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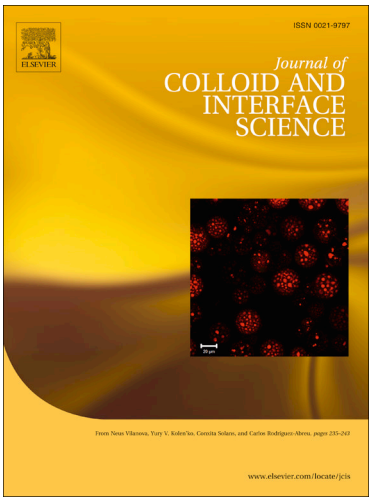

A new insight on the dependence of relaxation time on frequency in viscoelastic surfactant solutions: From experimental to modeling study

Brayan F. García, Soheil Saraji

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A new insight on the dependence of relaxation time on frequency in viscoelastic surfactant solutions: From experimental to modeling study

Brayan F. García, Soheil Saraji[1]

bgarcia6@uwyo.edu, ssaraji@uwyo.edu

Department of Petroleum Engineering, University of Wyoming

1000 East University Avenue, Laramie, Wyoming 82071, United States

Abstract:

Hypothesis: The relaxation time in viscoelastic surfactant solutions is a function of temperature, salt/surfactant concentrations, resting conditions, as well as shear frequency. The simplistic assumption of a single and constant relaxation time is not representative of all relaxation modes in these solutions especially at high frequencies.

Experiments: Steady-state and oscillatory measurements are carried out to study the effects of high temperatures, concentrations and resting conditions on the rheology of two sets of surfactants/salt mixtures including a non-ionic and a zwitterionic/anionic surfactant system. Furthermore, a novel semi-empirical rheological model is deducted based on Cates theory. This model introduces, for the first time, the frequency-dependence of the continuous relaxation time spectrum.

Findings: At high temperatures, the non-ionic surfactant become more viscoelastic and the zwitterionic/anionic system loses its viscoelasticity. The addition of surfactant/salt improves the viscoelasticity on both systems, and, for the zwitterionic/anionic mixture, increasing the resting temperature stimulates its viscoelasticity. In addition, the proposed model significantly improves predictions of traditional Maxwell model for different viscoelastic surfactant solutions (using data from this study and the literature) for a considerable range of surfactant and salt combinations at a wide range of temperature.

Keywords: non-Newtonian fluids, rheological modeling, viscoelastic surfactant solution, viscoelasticity, wormlike micelles, relaxation time.

[1] Corresponding author.
Office phone: +1 307 766-6557