

Temperature Transition Between Viscoelastic and Viscous Behavior of Heavy Crude Oils

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The rheological behavior of heavy oils is critical for oil exploitation in different stages such as extraction, transportation and refinery. It is well known that viscosity of heavy oils is higher than light oils in several orders of magnitude. Temperature is a key parameter directly related with viscosity and non-Newtonian behavior of heavy oils. In particular, the viscoelasticity is a parameter that has not been extensively explored; however, it provides valuable information about the structure of the material. Heavy crude oils were characterized, the most of them with API gravity around 12. The measurements were carried out in a controlled stress rheometer with 40mm parallel plate geometry with a gap of 1 mm. The fluids were tested in rotational and oscillatory modes at temperatures from 5 to 100°C. Fluids with similar API gravity were found to have zero shear viscosity very different, up to two orders of magnitude variation. This fact can be explained in terms of composition. The oils behave as shear thinning fluids for low temperatures and exhibit normal stress, which indicates the elastic component of the system. In the oscillatory experiments the magnitude of the loss and elastic modulus is presented. Above a critical temperature, the viscosity, the normal force and the elastic modulus decrease, suggesting that the non-Newtonian behavior is strongly related to the temperature. Furthermore, the departure from linearity in the curve zero shear viscosity vs temperature allows us to identify the change in rheological behavior from non-Newtonian to Newtonian fluid. The WLF equation was used in order to correlate viscosity with temperature, and was helpful to find the transition temperature.