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Modelling the Yield Stress of Magnetorheological Fluids

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Abstract : Magnetorheological fluids (MRF) are a category of smart materials. They exhibit a reversible change from a Newtonian-like fluid to a semi-solid state upon application of an external magnetic field. In contrast to ordinary fluids, MRFs can tolerate shear stresses up to a threshold value called yield stress which strongly depends on the strength of the magnetic field, magnetic particles volume fraction and temperature. Even beyond the yield, a magnetic field can increase MR fluid viscosity up to several orders. As yield stress is an important parameter in the design of MR devices, in this work, the effects of magnetic field intensity and magnetic particle concentration on the yield stress of MRFs are investigated. Four MRF samples with different particle concentrations are developed and tested through flow-ramp analysis to obtain the flow curves at a range of magnetic field intensity as well as shear rate. The viscosity of the fluids is determined by means of the flow curves. The results are then used to determine the yield stresses by means of the steady stress sweep method. The yield stresses are then determined by means of a modified form of the dipole model as well as empirical models. The exponential distribution function is used to describe the orientation of particle chains in the dipole model under the action of the external magnetic field. Moreover, the modified dipole model results in a reasonable distribution of chains compared to previous similar models.

Keywords : magnetorheological fluids, yield stress, particles concentration, dipole model
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