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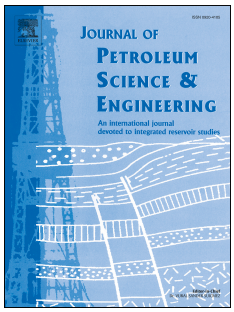

Effects of nanoparticles and temperature on heavy oil viscosity

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Effects of Nanoparticles and Temperature on Heavy Oil Viscosity

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Abstract

The objective of this research is to investigate the efficacy of nanoparticles in reducing the viscosity of heavy oil. In this study, three types of metal oxide nanoparticles (CuO, Fe_2O_3, and NiO) are employed, and their effect on heavy oil viscosity is examined at three different concentrations (0.05, 0.1, and 0.5 wt.% of oil). For all test fluids, rheological measurements were obtained at four different temperatures ranging from 27 to 71°C. The experimental work is conducted with two extremely viscous heavy oil samples having viscosity of approximately 77 and 350 Pas at ambient temperature. This study is unprecedented in terms of viscosity of heavy oil samples investigated. The heavy oil samples used in this study are 9 to 40 times more viscous than those used in previous similar studies.

The addition of nanoparticles resulted in a notable reduction in viscosity of both heavy oil samples. For each type of nanoparticles, 50 to 70% viscosity reduction was observed. The level of viscosity reduction is sensitive to the types of nanoparticles, their concentration, and fluid temperature. Moreover, the results indicate existence of an optimum concentration of nanoparticles at which maximum viscosity reduction occurs. This optimum concentration is a function of the metal type and fluid temperature.

To explain observed viscosity alteration behavior, the paper provides a theoretical overview of various molecular-level physical and chemical interactions between nanoparticles and heavy oil. Additionally, the study presents a new heavy oil viscosity data and delineates some of the challenges associated with viscosity measurement of heavy oil.

This research provides valuable information for future rheological and core-flooding studies involving nanoparticle stabilized solvent-based emulsions. Besides, remarkable viscosity reduction obtained in this work reinforces the industry's interest in developing an economically feasible nanoparticle-based technique and helps to solve real problems in the field.

Keywords: Heavy oil, nanoparticles, rheology, viscosity reduction, oil recovery, optimum concentration