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ENHANCED OIL RECOVERY AND APPLIED GEOSCIENCE RESEARCH PROGRAM

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Idaho National Engineering Laboratory
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OBJECTIVES

The objectives of this research program are to develop microbial enhanced oil recovery (MEOR) systems for application to reservoirs containing medium to heavy oils and to evaluate reservoir wettability and its effects on oil recovery.

The MEOR research goals include: a) development of bacterial cultures that are effective for oil displacement under a broad range of reservoir conditions, b) improved understanding of the mechanisms by which microbial systems displace oil under reservoir conditions, c) determination of the feasibility of combining microbial systems with or following conventional enhanced oil recovery (EOR) processes, d) development and implementation of industry cost-shared field demonstration projects for MEOR technology.

The goals of the reservoir wettability project are to develop: a) better methods for assessment of reservoir core wettability, b) more certainty in relating laboratory core analysis procedures to field conditions, c) a better understanding of the effects of reservoir matrix properties and heterogeneity on wettability, and d) improved ability to predict and influence waterflood and EOR response through control of wettability in reservoirs.

SUMMARY OF TECHNICAL PROGRESS

MEOR Research and Field Application

A field trial of MEOR technology had been tentatively planned for the Schuricht lease (Crook county, Wyoming). Pressure transient testing to better characterize the reservoir has been completed. Build-up data were collected for 3½ weeks. A reservoir permeability of 2.2 mD, calculated from a Horner analysis of the data, is substantially lower than the value estimated by the field owners and operators. However, the build-up permeability value is very close to the permeability indicated by a Fetkovitch decline curve analysis[1] of 3.1 mD and only slightly lower than the permeability of 10.2 mD calculated from drillstem test data. It is concluded, therefore, that the permeability of the Schuricht 21-24 reservoir is between 2.2 mD and 10.2 mD. Given that formation permeability of 75 mD or higher is needed to successfully inject and transport bacteria into the formation,[2] the permeability of the Schuricht field indicates that the reservoir permeability is too low to successfully demonstrate MEOR technology.

Efforts to locate a reservoir that is more suitable for an MEOR field trial are ongoing. The first priority is to locate a reservoir in the same area to take advantage of the characterization work on microbial systems that has already been completed.

Reservoir Wettability and Its Effects on Oil Recovery

Asphaltenes and Wetting

The mechanisms by which crude oils interact in crude oil/brine/rock (COBR) systems to alter wetting are the subject of a SPE paper entitled "Asphaltene Precipitation and Crude Oil Wetting."[3] Wetting alteration by Moutray crude oil from West Texas and ST-86 from the North Sea have been reported previously for a wide variety of test conditions.[4,5] In one set of measurements, aged crude oil was flushed from cores with fresh crude oil. In the other, Soltrol 130 was used to remove crude oil after aging. Precipitation of heavy components can occur on contact between crude oil and the low molecular weight paraffins in the Soltrol mixture. Results of the two methods are compared to see what effect precipitation has on alteration of wetting by these oils.

Although an appreciable amount of precipitation is observed on contact of Moutray and Soltrol 130, wetting conditions, as measured by Amott-type tests, are generally comparable to tests under conditions where precipitation is not initiated. Most of the alteration of wetting appears to be associated with contact between rock and crude oil in the presence of a water saturation. Similarity between waterfloods with and without precipitation of asphaltic material is confirmed by visual observations in micromodels.

Wetting Alteration by Schuricht Crude Oil

Studies of wetting alteration by exposure to crude oil have been extended to include a moderately viscous oil from the Schuricht field in Wyoming. This work is the basis for a paper entitled "Wetting and Waterflood Oil Recovery of a Moderately Viscous Crude Oil,"[6] to be presented in Houston at the 1993 Society of Core Analyst's meeting in August of 1993.

Wetting is altered to weakly water-wet by extended contact between Berea sandstone cores and Schuricht crude oil. Elevated temperatures (up to 80°C) increase the extent of wetting alteration. Stable conditions are reached within about 15 days. Cores with wetting altered to weakly water-wet conditions by exposure to Schuricht crude oil exhibited better waterflood recovery than cores from which Schuricht was displaced under more water-wet conditions. Thus, Schuricht crude oil follows the same pattern established for less viscous crude oils, with weakly water-wet conditions giving improved oil recovery by waterflooding. An Amott index to water can be extracted from the capillary pressure curve that provides the best history match to waterflood data in the core. This simulated Amott index is in reasonable agreement with the measured values. Micromodel visualizations of waterfloods before and after high temperature aging suggest some explanations for the differences in core displacement efficiencies.

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