Ferrofluids and ferrofluid based magnetorheological fluids: tuning the flow behavior by micron-size Fe particles and magnetite nanoclusters

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The flow behavior of practically structure-less ferrofluids was tuned over a large range by adding well-defined amounts of magnetite nanoparticle clusters. Magnetite nanoparticle clusters with hydrophobic coating were dispersed in high colloidal stability transformer oil based ferrofluid samples having 120 and 500 G saturation magnetization, initially free of clusters. The resulting ferrofluid composition consists both of single (approx. 7 nm mean size) and clustered (280 nm average size) magnetite nanoparticles, each of them in a prescribed amount. This new approach allows a precise evaluation of the role of clusters on the ferrofluid flow behavior. The magnetite nanoparticle clusters obtained by a solvothermal method have a saturation magnetization of 75 emu/g and a remnant magnetization of 0.2 emu/g due to the large size (~25nm) of the magnetite nanoparticles in their composition. Long bundles of thin elongated needle like aggregates of magnetic nanocluster particles are formed in a magnetic field and produce a significant magnetorheological response of the bidisperse magnetic suspensions observed already for moderate applied magnetic field values (fig.1). The dynamic yield stress and magnetoviscous (MV) effect are analyzed and compared with previous results concerning suspensions of micrometer size iron particles in a ferrofluid carrier [1]. The viscoelastic properties and the interactions between the components of ferrofluid based magnetite nanoparticle cluster suspensions were evaluated by creep tests in zero and nonzero applied magnetic field. The bidisperse magnetic nanocomposite suspensions provide a promising new formulation of MR fluids with improved kinetic stability to be used in seismic dampers and flow control devices for hydraulic machinery.

References

[1] Susan-Resiga D., Vekas L., *Ferrofluid based composite fluids: Magnetorheological properties correlated by Mason and Casson numbers*, Journal of Rheology, 61, 401-408 (2017)

Figures

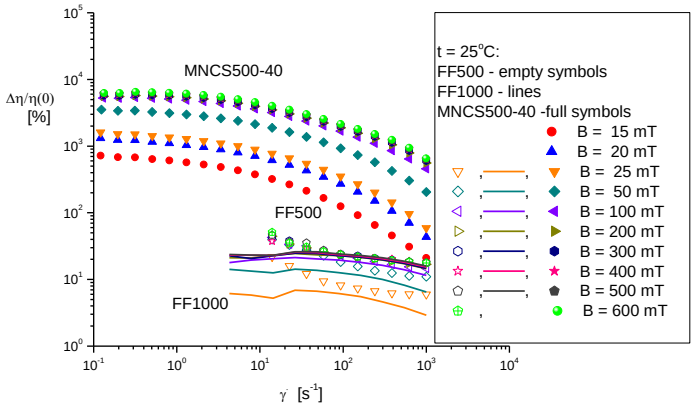

Figure 1. The MV effect of: a) MNCS120-5 and FF120, b) MNCS120-10 and FF120, c) MNCS500-10, FF500 and FF600, and d) MNCS500-40, FF500 and FF 1000 at several values of the applied field magnetic field