Study of live oil wax precipitation with high pressure DSC

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Wax Appearance Temperature (WAT) is an important measure of the crystallization behavior of a crude oil. The deposition and gelation of waxes are governed by the WAT and the amount of wax precipitated at temperatures below the WAT. For reservoir fluids with high Gas-Oil Ratio (GOR), the effect of pressure on wax precipitation can be quite pronounced. Both the WAT and the amount of wax precipitated will be reduced with an increasing amount of dissolved gas. Quantifying these values with reasonable confidence is important in appropriately designing flow assurance strategies for new field development as well as mitigating problems in existing operations.

This study describes the use of a high pressure micro Differential Scanning Calorimeter (HP μ-DSC) to determine the WAT as well as the amount of wax precipitated. A model wax-oil system and a crude oil were used in the study. A Setaram (Setaram Inc.) high pressure micro-DSC VII was used in the analysis at a temperature range of 90°C to -40°C. A motorised pump with a maximum pressure limit of 1000 bar was used to charge the sample with pressures ranging from 250 to 4000 psia.

First, the accuracy of the HP μ-DSC was tested with the model oil system at ambient pressures. The measured WAT was compared with measurements using a conventional DSC and Cross Polar Microscopy (CPM). The amount of wax precipitated as a function of temperature was inferred from the exotherm, and was compared with model predictions. These results confirmed that the results from the HP μ-DSC were well within acceptable limits.

The crude oil was then tested at ambient pressure and the results from the HP μ-DSC again agreed with other measurements including conventional DSC, CPM and rheological experiments performed under low shear. Finally, the effect of dissolved gases was studied by saturating the oil with synthetic gas at various pressures in the HP μ-DSC and performing the experiments at various cooling rates. Fig. 1 shows the measured WAT as a function of saturation pressure. As expected, the WAT of the oil reduces with increasing amounts of dissolved gas. The amount of wax precipitated also decreases with increasing pressure.

Different thermodynamic models were used to compare these experimental results. It was found that a reasonable match could be obtained with well tuned models.

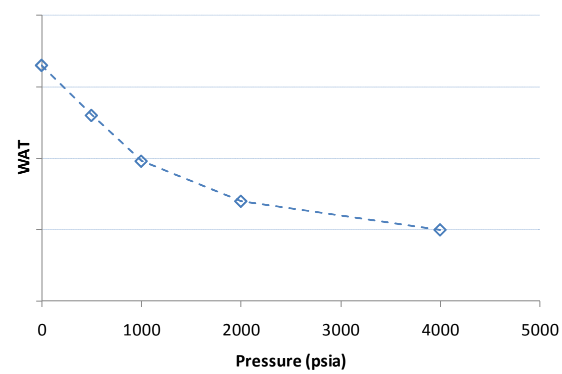

Fig. 1. Measured decrease in the WAT with saturation pressure