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EL DORADO MICELLAR - POLYMER PROJECT

TECHNICAL LETTER FOR JANUARY, 1976

MASTER

Summary of Activities for January, 1976

The primary field activity for January has been to maintain operations of the plant during extremely cold weather in the early weeks and to maintain and improve on the relative quality of the various pre-treatment fluids. Another area requiring attention was changeover of the saturated salt system to a permanent installation.

A total of 11,168 and 12,185 barrels of pre-treatment fluids were injected into the Chesney and Hegberg patterns respectively. This is a composite average of 42 barrels per day, down eight from the previous month.

During January, the number and type of observation wells needed was studied extensively. This resulted in a recommendation for two such wells located between an injection and production well in each pattern.

Chemical analyses were performed on various waters, filtrates, and scales in an effort to determine the likely causes of injection problems. A clay study was also directed toward this problem. Remedial well treatments were then recommended.

Laboratory work has also included steady-state relative permeability tests, analysis of sulfonates, tests of soluble oil mixtures, flow tests with the preliminary Shell system, study of new polymer samples, and both development and support work relating to well treatments.

Two papers entitled "Reservoir Simulation for the El Dorado Micellar-Polymer Project" and "Interference Testing for Reservoir Definition - The State of the Art" were completed in January. Both will be presented at the Society of Petroleum Engineers of AIME Improved Recovery Symposium to be held in Tulsa, Oklahoma during mid-March 1976.

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CONSTRUCTION

Injection Plant

The rental frac tank used to prepare the saturated salt water fluid was replaced with a permanent fiberglass tank and a downflow filter bed was installed in the tank. This will insure a more efficient method of mixing saturated salt water than before.

The fresh water filter flush pump froze on January 9, 1976 and the case broke. The break was repaired and a back-up pump has been ordered. The insulated building material for the skid arrived at the end of the month and will be installed in early February, 1976.

All gas blankets at the plant have been installed and are in operation.

Mr. Roger Kleinschmidt, Project Manager for Phillips Petroleum Company's Burbank Project, was given a tour of the El Dorado MP Project on January 14, 1976.

Fresh Water Line

Air relief vent valves were installed at several high elevation points along this line on January 20, 1976.

ENGINEERING AND OPERATIONS

Pattern Injectivity and Well Stimulation

The injection rates for both patterns continued to decline during January. They were 40 and 43 barrels per day for the respective Chesney and Hegberg patterns.

A meeting was held with Shell technical personnel on January 16 to discuss the injectivity problem and possible solutions. Following this and a subsequent meeting with Mr. W. D. Howell, TPO, on January 20, a decision was made to change stimulation attempts to a combination HCL-HF acid system with Xylene instead of

the Xylene-HCL system used on MP 118, 120 and 203 last month. MP 120 was the only one of the three to maintain its initial increase in injectivity. It was also decided to attempt a surfactant well bore treatment. Plans are to treat MP 116 and MP 205 with Xylene, HCL and HF acid and to surfactant treat MP 130 and MP 215 sometime in mid-February.

Due to near drought conditions the City of El Dorado switched their water supply from Lake Bluestem to Lake El Dorado. During the switchover, our water supply came from the Walnut River for several days. Although aware of the impending change, the very high solids content of the raw fresh water while on river water upset the fresh water filter system considerably. Efforts are continuing to return the water to the quality which was obtained prior to the switchover.

MP 126, 201, and 211 have increased in injectivity for no apparent reason. Tracer surveys were run to insure all of the pretreatment was going into the proper interval. The surveys on all three wells confirmed that the fluid is leaving the wellbore into the 650' sand interval only.

In order to prevent a volumetric imbalance of individual injection wells, six (6) wells with relatively high cumulative injection volumes were shut-in at the end of the month until the injectivity problem is solved and the relative pattern volumes can be returned to their proper balance. These were MP 106, 110, 126, 201, 211 and 213.

MONTHLY PRODUCTION REPORT

Well No.	Monthly Volumes, Bbls.		Days Prod.	Cumul. Since Start		Date Started
	Oil	Water		Oil	Water	
MP 112	11	715	31	34	2107	11/17/75
MP 114	26	182	23	98	674	"
MP 122	12	486	31	36	1446	"
MP 124	23	920	31	35	2708	"
Chesney	72	2303		203	6935	
MP 207	35	249	23	131	969	"
MP 209	5	535	31	17	1795	"
MP 217	12	725	31	36	2034	"
MP 219	18	846	31	42	2310	"
Hegberg	70	2356		226	7108	

MONTHLY INJECTION REPORT (Pretreatment)

Well No.	Barrels Injected	Injection Press. psig	Days on	Cumulative Inj. bbls.	Date Started
MP 106	648	200	25	2,231	11/17/75
MP 108	687	200	24	2,516	"
MP 110	1,827	195	28	6,243	"
MP 116	515	200	25	2,035	"
MP 118	939	200	31	2,952	"
MP 120	3,060	200	31	5,435	"
MP 126	2,749	140	28	6,323	"
MP 128	562	200	27	2,470	"
MP 130	181	200	16	1,617	"
Chesney	11,168			31,822	
MP 201	2,724	170	26	6,922	"
MP 203	940	210	31	2,427	"
MP 205	473	215	31	2,428	"
MP 211	2,941	180	28	6,044	"
MP 213-226	1,411	205	28	4,799	"
MP 215	778	215	31	2,561	"
MP 221	834	215	31	3,539	"
MP 223	1,209	200	31	4,342	"
MP 225	875	215	31	3,278	"
Hegberg	12,185			36,340	
Total Project	23,353			68,162	

MONTHLY PRODUCING WELL TEST REPORT

Well No.	Actual Vol. Produced		Hours Tested	Pump Size	Stroke Length	Strokes Per Min.
	Oil	Water				
MP 112	2	138	24	1½	42"	13.5
MP 114	2	60	24	1½	22"	13.5
MP 122	2	80	24	1½	42"	12.0
MP 124	6	156	24	1½	42"	13.5
MP 207	9	55	24	1½	22"	13.5
MP 209	2	114	24	1½	42"	13.5
MP 217	2	125	24	1½	42"	13.5
MP 219	3	124	24	1½	42"	13.5

RESEARCH SUPPORTChemical Selection and Support

Soluble oil work. Samples of two Witco sulfonates were analyzed for average equivalent weight and sodium sulfonate, oil, inorganic salt, and water percentages using modified ASTM 855 and modified ASTM 2548 methods. Witco stated these samples are representative of materials being isolated in storage tanks at Petrolia for use in preparing Union's soluble oil slug for the El Dorado field demonstration. In general the results are in good agreement with Witco's measurements.

A soluble oil and micellar water were prepared according to the specifications given in the letter to the Research Project Leader from L. W. Holm of Union dated December 30, 1975. The properties of the resultant mixtures of these fluids were in agreement with the performance specifications detailed by Union. A slightly revised formulation is expected from Union in the near future.

The amounts (and costs) of two commercial chelating chemicals required for the preparation of Union slugs were calculated and reported during the January monthly technical meeting. The calculations were based on a lake water hardness assumed to be 0.1 gram of calcium carbonate hardness per liter. The results were:

	<u>Relative Total Cost</u>
Chelating Agent A	\$51,122
Chelating Agent B	\$23,903

Flow tests. Two flow tests were performed with the preliminary Shell formulation using two-inch diameter by ten-inch long Berea Sandstone cores. Residual oil saturations were reduced to 0.4 and 1.0 percent with 0.12 PV (pore volume) and 0.08 PV slug sizes, respectively.

Runs to determine surfactant adsorption are being made. Results should be available to report next month.

Polymers. A new sample of Nalco Q41F polymer was received (Q41F-B5275 A).

A 600 ppm active polymer solution was prepared in synthetic El Dorado raw water (EDRW). Solution viscosity and screen factor measurements were satisfactory as compared with design polymer Q41F-CG160 used by Union. Results are shown in the table below.

VISCOSITY AND SCREEN FACTOR MEASUREMENTS--NALCO POLYMERS

<u>Water Composition</u>	<u>Q41F Design Polymer</u>	<u>Q41F (New Sample) B-5275A</u>
Synthetic EDRW		
63 ppm NaCl		
82 ppm CaCl ₂	43.5	46.4
20 ppm MgCl ₂		
in deionized water		
Screen Factor	17.1	20.0

Observation wells. Several members of the Laboratory studied the need, type, and use of observation wells between injection and production wells in both the Chesney and Hegberg leases. This topic was the primary subject at a meeting with Shell technical representatives on January 16. The recommendations of those in the Cities Service Laboratory were directed to the Project Manager in the form of two letters, one from R. P. Murray (January 29) and the second from H. L. Chang (January 30). The final design is being considered.

Wellbore clean-up work. The low injectivity rate being experienced in El Dorado has been studied by several members of the Laboratory (see also the sections "Coring and Core Analyses" and "Pressure Transient Tests and Well Stimulations"). Laboratory experiments were performed in an effort to recommend an effective, surfactant containing, wellbore clean-up fluid. Five distinct fluids were considered. The composition of the most successful of these fluids based on flow tests through native state cores, viscosity measurements, and interfacial tension measurements was verbally communicated to the project engineer by telephone on January 28, 1976. On January 29, the project engineer stated that Shell and Union had given their tentative approval to use the recommended fluid.

Other chemical work. Barium sulfate scale treatments on two wells treated in November were evaluated. Visco 953 has prevented scale formation, but the feedback rate of the chemical is poor. Other scale inhibitor chemicals are being considered for future use.

A tar removed from the storage tank cars was analyzed. This material can be removed by an aromatic solvent.

Coring and Core Analyses

A paper entitled "Core Analysis Study for the El Dorado Micellar-Polymer Project" by W. H. Pusch was completed and sent to the Society of Petroleum Engineers of AIME Headquarters for presentation at the Improved Oil Recovery Symposium to be held in Tulsa in March, 1976.

Results of steady-state relative permeability data measured on two native-state samples from well MP-217 are being prepared. The results will be reported by inter-office letter.

Analyses relating to well treatments. Clay mineral analysis of six wells in the project area indicate that the clay minerals are not the sole cause of the injectivity problems currently being experienced. These mineral analyses are given in the attached table. There is no clearly demonstrable relationship between clay mineral composition and injectivity behavior among the wells examined. Note that migration of kaolinite and illite fines have been observed in various flow tests using El Dorado cores.

Pressure Transient Tests and Well Stimulations

Documentation of the directional permeability tests made last summer and the theoretical basis of interpreting the results therefrom was presented during January. This information was in a report "Directional Permeability Analysis;

El Dorado Micellar-Polymer Project" attached to a memo from L. P. Brown and S. C. Swift dated January 7. This information was submitted to ERDA as a special report on January 29, 1976. The information in this report also served as a basis for technical paper SPE 5809, "Interference Testing for Reservoir Definition--The State of the Art," by S. C. Swift and L. P. Brown. This paper is to be presented at the Society of Petroleum Engineers of AIME Improved Oil Recovery Symposium this springs.

Injection history was analyzed and the possible causes of injection well plugging were enumerated. As a result of these efforts, injection well stimulation treatments believed to be the best remedial methods, were selected and recommended. Initially two acid treatments and two surfactant treatments are to be undertaken (see also the sections "Chemical Selection and Support" and "Coring and Core Analyses").

Performance Predictions

The technical paper SPE 5807, "Reservoir Simulation for the El Dorado Micellar-Polymer Project," by D. F. Zetik was completed during January. This paper will be presented at the Society of Petroleum Engineers of the AIME Fourth Symposium on Improved Oil Recovery, Tulsa, March 22-24, 1976.

The polymerflood simulator is being used to evaluate the relative displacement efficiency for different concentration gradings of the polymer slug. Earlier runs were rerun because of an error which was found in the data. Three runs were completed using the imbibition relative permeability curves. Each case simulates a different polymer slug design. One run having a constant polymer concentration and using the drainage relative permeability curves was completed.

EL DORADO MICELLAR-POLYMER FLOOD
SEMIQUANTITATIVE X-RAY DIFFRACTION ANALYSIS
OF THE LESS-THAN 5 MICRON SIZE FRACTION

	<u>Illite</u>	<u>Illite/Mont.</u>	<u>Chloride</u>	<u>Kaolinite</u>	<u>Calcite</u>	<u>Quartz</u>	<u>Percent <5μ</u>
<u>Well MP-221</u> (depth in feet)							
662	40	5	1	39	10	10	7.8
663	30	10	15	40	--	5	30.0
664-7	35	--	10	45	5	5	5.9
668-72	25	5	15	40	5	10	6.6
673-74	30	--	10	50	--	10	8.4
675	30	--	15	45	--	10	7.0
677-80	35	--	--	45	5	10	8.9
<u>Well MP-225</u> (depth in feet)							
657-8	45	5	10	20	10	10	13.6
659	40	15	10	20	--	15	6.8
660	55	15	10	10	--	10	16.2
660.4-62.0	45	10	10	20	5	10	7.4
664	40	15	10	25	--	10	7.1
665-66	50	10	10	25	--	5	8.7
667	40	10	15	20	--	5	6.1
668-69	50	10	15	20	--	5	11.0
669.8	40	10	15	25	--	10	5.8
670-71	35	15	15	20	--	15	6.3
672-73	40	10	15	20	--	15	5.7
675-77	50	10	20	15	--	5	15.2
678	45	5	25	20	--	5	23.0
<u>Well MP-215</u> (depth in feet)							
650	18	3	7	12	--	60	9.2
656	21	4	7	17	--	51	9.1
664	14	2	5	14	--	65	7.3
<u>Well MP-223</u> (depth in feet)							
672	19	2	6	15	--	59	9.7
679	20	3	7	17	--	53	7.7
684	16	2	6	15	--	62	9.4

	<u>Illite</u>	<u>Illite/Mont.</u>	<u>Chloride</u>	<u>Kaolinite</u>	<u>Calcite</u>	<u>Quartz</u>	<u>Percent <5μ</u>
<u>Well MP-213</u>							
(depth in feet)							
674.5	26	4	6	20	1	43	10.2
677	15	3	5	14	--	63	8.0
680	30	4	10	19	--	37	12.1
<u>Well MP-211</u>							
(depth in feet)							
660	17	2	4	19	--	57	8.9
667	20	4	6	18	--	51	7.7
674	20	3	6	17	--	54	8.0
<u>Well MP-201</u>							
(depth in feet)							
657	11	3	4	17	--	65	9.1
665	18	3	5	17	--	57	8.1
673	16	2	6	15	--	62	9.5

PATTERN

CHESNEY

----- RATE
----- CUM

CUM
0 5000 10000 15000 20000 25000 30000 35000 40000 45000 50000
RATE (STB/D)
0 200 400 600 800 1000 1200 1400 1600 1800 2000
PRESSURE
0 20 40 60 80 100 120 140 160 180 200

PATTERN

HEGBERG

----- RATE

----- CUM