POSTCOOLING FLOW PROPERTIES OF A MODEL WAXY CRUDE OIL

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Waxy crude oils and lubricating mineral oils are two economically important examples of materials that contain paraffin in significant concentration levels. From the rheological viewpoint, above the crystallization temperature (T_c) these materials are simple Newtonian liquids, but, below it, the appearance of wax crystals leads to a gelation process and consequently to the formation of an interlocking network of wax crystals that gives rise to an extremely complex non-Newtonian behavior. Below (T_c), their rheological properties depend not only on time, temperature, and shear rate as usually observed in complex fluids, but also on the temperature and shear histories. This fact constitutes an interesting scientific challenge, and, from the applications standpoint brings difficulties to the design of operations that require the transport of such materials at low temperatures. In this paper, we used a model waxy oil consisting of 15% of n-paraffin dissolved in kerosene to investigate the post-cooling flow properties of waxy oils with the aid of a rotational rheometer. We carried out temperature ramps and stress amplitude sweep tests. We also performed constant-shear-rate transient experiments and steady-state experiments (flow curves) with different measurement temperatures, by fixing both the cooling rate and the shear rate during cooling. The steady-state results show that decreasing the measurement temperature (which corresponds to an increase in the amount of wax crystals) can lead to non-monotonic flow curves and also to an increasingly apparent wall slip. At last, we used a thixotropic elasto-viscoplastic model recently proposed as an attempt to mimic the rheological behavior of waxy oils.

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