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DIST. CATEGORY UC-92

STUDY TO DETERMINE THE TECHNICAL AND ECONOMIC FEASIBILITY OF RECLAIMING CHEMICALS USED IN MICELLAR POLYMER AND LOW TENSION SURFACTANT FLOODING

Progress Report for the Period
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Dr. Richard H. Stephens

ENERGY RESOURCES COMPANY INC.
Cambridge, Massachusetts 02138

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I. Program Objective

The objective of this program is to determine the need for and technical/economic feasibility of using Energy Resources' concepts for ultrafiltration and reverse osmosis for treating oil field fluids and for reclaiming chemicals. This will be accomplished through the following tasks:

1. A review and evaluation of the state-of-the-art of oil/water separation techniques and the economics of oil field emulsion separation;

2. A characterization of simulated emulsions and brines that typify expected produced fluids from micellar-polymer floods;

3. An experimental program using ultrafiltration membranes to aid in breaking the simulated emulsions and recover surfactant and water as permeate from the fluids;

4. An experimental program using reverse osmosis or ultrafiltration membranes to concentrate and recover surfactant in produced brine; and

5. As part of the final report—a conceptual design and cost estimate for an ultrafiltration/reverse osmosis unit for field use and an analysis of the impact of the technology on micellar-polymer flooding techniques.

II. Work This Period

Most of the work performed in the past reporting period has been involved in running the emulsion through the ultrafiltration membranes to determine flux rates. The higher pressure pilot plant has been received from Rev-O-Pak and has been wired, leak-checked, and is in use and operating

satisfactorily. Additionally, the modifications required to run the Union Carbide as well as the Abcor membrane have been made to the low-pressure (ultrafiltration) pilot plant.

Some reformulation of the base-case emulsions for testing was required since the emulsions that were prepared on the bench scale with either a hand homogenizer or in a blender could not be duplicated in the pilot plant or did not produce a remixable (and therefore reusable) emulsion on the pilot scale or the bench scale. To speed up the testing process and to provide a consistent emulsion for testing with various membranes, a single batch of emulsion has been used.

While a stable, remixable emulsion could not always be formulated using any sort of surfactant when starting from scratch, we have found that fairly stable emulsions can be made by starting with a small amount of "feed" emulsion from another batch. That is, water and oil are alternatively added to a small amount of stable emulsion until the resulting emulsion is approximately 10 parts of new material to 1 part of the starting emulsion. The resulting emulsion is quite stable and can be remixed easily by simple shaking after it has separated. Formulations using the same materials without starting from a seeding emulsion produce only a small water-in-oil layer, if any emulsion at all.

Preliminary rate data for the various emulsions are shown in Table 1. While there is about a 50 percent range in the flux rate for particular membranes, there are also restrictions on pressure, temperature, and pH. There does not seem to be a great effect, at least at the base-case conditions, produced by switching from one oil or emulsion to another. Therefore, instead of testing the optimum (highest flux rate) membrane with its corresponding emulsion, it

TABLE 1

AVERAGE FLUX RATES FOR THE MEMBRANES

(in gallons per day per square foot)

	PRESSURE[a] (psig)	PHILLIPS BASE CASE EMULSION[b]	CITGO BASE CASE EMULSION[c]
Abcor	30	30.2	28.0
Union Carbide	30	25.4	24.1
Rev-O-Pak 120	60-200	10.9-14.6	8.1-10.2
Rev-O-Pak 150	60-200	7.3-11.6	5.9-9.4

[a]Because of the differences in membrane configurations and test equipment, not all membranes could or should be operated at the same pressure.

[b]Water-to-oil ratio of 3.

[c]Water-to-oil ratio of 4.

would be more appropriate to run parametric studies of all of the membrane types tested in order to determine the range of their operating conditions so as to determine their limitations and relative advantages. For example, while the Rev-O-Pak membranes have a lower flux rate at 50 psig than the Abcor membrane, they can be operated at much higher pressures than the Abcor membrane. This allows the Rev-O-Pak membrane to utilize high wellhead pressures, if available. Conversely, the Abcor membranes can tolerate a higher pH than the Rev-O-Pak membrane. These relative advantages and disadvantages are highlighted in Table 2.

III. Problems Encountered

No major problems were encountered this period. Considerably more time than expected was needed to install the Rev-O-Pak unit.

IV. Future Work

The experimental program should be finished by the end of the next period.

TABLE 2

COMPARISON OF ULTRAFILTRATION MEMBRANES TESTED

	ABCOR	UNION CARBIDE	REV-O-PAK	
			120	150
Membrane Material	Cellulose Acetate	Carbon + Zirconium Oxide	Cellulose Acetate	Cellulose Acetate
Module Membrane Area	2.2 ft^2	∿0.15 ft^2[a]	0.5 ft^2	0.5 ft^2
Module Flow Diameter	1"	1/4"	∿1/2"	∿1/2"
Relative Membrane Tightness	4	3	2	1
Maximum Temperature	120° F	200° F	108° F	108° F
pH Range	2-11	1-14	2.5-7.5	2.5-7.5
Maximum Pressure	60 psig	125 psig	500 psig[b]	500 psig[b]
Suggested Superficial Velocity	12 ft/sec	13-20 ft/sec	6.5 ft/sec	6.5 ft/sec
Relative Concentrate Pressure Drop	2	1	3	3

[a] Shortened by 22% since receiving.

[b] at 77° F, approximately 150 psig at 108° F.