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PILOT DEMONSTRATION-ENHANCED OIL RECOVERY
BY MICELLAR-POLYMER WATERFLOODING
BELL CREEK FIELD

MONTHLY TECHNICAL PROGRESS REPORT
FOR JUNE 1977

MASTER

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ENGLEWOOD, COLORADO 80110
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BELL CREEK FIELD
MONTHLY TECHNICAL PROGRESS REPORT - 12
JUNE 1977

ABSTRACT

This is the twelfth Monthly Technical Progress Report submitted under ERDA Contract No. EF-77-C-02-4207, formerly Contract No. E(49-18)-2237. As such it continues the coverage of the activities undertaken by Gary Operating Company, as well as by the major subcontractors, Atlantic Richfield, Union and Intercomp. The work described herein covers the tasks for: Micellar-Polymer Systems Selection and Evaluation, Site Development, Pilot Performance Predictions and Fluid Distribution Facilities.

The major activity at this time is Phase II, Task 1, the Micellar-Polymer Systems Selection as between the two competing designs being developed by Atlantic Richfield and Union Oil. This activity comes to closure with Decision Point 2 in August.

PHASE II - PRELIMINARY TEST PROGRAM

Task 1: Micellar-Polymer Systems Selection and Evaluation

Work Accomplished:

Atlantic Richfield and Union Oil are running their respective process optimal designs for the Bell Creek pilot through a standard set of laboratory tests (FE-2237-9, Third Quarterly Technical Progress Report, January 1977 - March 1977, Attachment 2). These standard tests were described in last month's report (FE-4207-11, May 1977). The rock and fluids to be used were described in the April report (FE-2237-8, April 1977).

Work Forecast:

Atlantic Richfield and Union Oil will continue to process their optimal designs through the standard test series described above and the results will be passed on to Intercomp for their numerical simulation work. Each design group will submit written reports on the outcome of the standard test due August 1, 1977.

PHASE II - PRELIMINARY TEST PROGRAM

Task 2: Site Development

Work Accomplished:

As discussed in last month's report, conventional log analysis did not lead to any consistent set of input-output data due to the common difficulty that R_w , the salinity of reservoir brine, in post waterflood logging is unknown. Thus, two courses of action were decided upon at the Technical Committee meeting of May 19th: to pursue log-inject-log tests on wells MPP #2 and #3, and to obtain Professor G. R. Pickett of Colorado School of Mines and his colleague, Dr. J. L. Bedwell, as consultants to aid in the total log analysis.

There has been a delay in the log-inject-log tests because Schlumberger's TDT-L tool needed for these tests has been down for repairs. Tests should be run by the end of July. Preliminary results from Dr. Bedwell indicate S_{or} of 32% (thickness weighted average). Dr. Rathmell presented new S_{or} data on Bell Creek fresh core tests, Table 1. Thus, a self-consistent picture on S_{or} is beginning to emerge with a core/log percentage value of about 30.

A three-layer zonation model for the numerical simulator was developed for the pay zone from the core and log data given in the May report. At the Technical Committee meeting of May 19th, it was agreed that this pay zone could be further simplified to one layer of varying permeability so long as another zone was added to provide for chemical exchange reactions with the micellar slug. This is shown in Figure 1. The average values were derived from the data in Table 2. First runs with the numerical simulator will use the average values of 1050 md and 65 md for the pay zone and chemical exchange zone respectively.

During June, site development continued with construction of the tertiary tank battery and fluid lines. The injection facility for produced water will be a temporary facility which will later be upgraded to be the permanent micellar-polymer fluid injection plant. Produced water injection will begin during the second week of July. Injection of four interwell tracers is planned during the pre-pilot waterflood phase of the project. One will be chemical (ammonium nitrate) and three will be radioactive isotopes (tritium, cobalt-60 and cobalt 57). These tracers were chosen based on trade-offs between detectability thresholds, handling qualities and cost.

Work Forecast:

The Pickett/Bedwell study will be completed and a written report submitted. The log-inject-log test will be started. The pre-pilot waterflood to stabilize the pattern into a repeated 5-spot streamline pattern will begin. The tracer test definition will be completed.

PHASE III - ENGINEERING AND ANALYSIS

Task 1: Performance Prediction

Work Accomplished:

The result from the waterflood history match is being used to predict fluid migration across the pilot area. A draft copy of the waterflood history match, "Coarse Grid Simulation Study of Unit 'A' Reservoir, Bell Creek Field", has been submitted to Gary Operating Company for approval. A refined grid multi-layer model is being constructed for the study of the pilot area. The lithology of the pilot area is being updated with the data provided in Phase II, Task 2. Cross-sectional runs are being made in the pilot area to determine the optimum number of vertical layers and the nature of the fine grid for the model.

Chemical Flood Simulator (CFS). The finite-difference, two-dimensional, six-component chemical flood simulator (CFS) has been completed and is now operational. It will use the zonation model shown in Figure 1. Program enhancements have been made to make it suitable for simulating certain aspects of laboratory and field data likely to be encountered in the project. Also, the finite-difference model has been configured as a back-up for the variational model, should this be necessary in simulating the pilot area flood.

Work Forecast:

The major work in July will be to take the data from the process designs and use the CFS in the Selection Methodology, Second Quarterly, October-December 1976, Attachment 1.

PHASE IV - DEMONSTRATION PROGRAM

Task 1: Fluid Distribution System Facilities

Work Forecast:

Final design of the fluid distribution system will be made after laboratory determinations of injection fluid properties are completed. Since the injection plant details are micellar-polymer process dependent, the design and construction is being carried forward as far as commonality between the two possible systems permits and then will be completed after Milestone 1400, "Fluid System Selection", July 1977.

TABLE 1

BELL CREEK FRESH CORE
RESIDUAL OIL SATURATION

<u>CORE</u>	<u>DEPTH (FEET)</u>	<u>ϕ (%)</u>	<u>$K_o @ S_{cw}$ (md)</u>	<u>$K_w @ S_{or}$ (md)</u>	<u>S_{orw} (% PV)</u>	<u>REMARKS</u>
MPP-1 ⁽¹⁾	4648-49	35	800	77	23	Live Crude
MPP-2	4601-2					
MPP-1 ⁽²⁾	4646-47	32	1134	164	28	Displacement
MPP-1 ⁽²⁾	4646-47	32	1120	84	21	Penn State

(1) Composite of 2 core plugs from 4648-49, MPP-1 and 2 core plugs from 4601-02, MPP-2

(2) Composite of 4 core plugs from 4647-47, MPP-1

TABLE 2
RESERVOIR PARAMETERS

<u>Well No.</u>	<u>h (ft)</u>	<u>ϕ (%)</u>	<u>Ka (md)</u>
MPP-1			
(Pay)	7	32	1000
(Chem. Ex.)	7	22	50
MPP-2			
(Pay)	9	31	1400
(Chem. Ex.)	6	20	40
MPP-3			
(Pay)	8	28	500
(Chem. Ex.)	4	17	20
MPP-4			
(Pay)	8	26	1700
(Chem. Ex.)	5	21	150
MPP-5			
(Pay)	10	31	600
(Chem. Ex.)	6	20	65
12-1			
(Pay)	7	29	1050
(Chem. Ex.)	5	13	65
Avg. 40-acre 5-spot			
(Pay)	8.1	29	1050
(Chem. Ex.)	5.4	20	65

Net ac-ft 40-acre area = 94

Net Pay PV of 40-acre area = 729,200 bbls.

Ac-ft of Chem. Ex. Zone in 40-acre area = 43

PV of Chem. Ex. Zone in 40-acre area = 335,100

Avg. S_w = 65%

Avg. S_o = 35%

FIGURE 1
ZONATION - II

CHEMICAL
EXCHANGE