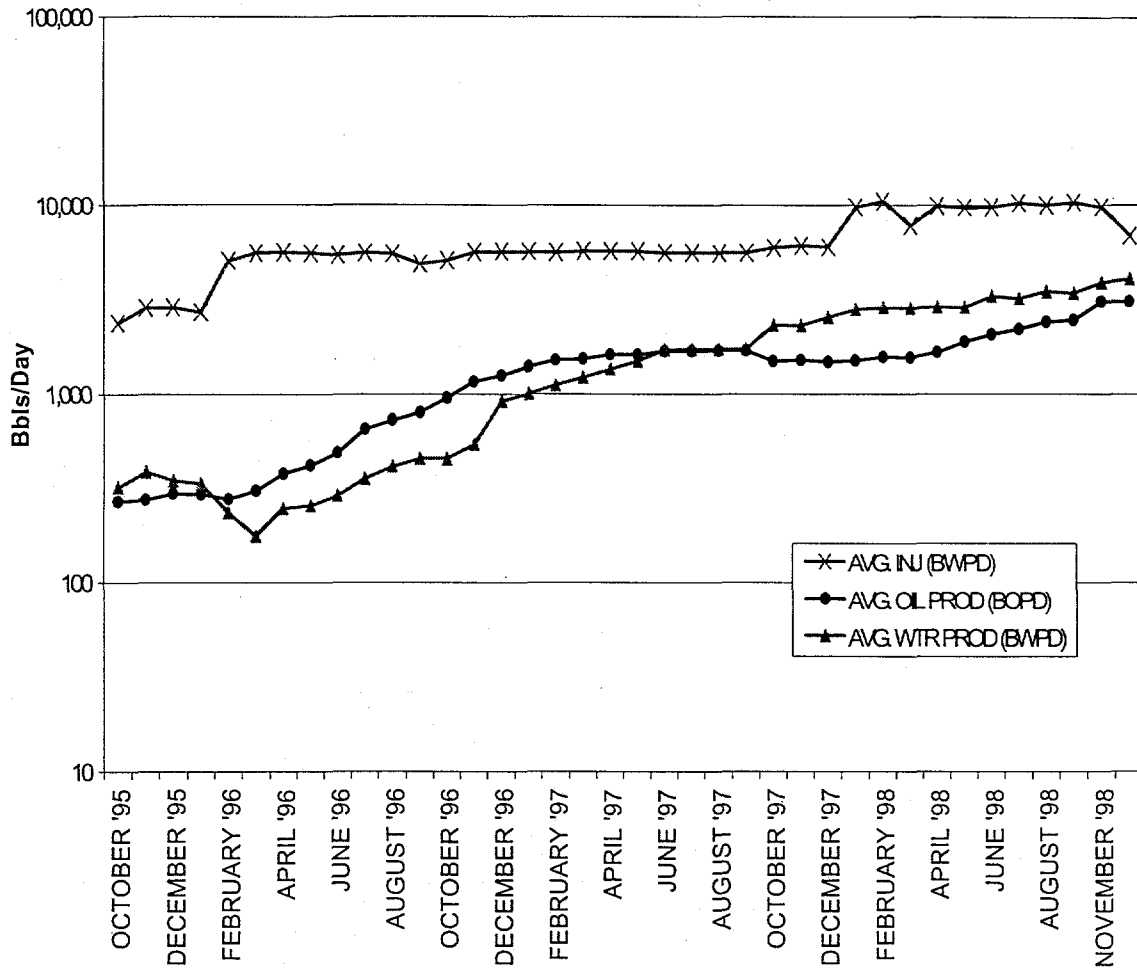


Figure 1. Stewart Field injection and Production Data since Initiation of the Waterflood.

Summary of Technical Progress

Savonburg Field Project

Task II.1 - Water Plant Development

Summary of work in last quarter

Testing of the AFU system continues. Venturis were repositioned. Water quality continued to be excellent. Sulfuric acid was added to the water and adequately reduced the barium to less than 5 ppm. The system continues to operate efficiently with 5 micron filters.

Summary of work planned for next quarter

Field work for project completed effective December 31, 1998.

Task II.2 - Profile Modification Treatments

Summary of work in last quarter

No channelblock treatments were performed during this quarter. Temperature logs were run on wells H-14 and RW-20. Both logs indicated high fill in the wells and consequently the wells were jetted, treated and put back into service.

Summary of work planned for next quarter

Field work for project completed effective December 31, 1998.

Task II.3 - Pattern Changes and Wellbore Cleanup

Summary of work in last quarter

The following wells were serviced during the last quarter; H-6, H-10 (3 times), H-16 (4 times, replaced pump string), H-17, H-20, H-22, H-30 (2 times), K-43 (2 times) K-44 (3 times), K-45 (3 times) and K-54. Acid treatments were applied to HW-1, H-14, H-29 and K-42. The following wells were jetted, washed and acidized; RW-1, RW-3, RW-13, HW-31, H-14, RW-20, KW-11 and RW-12.

Wells K-32, K-33, K-34, K-35, K-36, and Nelson #2 were plugged and abandoned.

Well H-1 was reactivated to production on November 27.

Summary of planned work for next quarter

Field work for project completed effective December 31, 1998.

Task II.4 - Reservoir Development (Polymer Flooding)

Summary of work in last quarter

Operator is developing a polymer flood. Water quality is satisfactory and new water lines and

electrical wiring has been installed. Work is continuing on piping and controls for the polymer mixing equipment.

Summary of work for next quarter

Field work for project completed effective December 31, 1998.

Task II.5 - 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.

<u>Month</u>	<u>Oil Production</u>
October 1993	26.4 B/D
November 1993	30.7 B/D
December 1993	32.0 B/D
January 1994	30.8 B/D
February 1994	30.9 B/D
March 1994	30.3 B/D
April 1994	29.1 B/D
May 1994	28.5 B/D
June 1994	30.3 B/D
July 1994	28.9 B/D
August 1994	24.6 B/D
October 1994	23.0 B/D
November 1994	25.7 B/D
December 1994	27.8 B/D
January 1995	27.0 B/D
February 1995	25.3 B/D
March 1995	22.4 B/D
April 1995	22.4 B/D
May 1995	25.0 B/D
June 1995	23.9 B/D
July 1995	26.8 B/D
August 1995	25.2 B/D
September 1995	24.8 B/D
October 1995	24.4 B/D
November 1995	24.4 B/D
December 1995	26.3 B/D
January 1996	28.0 B/D
February 1996	29.2 B/D
March 1996	27.2 B/D
April 1996	26.7 B/D
May 1996	26.6 B/D
June 1996	24.9 B/D

July 1996	25.4 B/D
August 1996	26.5 B/D
September 1996	26.1 B/D
October 1996	27.1 B/D
November 1996	26.4 B/D
December 1996	27.8 B/D
January 1997	26.9 B/D
February 1997	26.9 B/D
March 1997	27.5 B/D
April 1997	26.3 B/D
May 1997	25.5 B/D
June 1997	24.6 B/D
July 1997	23.5 B/D
August 1997	24.3 B/D
September 1997	23.8 B/D
October 1997	22.9 B/D
November 1997	23.5 B/D
December 1997	21.7 B/D
January 1998	19.0 B/D
February 1998	18.3 B/D
March 1998	18.9 B/D
April 1998	18.0 B/D
May 1998	19.5 B/D
June 1998	18.8 B/D
July 1998	21.2 B/D
August 1998	21.0 B/D
September 1998	22.4 B/D
October 1998	21.7 B/D
November 1998	23.6 B/D
December 1998	23.7 B/D

Summary of planned work for next quarter

Field operations for project completed effective December 31, 1998.

Task II.6 - Technology Transfer

Summary of work in last quarter

Monthly meetings were conducted with personnel from the James Russell Petroleum, Inc., the Tertiary Oil Recovery Project and the Petroleum Technology Transfer Council attending. A review of the project was presented to the Tertiary Oil Recovery Project Advisory Group on October 31 in Lawrence, Kansas.

Summary of planned work for next quarter

A presentation on this project will be presented at the Tertiary Oil Recovery Project's 13th Oil Recovery Conference in Wichita, KS on March 17-18.