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STUDY OF HYDROCARBON MISCIBLE SOLVENT SLUG INJECTION PROCESS FOR IMPROVED RECOVERY OF HEAVY OIL FROM SCHRADER BLUFF POOL, MILNE POINT UNIT, ALASKA

Cooperative Agreement DE-FG22-93BC14864

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Contractor:	\$129,726
Total	\$329,726

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US/DOE Patent Clearance is not required prior to the publication of this document.

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OBJECTIVES:

The ultimate objective of this three-year research project is to evaluate the performance of the hydrocarbon miscible solvent slug process and to assess the feasibility of this process for improving recovery of heavy oil from Schrader Bluff reservoir. This will be accomplished through measurement of PVT and fluid properties of Schrader Bluff oil, determination of phase behavior of Schrader Bluff oil solvent mixtures, asphaltene precipitation tests, slim tube dis-

placement tests, core flood experiments and reservoir simulation studies. The expected results from this project include: determination of optimum hydrocarbon solvent composition suitable for hydrocarbon miscible solvent slug displacement process, optimum slug sizes of solvent needed, solvent recovery factor, solvent requirements, extent and timing of solvent recycle, displacement and sweep efficiency to be achieved and oil recovery.

SUMMARY OF TECHNICAL PROGRESS:

During this quarter, more displacement experiments in slim tube and miscible coreflood experiments have been conducted. Also, work has been initiated to match the slim tube displacement results using GEM, a compositional simulator developed by Computer Modelling Group.

Slim Tube Experiments

Three experimental displacement runs were conducted in the slim tube apparatus. Solvent used for these tests was carbon-dioxide and various enrichments of carbon-dioxide with natural gas liquids.

1. 100% Carbon-dioxide at 1300 psia and 72°F

This run was conducted using 100% carbon-dioxide as solvent at 1300 psia and 72°F. This run resulted in recovery of 71% at 1.2 pore volume injection (Figure 1). This shows that there is no development of miscibility. Sight glass observations also show the presence of two phases. Figure 2 shows that solvent breakthrough occurred around 67% pore volume injection.

2. 90% Carbon-dioxide and 10% Natural Gas Liquids at 1300 psia and 72°F

This run was conducted by enriching carbon-dioxide with 10 mole percent of natural gas liquid. Oil recovery at 1.2 pore volume injection improved to 86%

(Figure 3). This increase in recovery was due to the presence of intermediates in the solvent. But sight glass observations indicated presence of two phases. Figure 4 shows that solvent breakthrough occurred after 85% of pure volume injection.

3. 85% Carbon-dioxide and 15% Natural Gas Liquids at 1300 psia and 72°F

This run was conducted by enriching carbon-dioxide with 15 mole percent of natural gas liquid at 1300 psia and 72°F. Oil recovery after injecting 1.2 pore volume increased to 96% (Figure 5). Sight glass observations did not indicate the presence of phases. Thus, it was inferred that miscibility was developed in this experiment. Figure 6 shows that solvent breakthrough occurred after 99% pore volume injection.

Coreflood Experiments

After initial unsteady state waterflood experiment, further experiments were conducted to study the effect of miscible slug size on recovery. A total of three experiments with slug size of 5%, 10% and 20% of pore volume were conducted. The miscible solvent used in these experiments was a mixture of 50% natural gas liquids and 50% Prudhoe Bay natural gas, which is miscible with Schrader Bluff oil. The properties of the core and experimental procedure were described in the earlier reports. Results of these experiments are shown in Figures 7 through 15.

FUTURE WORK PLAN:

Core flood experiments will continue during the next quarter using live Schrader Bluff oil and miscible solvent. Effect of slug size and WAG ratio will be examined. Slim tube displacement experiments and data matching will also be continued during the next quarter.

Figure 1: Recovery Versus Pore Volume Injected.
(Solvent: 100% Carbon-dioxide)

Figure 2: GOR Versus Pore Volume Injected.
(Solvent: 100% Carbon-dioxide)

Figure 3: Recovery Versus Pore Volume Injected.
(Solvent: 90% Carbon-dioxide; 10% NCL's)

Figure 4: GOR Versus Pore Volume Injected.
(Solvent: 90% Carbon-dioxide; 10% NGL's)

Figure 5: Recovery Versus Pore Volume Injected.
(Solvent: 85% Carbon-dioxide; 15% NGS's)

Figure 6: GOR Versus Pore Volume Injected.
(Solvent: 85% Carbon-dioxide; 15% NGS's)

Recovery vs PV Injected (Effect of miscible slug size)

(SLUG SIZE=0.05 PV)

Figure 7: Recovery Versus Pore Volume Injected.
(Slug Size = 0.05 PV)

WOR vs PV Injected
(Effect of miscible slug size)
(SLUG SIZE=0.05 PV)

Figure 8: WOR Versus Pore Volume Injected.
(Slug Size = 0.05 PV)

GOR vs PV injected (Effect of miscible slug size)

(SLUG SIZE=0.05 PV)

—+— Incremental GOR

Figure 9: GOR Versus Pore Volume Injected.
(Slug Size = 0.05 PV)

Recovery vs PV Injected (Effect of miscible slug size)

(SLUG SIZE=0.10 PV)

Figure 10: Recovery Versus Pore Volume Injected.
(Slug Size = 0.1 PV)

WOR vs PV Injected **(Effect of miscible slug size)** (SLUG SIZE=0.10 PV)

Figure 11: WOR Versus Pore Volume Injected.
 (Slug Size = 0.1 PV)

GOR vs PV Injected (Effect of miscible slug size) (SLUG SIZE=0.10 PV)

Figure 12: GOR Versus Pore Volume Injected.
(Slug Size = 0.1 PV)

Recovery vs PV Injected (Effect of miscible slug size)

(SLUG SIZE=0.20 PV)

Figure 13: Recovery Versus Pore Volume Injected.
(Slug Size = 0.2 PV)

WOR vs PV Injected
(Effect of miscible slug size)
(SLUG SIZE=0.20 PV)

Figure 14: WOR Versus Pore Volume Injected.
(Slug Size = 0.2 PV)

GOR vs PV Injected
(Effect of miscible slug size)
(SLUG SIZE=0.20 PV)

—+— Incremental GOR

Figure 15: GOR Versus Pore Volume Injected.
(Slug Size = 0.2 PV)

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