RHEOLOGY SOLUTIONS

“Outwaxing” of Crude Oil

PROBLEM

Most crude oils contain some amount of crystalline wax whose melting point occurs in the range -30 to 35°C. If the temperature of the oil drops below the recrystallization point of this wax, then the flow properties (rheology) of the overall oil changes. Hence, producers of both crude and refined oils are interested in knowing where this recrystallization occurs so that pumping and other transfer processes are not affected. Viscometers have traditionally been used to determine this critical temperature, but the temperature obtained is often not accurate. There are probably two reasons for this inaccuracy:

1. Viscometers measure the recrystallization (“outwaxing”) temperature by exerting a significant shearing force on the oil which may delay the onset of recrystallization by disrupting the nucleation process. Furthermore, this high shear environment is not representative of the real-world situation seen by the oil, since the oil is at rest just prior to pumping.
2. Many viscometers do not have good temperature control during the measurement.

SOLUTION

Controlled stress rheometers using the oscillation mode of evaluation provide a better way to make this measurement. In the oscillation mode, the material is subjected to a small oscillatory strain (around 0.005°) and its viscosity is measured without disturbing any structure that is present. In addition, the presence of a very responsive and accurate temperature control device such as a Peltier heater ensures that the temperature measured is accurate and reproducible.

Figure 1 shows the results for a typical crude oil. The oil was initially warmed in a 40°C water bath before loading in the rheometer. Once loaded in the rheometer, the material was evaluated while cooling at 2°C/minute. The onset of the significant increase in viscosity which occurs at 31°C is the “outwaxing” point for this oil.

The “outwaxing” temperature for refined oils is also of interest since it is generally considered to be the lowest end-use temperature for the oil. Differential scanning calorimetry (DSC)
is commonly used for this measurement (1). However, in oils where the level of wax is low, DSC does not have as much sensitivity for detecting the “outwaxing” point. Figure 2, for example, shows the DSC results for the crude oil from Figure 1. It is hard in this case to distinguish the exothermic event associated with the wax crystallization.

References