Modeling the rheological response of petroleum oil-in-water emulsions

During drilling, crude oil is often mixed with water, leading to the formation of water-in-oil (W/O) emulsions. Since these emulsions pose severe flow resistance, such as higher pressure drops, due to their complex fluid rheology, it is important to have in our arsenal a rheological constitutive model that accurately predicts their rheological response. In this work, we propose such a model for W/O emulsions wherein the emulsions are modeled as deformable volume-preserving droplets via the use of a determinant-preserving contravariant second-rank tensor. We use the generalized bracket formalism of non-equilibrium thermodynamics, in order to make sure that the derived model is by construction thermodynamically admissible. An additional scalar structural variable is considered to allow for the prediction of a yield point, following previous work. The predictions of the new model are shown to be in very good agreement with available experimental measurements**.**

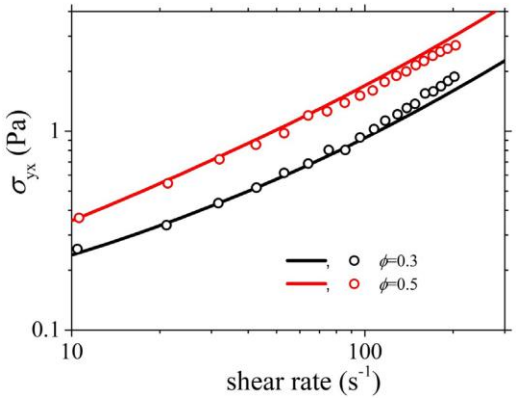

Figure: Comparison of the model predictions (lines) for the shear stress with experimental rheological data (circles) of light crude oil–seawater emulsions with 30% (black) and 50% (red) of seawater at 25 ^{o}C

References

M. Papademetriou, and **P. S. Stephanou***, “Modeling the rheological response of crude oil emulsions”, *Phys Fluids*, 34, 113107 **(2022)**