SURTEK

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Technical Progress Report

DOE Contract No DE-AC22-92 BC14886

Investigation of Oil Recovery Improvement by Coupling
an Interfacial Tension Agent and a Mobility Control Agent
in Light Oil Reservoirs

submitted by
Surtek, Inc.

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Contract date: September 28, 1992

Anticipated Completion Date: September 30, 1995

Government Award for Fiscal Year October 1, 1994 to September 30, 1995: \$85,738

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Report for the Period of
July to September 1995

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I. Objectives of Study

The study will investigate two major areas concerning co-injecting an interfacial tension reduction agent(s) and a mobility control agent into petroleum reservoirs. The first will consist of defining the mechanisms of interaction of an alkaline agent, a surfactant, and a polymer on a fluid-fluid and a fluid-rock basis. The second is the improvement of the economics of the combined technology.

This report examines altering the concentration of alkali and polymer on the oil recovery economics of alkaline-surfactant-polymer solution.

II. Summary of Technical Progress

1,000 mg/l NaCl solution was used for coreflooding and chemical make-up. Crude oil was from the Adena field, Morgan County, Colorado; a fluvial deltaic reservoir. Crude oil has an API gravity of 42°. The crude is a dead oil with viscosity of 3.8 cp at 72°F and 1.3 cp at the 180°F reservoir temperature. All studies performed for this report were performed at 150°F. Dead crude oil viscosity was 1.4 cp at 150°F.

A prior series of corefloods indicated polymer addition to the alkaline-surfactant solution prevented mobility ratio increases and improved oil recovery.¹ Injection of Na₂CO₃-surfactant-polymer recovered up to 30% of the waterflood residual oil. The lithology of the rock matrix significantly affects oil recovery by alkaline-surfactant-polymer solutions.² However, injecting the alkaline agent as a concentration gradient increased recoveries to 40% of the waterflood residual oil.³ An alkali-polymer post-flush after the alkaline-surfactant solution and before the polymer drive did not further improve oil recovery.⁴

The last series of corefloods was performed to evaluate the oil recovery efficiency of the alkaline-surfactant-polymer technology using J sand core from the Adena field. A 30% pore volume (PV) of 2.0 to 1.0 wt% graded Na₂CO₃ plus 0.2 wt% Petrostep B-100 plus 500 mg/l Flopaam 3330S was injected followed by 30% pore volume 500 mg/l Flopaam 3330S. A water flush of 1.5 to 2 PV followed chemical injection. A second series of corefloods with 1.5 to 0.5 wt% graded Na₂CO₃ plus 0.1 wt% LXS 420 plus 500 mg/l Flopaam 3330S followed by 30% PV 500 mg/l Flopaam 3330S. A water flush of 1.5 to 2 PV followed chemical injection in both series.

Both chemical combinations recovered incremental oil when injected into linear J sand core. The data are summarized as well as compared to the corresponding flood in Berea sandstone in Table 1.

Table 1

J Sand and Berea Sandstone Alkaline-Surfactant-Polymer Oil Recovery

<u>Recovery Parameter</u>	-----Chemical Solution Composition-----			
	Na ₂ CO ₃ -B-100-3330S		Na ₂ CO ₃ -LXS 420-3330S	
	<u>Berea</u>	<u>J Sand</u>	<u>Berea</u>	<u>J Sand</u>
Initial Oil Saturation, S _{oi} , (PV)	0.457	0.724	0.484	0.728
Waterflood Recovery (PV)	0.133	0.295	0.160	0.286
%S _{oi}	29.1	40.8	33.1	39.3
Waterflood Residual Oil Saturation, S _{or} , (PV)	0.324	0.429	0.324	0.442
ASP Oil Recovery (PV)	0.122	0.133	0.141	0.149
%S _{oi}	26.8	18.3	29.1	20.5
%S _{or}	37.8	30.9	43.6	33.8
Final Oil Saturation (PV)	0.202	0.296	0.183	0.293
Total Oil Recovery (PV)	0.256	0.428	0.301	0.435
%S _{oi}	55.9	59.1	62.2	59.8

Figure 1 depicts the cumulative oil recovery and oil cut versus cumulative produced fluids for the Na₂CO₃-Petrostep B-100-3330S J sand coreflood.

Table 2
Injected Cost of Alkaline-Surfactant-Polymer Solution

<u>Chemical</u>	<u>\$/injected bbl</u>	<u>Pore Volume Injected</u>	<u>Cost \$/bbl PV</u>
1.0 wt% Na ₂ CO ₃	0.228	0.30	0.068
0.2 wt% Petrostep B-100	0.665	0.30	0.200
0.1 wt% LXS 420	0.525	0.30	0.158
500 mg/l Flopaam 3330S	0.262	0.60	0.157

Using the chemical costs listed in Table 2, the incremental oil was produced using the Na₂CO₃-Petrostep B-100-Flopaam 3330S solution for \$3.20 per barrel and for \$2.56 per barrel using the Na₂CO₃-LXS 420-Flopaam 3330S solution.

A final report discussing the various elements of the study of using the alkaline-surfactant-polymer technology in light oil reservoirs has been submitted to the Department of Energy.

IV. References

1. Pitts, M.J.: "Investigation of Oil Recovery Improvement by Coupling an Interfacial Tension Agent and a Mobility Control Agent in Light Oil Reservoirs", Second Annual Report October 1993 to September 1994, DOE/BC/14886-9.
2. Pitts, M.J.: "Investigation of Oil Recovery Improvement by Coupling an Interfacial Tension Agent and a Mobility Control Agent in Light Oil Reservoirs", April through June 1994 Quarterly Report.
3. Pitts, M.J.: "Investigation of Oil Recovery Improvement by Coupling an Interfacial Tension Agent and a Mobility Control Agent in Light Oil Reservoirs", January through March 1995 Quarterly Report.
4. Pitts, M.J.: "Investigation of Oil Recovery Improvement by Coupling an Interfacial Tension Agent and a Mobility Control Agent in Light Oil Reservoirs", April through June 1995 Quarterly Report.

Cumulative Oil Recovery and Incremental
Oil Cut versus Cumulative Produced Fluids