MCoCa27-001

The effect of graphite, molybdenum disulfide, and PTFE on tribology of magnetorheological fluid.

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Magnetorheological fluids (MRFs) are a class of smart materials that can reversibly change from fluid state to viscoelastic solid in up to 10 ms, enabling their application in functional composite materials, vibration control devices, damping, torque transfer, polishing in advanced optics, mechatronics, and smart prosthetics. As MRFs are concentrated dispersions of metallic particles in liquids, inherent problems associated with friction and wear are recurrent, and these phenomena should be considered in the development of tribologically effective MRFs. However, although a plethora of works on MRFs have already been published, fewer studies have focused on the tribological aspect of MRF application. This work aimed to evaluate the effect of three solid lubricants on the tribological performance of MRFs prepared with synthetic oil (Synfluid PAO 2) and 30 vol% carbonyl iron powder (HS grade, BASF SE). The solid lubricants evaluated were graphite, molybdenum disulfide, and Teflon, all in powder form and at a concentration of 1 vol% of the formulation of each MRF. A thixotropic additive (organophilic hectorite) was included in all formulations to mitigate the sedimentation of dense iron powder. After preparation, samples of each MRF, C (control: no lubricant added); G (Graphite); M (MoS2), and T (Teflon, Zonyl), were tested on an SRV® 4 reciprocating tribometer (Optimol Instruments), in the ball (steel 52100) on disc (steel H13) configuration, in the absence and presence of a magnetic field of 50 mT. The average coefficient of friction (COF) measured in the absence of the magnetic field was MRF-C = 0.274, MRF-G = 0.280, MRF-M = 0.256, and MRF-T = 0.257. COF values increased in all cases when the magnetic field was applied, resulting in MRF-C = 0.297, MRF-G = 0.308, MRF-M = 0.330, and MRF-T = 0.294. As for wear, the worst solid lubricant was graphite, which showed a width of the wear scar on the ball, and the volume of the wear spherical cap on the disc, practically equal to the control values. In the absence of the magnetic field, Teflon and MoS2 significantly reduced the diameter of the spherical cap on the ball (-15%) and the volume of the spherical cap(-50%) compared to the control values. However, under the applied magnetic field, there was no difference in the volume of the spherical cap, although a slight worsening of the wear mark on the ball and in the cap volume was observed with Teflon. In the absence of the magnetic field, the best solid lubricants were MoS2 and Teflon, reducing the COF from 0.274 (control) to 0.257. Under the magnetic field, COF values increased in all cases, and the best solid lubricant was Teflon, whose COF was equal to that of the reference lubricant with the applied field. The MoS2 additive was the worst, significantly increasing the COF. In future studies, we intend to vary the volume concentrations of iron powder and Teflon, selecting the latter as a lubricant for MRF.