RHEOLOGY AND CHEMICAL CHARACTERIZATION OF ALASKA HEAVY OILS

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Introduction

Although the reserves of heavy oil on the North Slope of Alaska are enormous (an estimate of at least 10 billion barrels are in place), difficult technical and economic hurdles are involved in producing these oils. The Ugnu formation contains the most viscous, biodegraded oils and standard production methods will be ineffective. Numerous alternative techniques for heavy oil production have been proposed (Cold production, steam injection, etc). The overall objective of the project at Colorado School of Mines is to advance the state-of-the-art of seismic monitoring, using chemical and physical characterization of core samples in combination with simulated production experiments, to optimize the recovery of heavy oils from Alaskan deposits. A preliminary study showed that we could correlate chemical inforamtion with rheological data.[1] New data will be presented concerning the non Newtonian rheology and chemical characterization by various techniques on samples from the Ugnu formation.

Experimental

Microscope Characterization. In order to work out the settling properties of the sand in the oil, the diameter distribution of the sand need to be quantified. The optical microscope Olympus IX81 was employed to take pictures of the sand grains, which was already dispersed in the mineral oil in advance in order to simulate the real conditions in the test.

Rheology Testing. The rheological properties of the Ugnu Samples were measured at three different temperatures (-10, 20, and 60 degrees centigrade). The frequency range was 0.001 to 20 Hz at a fixed stain of 0.1, using an AR-G2 rheometer with a 40 mm plate geometry at an operating gap of 1000 mm. To see how the Ugnu heavy oil changes its properties, a sequence of experiments on the heavy oil with different sand cuts were conducted.

Molecular Beam Mass Spectrometry (MBMS). Helium was used as the carrier gas with the flow rate of 150 ml/min. The temperature rises from 40 to 800 ˚C with the rate of 15 ˚C/min.

Results and Discussion

Size Distribution of the Sand. With the help of the software ImageJ, the perimeters P and the areas A of more than 2,500 particles were measured, and then the diameters were calculated by using the definition of hydraulic diameter:

$$D = \frac{4A}{P} \quad \text{..... (5)}$$

The distribution of the diameter is shown in Figure 1, and the average value is 5.31 μm, with a standard derivation of 5.57 μm.

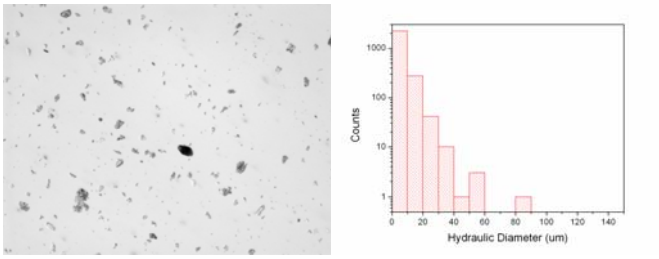

Figure 1. Microscope image of the sand grains and the distribution of the diameter

Rheological Properties. Figure 2 shows that the Ugnu heavy oil with 40% clean sand is shear thinning at high temperatures (40 and 60 ˚C), which is not surprising; and after all volatile compositions evaporate, it becomes Newtonian (20 ˚C).

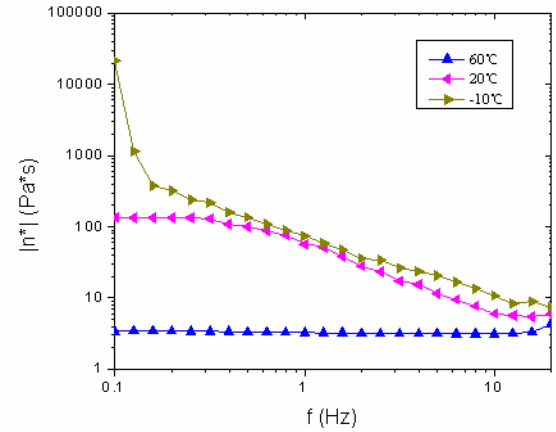

Figure 2. The rheological behavior of the Ugnu heavy oil with 40% clean sand (by mass) at three different temperatures

and then these particular ions were tracked through the whole temperature profile to see the reactivity.

Figure 3 shows that there are three regions of reactivity during the pyrolysis. The initial volatility takes place at 100 to 150 ˚C; the maximum vapors show up at 200 to 300 ˚C; and the cracking appears at 550 to 700˚C.

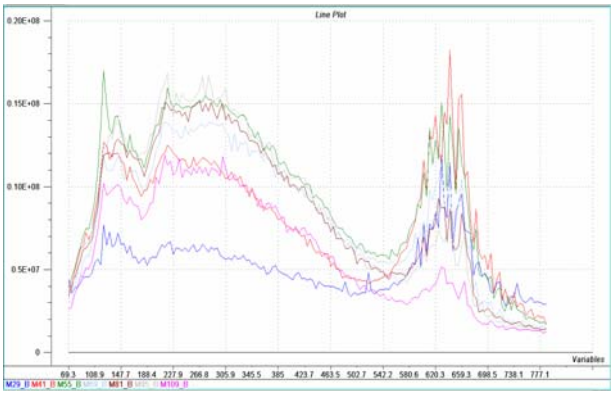

Figure 3. The MBMS pyrolysis profiles of the most abundant ions

Conclusions

Rheological and chemical information is being gathered so that meaningful correlations may be made. This information will be used to predict flow properties of real heavy oils in the UGNU formation.

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References

(1) E.-J. Shin, M.W. Liberatore, A.M. Herring, M. Batzle, *Fuel*, **2008**, *87*, 3065