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Rheological behavior of concentrated magnetic suspensions submitted to an oscillating shear flow

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A discontinuous shear viscosity transition (DST) has been observed in suspensions of iron carbonyl (CI) particles in ethylene glycol, for sufficiently high-volume fractions, typically above 60%. The viscosity jump resulting from this transition can be controlled by applying a weak magnetic field, thus significantly improving the efficiency of magnetorheological (MR) fluids. Here, we present the effect of the magnetic field on the DST transition in the oscillatory regime. We present the results for the storage modulus G' and the loss modulus G'' and show that the modulus variation induced by the field, triggering the DST transition, is much greater than that induced by the magnetic field alone, as is the case in a conventional magnetorheological fluid.

We also observe that the critical stress depends on the flow oscillation frequency and the way the magnetic field is applied to the suspension. A qualitative explanation is proposed, based on the decrease in the critical strain amplitude, which becomes less than unity for frequencies above 5 Hz. Each particle then oscillates within the cage formed by its neighbors, which reduces the collision frequency and therefore the viscosity. On the other hand, at low frequencies, the critical strain is significantly greater than unity, leading to a substantial structural rearrangement of the particles during oscillation. This interpretation is confirmed by the simultaneous measurement of the suspension's magnetic permeability and hydrodynamic stress.

Type:
Oral