EFFECT OF THE CONFINEMENT DISTANCE ON THE VISCOELASTIC RESPONSE OF MAGNETORHEOLOGICAL FLUIDS IN PLATE-PLATE RHEOMETRY

L. Rodriguez-Arco[1], M.T. Lopez-Lopez[1], A. Zubarev[2], L. Iskakova[2], J.D.G. Duran[1], F. Gonzalez-Caballero[1]

1 - University of Granada, Department of Applied Physics, Granada, Spain
2 - Urals State University, Department of Mathematical Physics, Ekaterinburg, Russia

l_rodriguezarco@ugr.es

In this work, we study the effect that the distance at which a standard magnetorheological (MR) fluid is confined has on its MR behavior. For this purpose, we measured the MR response of a suspension of iron microparticles (30 vol.%) dispersed in mineral oil. A commercial magnetorheometer, provided with parallel-plate geometry, was employed and the distance between both plates (gap thickness) was changed from 10 to 400 μm. The experimental results showed that an increase of the gap thickness implies a hardening of the suspension; i.e. both the shear stress and the viscoelastic moduli increase. However, such effect only appears in the preyield regime, since no gap effects were observed in the properties that characterize the flow regime. The explanation to these phenomena would arise from the chain-like particle structures induced by the applied magnetic field. According to our calculations, they are expected to be gap-spanning in the pre-yield regime, with an increasing aspect ratio (length/diameter) as the gap thickness is increased. Actually, these structures and the increase of their aspect ratio were experimentally observed in diluted systems with the help of an optical microscope. In addition, we developed a theoretical model that predicts an increase of the magnetic torque, which is responsible for the alignment of the particle structures with the applied field, as the aspect ratio increases. As a result, our model predicts a strengthening of the suspension in the pre-yield regime, as the gap is increased, in agreement with the experimental results. As soon as the mechanic torque excesses the magnetic one, as a consequence of the shear (transition from pre-yield to flow regimes), the magnetic field-induced structures break up and become non-gap-spanning. Thus, the disappearance of effect of the gap thickness in the flow regime is justified. This influence of the confinement distance should be taken into account from now on when studying the MR properties of MR fluids.