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EL DORADO MICELLAR - POLYMER PROJECT

TECHNICAL LETTER FOR FEBRUARY, 1976

MASTER

Summary of Activities for February, 1976

The relatively low fluid injectivity has received prime attention from field personnel during the month of February. A well stimulation program which consisted of a solvent-acid treatment began in late February. The preliminary results appear quite favorable. A considerable amount of effort has been directed toward improving the water quality.

A total of 5100 and 3419 barrels of pretreatment fluids were injected into the Chesney and Hegberg pattern, respectively.

A representative of Gary Operating Company was given a tour of the plant facilities February 19.

Considerable effort has been made on site and in the laboratory to determine the major factors responsible for the less than desirable water quality being found in the field. Oil recovery flow tests and adsorption tests have been made using a preliminary Shell formulation. Steady-state relative permeability tests have been completed for two core samples. Work with the polymerflood simulator has continued; the simulation runs made to date are now being evaluated.

ENGINEERING AND OPERATIONS

Pattern Injectivity and Well Stimulation

The injection rates of individual wells have continued to decrease. In an effort to stimulate injectivity it was decided to implement the following treatment:

1. Swab Well
2. Spot 200 Gallons Xylene
3. Spot 250 Gallons Hydrochloric Acid
4. Spot 1000 Gallons Hydrofluoric Acid
5. Spot 250 Gallons Hydrochloric Acid
6. Resume Injection

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The preliminary results have been encouraging. The results of the first four acid treatments are listed below:

<u>WELL</u>	<u>RATE BEFORE B/D</u>	<u>PRESSURE</u>	<u>RATE AFTER</u>	<u>PRESSURE</u>	<u>RATE NOW B/D</u>	<u>PRESSURE</u>
116	27	200	110	155	152	170
205	16	190	250	150	149	180
203	82	190	168	160	149	190
106	20	200	149	160	113	190

Work will continue to stimulate the remaining wells next month.

In addition to the well stimulation, work to analyze and improve the water quality has been undertaken. Both suspended and dissolved solids in the El Dorado Lake water were identified. The total suspended solids in the raw lake water are 11 mg/L. Five milligrams per liter (45 percent) was analyzed as organics. The solids in the suction tanks were nine milligrams per liter of which six milligrams per liter (67 percent) was analyzed as organics. The increasing organic content indicated a bacteria problem. A standard bacteria plate count confirmed this theory. Analysis of water quality, bacteria count, and particle size distribution is attached.

Future work will include introducing a biocide.

MONTHLY PRODUCTION REPORT

Well No.	Monthly Volumes, Bbls.		Days Prod.	Cumul. Since Start		Date Started
	Oil	Water		Oil	Water	
MP 112	34	1383	29	68	3490	11/17/75
MP 114	45	540	29	143	1214	"
MP 122	23	863	29	59	2309	"
MP 124	57	1767	29	92	4475	"
Chesney	159	4553		272	11488	
MP 207	103	607	29	234	1576	"
MP 209	34	1111	29	51	2906	"
MP 217	23	1392	29	59	3426	"
MP 219	23	1173	29	65	3483	"
Hegberg	183	4283			11391	

MONTHLY INJECTION REPORT (Pretreatment)

Well No.	Barrels Injected	Injection Press. psig	Days on	Cumulative Inj. bbls.	Date Started
MP 106	216	190	20	2,447	11/17/75
MP 108	564	190	31	3,080	"
MP 110	0	190	7	6,243	"
MP 116	476	190	31	2,511	"
MP 118	548	190	31	3,500	"
MP 120	1,328	190	31	6,763	"
MP 126	1	112	7	6,324	"
MP 128	1,688	190	31	4,158	"
MP 130	279	190	31	1,896	"
Chesney	5,100			36,922	
MP 201	2,724	170	7	6,923	"
MP 203	968	200	31	3,395	"
MP 205	316	200	31	2,744	"
MP 211	7	180	7	6,051	"
MP 213-226	0	200	8	4,799	"
MP 215	577	200	31	3,138	"
MP 221	900	200	31	4,439	"
MP 223	1	200	7	4,343	"
MP 225	649	200	31	3,927	"
Hegberg	3,419			39,759	
Total Project	8,519			76,681	

MONTHLY PRODUCING WELL TEST REPORT

Well No.	Actual Vol. Produced		Hours Tested	Pump Size	Stroke Length	Strokes Per Min.
	Oil	Water				
MP 112	2.5	122	24	1½	42"	13.5
MP 114	3.7	48	24	1½	22"	13.5
MP 122	2	75	24	1½	42"	12.0
MP 124	5.3	155	24	1½	42"	13.5
MP 207	9	53	24	1½	22"	13.5
MP 209	3	98	24	1½	42"	13.5
MP 217	2	121	24	1½	42"	13.5
MP 219	2	102	24	1½	42"	13.5

RESEARCH SUPPORTChemical Selection and Support

Water Quality. A permanently mounted water quality testing apparatus was installed with direct lines to the three triplex pumps, the saturated brine line at the skid, and the fresh water tank at the skid. The field laboratory technician was instructed in the use of the apparatus and in running water quality tests.

Laboratory personnel spent several days at the field site in an effort to determine major factors responsible for the relatively poor quality of water downstream from the up-flow sand filter. Accomplishments, comments, data collected, etc. for the field work are:

1. An analysis of Lake El Dorado water (a new fresh water source) was obtained from the city water-plant personnel.
2. The polymer flocculant was being injected at erratic rates. Accordingly, the polymer pump was replaced and the replacement pump calibrated. For a polymer solution prepared by mixing 50 gallons of water with 1 gallon of polymer concentrate and a lake water flow rate of 60 gallons per minute, a setting of 14 on the polymer pump results in a polymer concentration in the lake water stream of about 6 parts per million. Under these conditions the turbidity of the water downstream of the up-flow sand filter was reduced to 0.24-0.26 NTU (nephelometric turbidity units). Water with a turbidity of less than 0.5 NTU is considered satisfactory water.
3. Water quality tests (rate of flow versus volume of flow through a 0.45 micron millipore filter) were performed using water straight from the sand filter for which the turbidity meter had indicated a turbidity of 0.24 NTU. The data given in Table 1 were obtained during two water quality tests made by Laboratory and Region personnel on February 6. This table illustrates the type of data recorded on the many water quality tests being made. For good quality water, millipore data indicate an initial flow rate of about 10 ml/sec with a flow rate still above 4 ml/sec after three liters have passed through the filter

(however, allowances must be made for viscosities not close to one cp). The data in Table 1 show that the water met these quality standards at that time. It appears that the turbidity meter reading and both of the water quality tests using a millipore apparatus are in agreement as to the suitability of the water for mixing purposes if the water is acceptable. There can be a difference in the conclusions drawn from the two water quality tests if the water is on the borderline of acceptability.

4. From the data obtained in early February and that obtained on a subsequent day, it has been concluded that the particulate matter is from 0.45 to 1.2 μ in size. As of the end of February, it appeared that most of the problem causing material is organic in nature and probably bacteriological as well. The plan for obtaining a good water quality is to chlorinate the supply water at the lake (with additional treatment at the plant as needed). Then if there are still problems with the water quality, optimization of the flocculant (polymer) is to be undertaken.

Table 1

WATER QUALITY TEST DATA FOR EL DORADO WATER

<u>Volume of Flow, Liters</u>	<u>Time Interval, Seconds</u>	
	<u>1st Test</u>	<u>2nd Test</u>
0.2	20.5	21.2
0.4	21.0	21.2
0.6	22.0	23.6
0.8	23.0	23.6
1.0	22.0	24.5
1.2	26.1	27.5
1.4	25.0	27.5
1.6	23.0	28.0
1.8	27.0	30.4
2.0	29.0	31.6
2.2	29.2	33.4
2.4	32.0	34.4
2.6	34.5	39.5
2.8	36.2	39.5
3.0	38.8	41.9
3.2	42.0	----

Water temperature = 44 degrees F

Date: February 6, 1976

5. The concentration of oxygen both upstream and downstream of the injection point of Tretolite K490 oxygen scavenger is being monitored by Tretolite personnel. Data available on February 4 are shown in Table 2.

Table 2

OXYGEN CONCENTRATION DATA FOR EL DORADO INJECTION WATER

<u>Date</u>	<u>Concentration of Oxygen in Water From the Fresh Water Tank, Parts per Million</u>	<u>Concentration of Oxygen at or near the Triplex Pumps, Parts per Million</u>	<u>Uncatalyzed K490 Present, Parts per Million</u>	<u>Water Temperature, Degrees F</u>
1/15/76	12	10	30	36
1/17/76	12	9	60	40
1/20/76	12	6	80	40
1/21/76	12	2	120	42
1/22/76	12	8	120	45
1/23/76	12	3	120	44
1/26/76	12	3	120	39
1/27/76	12	1	120	44
1/28/76	12	1	120	40

Adsorption Tests. Three experiments on the adsorption of a preliminary Shell formula for an aqueous surfactant have been completed. The three tests gave rather odd results. All three tests were done on Berea cores one inch in diameter by about 3.5 inches long. Experimental conditions were identical except for the flow rate which was varied. The rates used were 1, 2, and 4 ml/hr; the first two tests yielded no reduction in the concentration of surfactant in the effluent when shut-in overnight while at 4 ml/hr, a reduction occurred. Thus, it was concluded that the first two represent equilibrium adsorption while the third does not. The adsorption test reported earlier this year was also run under high flow rate (non-equilibrium) conditions.

The surfactant recovered from the isopropyl alcohol extractions of El Dorado core and adsorption values calculated from a material balance do not agree. It is felt that the material balance problems may be due in part to chromatographic separation in the core. Adsorption tests will be continuing to be run to resolve the difference between these two methods of obtaining adsorption numbers.

Oil Recovery Flow Tests. Additional flow tests using a preliminary Shell formulation in two-inch diameter by ten-inch long Berea cores were performed in February. A summary of the results of these tests is given in Table 3.

Table 3

RESULTS OF OIL RECOVERY FLOW TESTS USING A SHELL SYSTEM

<u>Run No.</u>	<u>Slug Size (Percent of Preliminary Design by Shell)</u>	<u>Percent Oil Recovery (Post Waterflood)</u>	<u>Residual Oil (Percent Pore Volume)</u>
1	100	98.7	0.4
2	66	96.7	1.2
3	33	78.0	7.4

Other Chemical Work. Other chemical work included laboratory evaluations of barium sulfate scale inhibitors and analyses of suspended solids in El Dorado Lake Water. The results of this work were reported in inter-office letters by R. S. Fulford (February 9 and 18).

Coring and Core Analyses

Results of steady-state relative permeability data from two core samples from well MP-217 were reported in an inter-office letter by W. H. Pusch (March 2). Native-state conditions were maintained and formation oil and water were used in two of the tests. The final test investigated the effect of native-state conditions. Detailed results are expected to be included in the next annual report for the project.

Literature Work

Work has been resumed on the literature survey for micellar and alkaline flooding. The completing of this report is expected within the next two months.

Performance Prediction

The relative displacement of several concentration gradations for polymer slugs is being evaluated with the polymer flood simulator. Two additional runs were completed this month, making the total number of runs six. Before continuing with

additional runs, the results already obtained need to be evaluated to determine if the simulator accurately describes the displacement process. There is concern that due to the way in which flow at the leading edge of the polymer slug is simulated, the results of the earlier runs may be misleading. Once the results of the six cases already completed are evaluated, the decision will be made as to whether or not to continue this modeling study.

Cities Service Oil Company

API Water Analysis

Field, Lease - El Dorado Micellar-Polymer

County, State - Butler, Kansas

Well -

Date Sampled - 2/19/76

Type Water (Produced, Supply, etc.) - El Dorado Lake water downstream of sand filter

Dissolved Solids

Other Properties

Cations

mg/l

meq/l

pH 8.3

Specific Gravity 1.000

Sodium, Na

8

-

Calcium, Ca

56

3

Magnesium, Mg

6

-

Barium, Ba

0

0

Strontium, Sr

0

0

Potassium

3

-

Anions

Chloride, Cl

9

-

Sulfate, SO₄

1

-

Carbonate, CO₃

10

-

Bicarbonate, HCO₃

206

3

Total Dissolved Solids 299

Iron, Fe (total)

0

Sulfide, as H₂S

-

Cities Service Oil Company

API Water Analysis

Field, Lease - El Dorado Micellar-Polymer Project

County, State - Butler, Kansas

Well -

Date Sampled - 2/24/76

Type Water (Produced, Supply, etc.) - El Dorado Lake water upstream of sand filter

Dissolved Solids

Other Properties

Cations

mg/l

meq/l

pH 7.7

Specific Gravity 1.000

Sodium, Na

8

0

Calcium, Ca

57

3

Magnesium, Mg

6

-

Barium, Ba

0

0

Strontium, Sr

0

0

Potassium

3

-

Anions

Chloride, Cl

8

-

Sulfate, SO₄

1

-

Carbonate, CO₃

0

0

Bicarbonate, HCO₃

217

4

Total Dissolved Solids 300

Iron, Fe (total)

1

Sulfide, as H₂S

-

CITIES SERVICE OIL COMPANY

MEMBRANE FILTER RESIDUE ANALYSIS

Field Test Made By: G. Davis Lab. No.: _____

Field: El Dorado County: Butler State: Kansas

Location of Test: Downstream of MP Project sand filter

Date of Test: 2/19/76 Lab Test Made By: Horwell

Test Pressure: 20 psig Type Filter: Millipore 0.45 micron

Temperature: ambient

Filter No.

Dry Weight-Clean Filter 0.8645

Volume Filtered: 20 liters

Color of Residue:

In field at time of test _____

In lab. at time of analysis cream

CHEMICAL ANALYSIS

Filter No.

mg/L

TOTAL SOLIDS: 0.3

ORGANIC CONTENT(Ignition Loss): 0.05

ACID SOLUBLE CONTENT:

Iron as Fe_2O_3 0.02

Calcium as CaCO_3 0.01

Sodium as NaCl 0.05

Unidentified 0.13

ACID INSOLUBLE CONTENT:

Silica 0.04

Barium Sulfate --

REMARKS: _____

CITIES SERVICE OIL COMPANY

MEMBRANE FILTER RESIDUE ANALYSIS

Field Test Made By: G. Davis Lab. No.: _____

Field: El Dorado County: Butler State: Kansas

Location of Test: Upstream of MP Project sand filter

Date of Test: 2/19/76 Lab Test Made By: Horwell

Test Pressure: 20 psig Type Filter: Millipore, 0.45 micron

Temperature: ambient

Filter No.

Dry Weight-Clean Filter

0.9095

Volume Filtered:

3 liters

Color of Residue:

In field at time of test

In lab. at time of analysis

tan

CHEMICAL ANALYSIS

Filter No.

mg/L

TOTAL SOLIDS:

11.0

ORGANIC CONTENT(Ignition Loss):

5.0

ACID SOLUBLE CONTENT:

Iron as Fe_2O_3

0.4

Calcium as CaCO_3

trace

Sodium as NaCl

0.2

Unidentified _____

1.0

ACID INSOLUBLE CONTENT:

Silica

4.4

Barium Sulfate

REMARKS: _____

February 27, 1976

Cities Service Oil Company
Box 300
Tulsa, Oklahoma 74102

Attention: Mr. Garrett L. Davis

Gentlemen:

Three filters were received from Cities Service Oil Company on 2/25/76 for determination of particle size. The filters are Millipore #HAWP-142, which are .45 micron pore size. Examination of the filters was made under low power magnification. Due to the extremely small size of the particles, it was impossible to measure them with standard methods. Low power examination indicates that the minimum size of the particles is below .5 microns. It is therefore estimated that 95% of the particles are in the range of 1 to .5 microns. The remaining 5% are 1.5 microns and larger. During the course of the examinations, it was noted that a number of bacteria were present.

Yours very truly,

SONICS INTERNATIONAL, INC.

W. K. Brewster II ds
W. K. Brewster II

WKB:ds

WILLIAMS
BROTHERS
WASTE
CONTROL, INC.

A RESOURCE SCIENCES COMPANY

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LABORATORY SERVICES

MISCELLANEOUS ANALYSIS

Submitted By: Cities Service Oil

Attn: Garrett L. Davis

Assigned Laboratory No: 760293

Date Received: 2-76 Date Reported: 3-5-76

Sample Identification: Fresh Water Filter 2-24-76
11 A.M.

<u>Test</u>	<u>Method*</u>	<u>Results**</u>
Standard Plate Count	406	100,000 organisms per ml

*APHA Standard Methods, 13th Ed., unless otherwise indicated

**Results are in milligrams per liter unless otherwise indicated

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LABORATORY SERVICES

MISCELLANEOUS ANALYSIS

Submitted By: Cities Service Oil

Attn: Garrett L. Davis

Assigned Laboratory No: 760294

Date Received: 2-76 Date Reported: 3-5-76

Sample Identification: Fresh Raw Water - Pump Sul

<u>Test</u>	<u>Method*</u>	<u>Results**</u>
Standard Plate Count	406	22,000 organisms per ml

*APHA Standard Methods, 13th Ed., unless otherwise indicated

**Results are in milligrams per liter unless otherwise indicated

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LABORATORY SERVICES

MISCELLANEOUS ANALYSIS

Submitted By: Cities Service Oil

Attn: Garrett L. Davis

Assigned Laboratory No: 760295

Date Received: 2-76 Date Reported: 3-5-76

Sample Identification: Suction #3 - Union Triflex Discharge

<u>Test</u>	<u>Method*</u>	<u>Results**</u>
Standard Plate Count	406	150,000 organisms per ml

*APHA Standard Methods, 13th Ed., unless otherwise indicated

**Results are in milligrams per liter unless otherwise indicated

HEGBERG PATTERN

————— PRESSURE
 - - - - - 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 25 50 75 100 125 150 175 200 225 250

11:16 11:23 11:30 12:07 12:14 12:21 12:28 1:04 1:11 1:18 1:25 2:01 2:08 2:15 2:22 2:29 3:07
 CALENDAR DATE

CHESNEY PATTERN

_____ PRESSURE
 - - - - - RATE
 - - - - - CUM