# EFFECT OF THE MULTIFUNCTIONAL AGENTS ON CRUDE OIL VISCOSITY

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Residual oil saturation in heavy crude oil reservoirs has been reported to range from 80 to 95% of the OOIP, after primary and secondary oil recovery [1, 5]. The most practical approach to enhance the recovery of heavy oil is viscosity reduction through thermal EOR. This section of the chapter describes the effectiveness of the multifunctional agents in reducing the viscosity of heavy oil. An Anton-Paar Physica MCR-301 rheometer equipped with a 50 mm PP50 plate-plate configuration and a gap of 1 mm was used to determine the viscosity of the oil samples.

The high viscosity of this heavy oil can be attributed to its high content of resins and asphaltenes. In addition, this heavy oil exhibits a non-Newtonian rheological behavior at 25°C , most likely due to the formation of wax-resin aggregates within the bulk of the oil phase at this temperature.

The multifunctional agents—AMESUS and the zwitterionic surfactant—were diluted in a fixed volume of n-heptane (1 ml) at preestablished concentrations to achieve a final concentration of the chemicals in the crude oil sample of 0.5 g/L. For comparative purposes, a reference system was prepared by dosing the heavy oil sample with the equivalent fixed volume of n- heptane that was used for dilution of the chemical agents. Figure 1 plots the apparent viscosity of the crude oil as a function of shear rate and chemical treatment. The experiments were conducted at 25°C, and the range of shear rate evaluated was 0.1/s to 100.0/s.

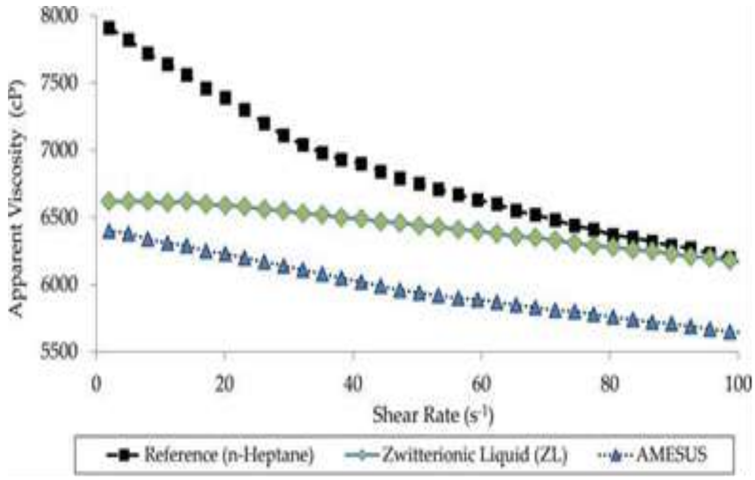


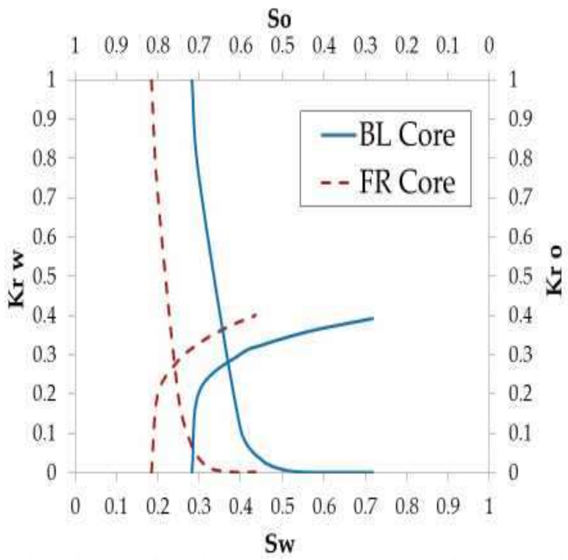

Figure 1 indicates that the viscosity of the samples (baseline and chemical treated oil) decreases as the shear rate increases following a shear thinning behavior. The chemical-treated oil samples show lower viscosities when compared with the viscosity of the reference sample. Therefore, both multifunctional agents are effective in decreasing the viscosity. Nevertheless, AMESUS offers a better performance in reducing the viscosity of the heavy oil than the ZS agent. Moreover, the performance of the ZS agent is hindered as the shear rate increases.

These experimental observations demonstrate that the multifunctional agents interact with the asphaltenes and resins contained in the heavy oil sample providing a significant viscosity reduction. The AMESUS supramolecular complex exhibits a suitable performance in preventing the aggregation of asphaltenes and resins which allows reducing the viscosity of the heavy crude oil evaluated.

Relative permeability. Oil-water relative permeability data offer relevant insights into the simultaneous flow of crude oil and brine that allows predicting the performance of waterflooding processes. Oil-water relative permeability is influenced by several variables such as fluids saturation, fluids saturation history, interfacial tension, fluids viscosity, overburden pressure, temperature, flow rate, wettability, and capillary end effects. In addition, relative permeability curves provide information on the wettability of the porous media, which significantly affect oil recovery processes [3, 4].

In this study, the oil-water relative permeability curves were obtained following the Johnson- Bossler-Neumann (JBN) method and the data were fitted using a Corey-type correlation.

The effect of the multifunctional agent ZS on the oil-water relative permeability curves was evaluated to establish their efficiency in altering rock wettability.




In this experimental work, the wettability of the core plugs was determined after waterflooding. Figure 2 presents the oil-water relative permeability curves after waterflooding. The crossover point (equal relative permeabilities) of the oil and water relative permeability curves shown in Figure 2 indicates that both porous media (BL and FR rocks) are predominantly oil- wet, which is expected for calcite rock formations.

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