The Effect of Mesocarbon Microbeads on the Behavior of Magnetorheological Fluid

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ABSTRACT

Magnetorheological fluids (MRFs) are composed of magnetizable carbonyl iron particles (CIPs) suspended in carrier fluids (e.g. hydrocarbon oil) and change their viscosity with the application of a magnetic field. This is particularly useful for applications in hydraulic devices where a variable yield force is desirable. Studies have shown that substituting or adding non-magnetizable particles in MRFs can increase this yield force [1-3]. Our previous study showed that flow mode damper testing of an MR fluid with hollow glass spheres substituted for 4.3 volume percent (vol%) of the CIP content resulted in a substantial increase of the yield force [1]. However, the glass beads were crushed and the yield force decreased over several hundred thousand cycles [1]. In the current study we investigate the effect of mesocarbon microbeads (MCMBs) with graphitization as an alternative non-magnetic particle substitute. As passive particles, the carbon beads should similarly increase the yield force [3]. The MCMBs were chosen due to the higher Young's modulus of graphite over borosilicate glass and the MCMBs' solid nature as opposed to the glass beads' hollow nature. It is thus expected that the MCMBs will be more resistant to crushing when endurance tested in a damper. Initial results of three MRF compositions, MR-Fe40-C0 (40 vol% bidisperse mixture of iron and 0 vol% carbon), MR-Fe35-C0 (35 vol% iron and 0 vol% carbon), and MR-Fe35-C5 (35 vol% iron and 5 vol% carbon) were tested in a LORD RD-8041-1 MR damper with a 1 Hz sinusoidal displacement input. The yield force was determined for a sweep of currents by fitting the resulting force vs. velocity information with the nonlinear Bingham plastic model. MR-Fe35-C5 exhibited yield forces above those of MR-Fe35-C0 but below those of MR-Fe40-C0. While the MCMBs appear to increase the MR effect when substituted for a portion of the carrier fluid, when substituted for the iron content, they do not show the same increase the glass beads did. In the final paper, we will investigate using a surfactant to better characterize the MCMBs' effect on the fluid's magnetorheological properties.

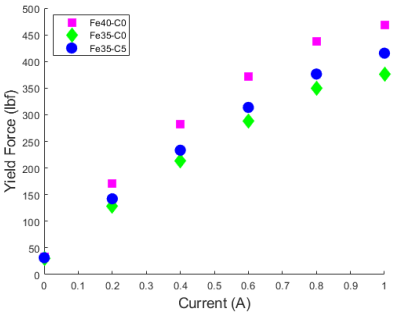

Fig. 1: MR damper on Material Test System (MTS) machine

Fig 2: Yield Force vs. Current for three MRFs

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