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# RHEOLOGICAL PROPERTIES OF EMULSIONS IMMERSED IN ELECTRIC FIELDS

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## ABSTRACT

The results of fully three-dimensional direct numerical simulations of the effects of electric fields on emulsions of drops will be displayed. The examination of the rheological properties of these systems is performed by imposing a simple-shear flow between two plates where the drops are immersed. An electric potential difference is applied perpendicular to the plates. The resulting electric field leads to two effects: a polarization of the drops and a viscous fluid motion on the interface between the drops and the suspending fluid. The direction and intensity of the viscous fluid motion depends on the electrical properties of the fluids. Drops more conductive than the suspending fluid exhibit a viscous fluid motion from the equator to the poles, whereas drops less conductive than the suspending fluid exhibit a viscous fluid motion from the poles to the equator. The numerical simulations show that the response of the emulsions is governed by the competition between the electric attraction and the fluid shear. The former leads to the aggregation of the drops in chains parallel to the electric field, while the latter tries to break-up the aggregated chains. The results are presented as a function of the Mason number and the electric capillary number, Mn and Ce. These non-dimensional numbers quantify the strength of the electric forces versus the fluid shear and the capillary forces, respectively. The significance of the electrical field on the viscosity and the normal stress differences will be discussed: At low Mason numbers, $Mn<0.1$, the application of the electric field results in the aggregation of the drops. This aggregation leads to an increase in the effective viscosity of the system and to an increase in the stresses, which result in higher normal stress differences than in hydrodynamic emulsions. At high Mason numbers, $Mn>1.0$, the fluid shear breaks up the aggregated structures and the properties are similar to hydrodynamic emulsions. At $0.1<Mn<1.0$ the properties of the emulsions exhibit an intermediate behavior.