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Thermal conductivity enhancement and sedimentation reduction of magnetorheological fluids with nano-sized Cu and Al additives

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Abstract

This work presents enhanced material characteristics of smart magnetorheological (MR) fluids by utilizing nano-sized metal particles. Especially, enhancement of thermal conductivity and reduction of sedimentation rate of MR fluids those are crucial properties for applications of MR fluids are focussed. In order to achieve this goal, a series of MR fluid samples are prepared using carbonyl iron particles (CIP) and hydraulic oil, and adding nano-sized particles of copper (Cu), aluminium (Al), and fumed silica (SiO_2). Subsequently, the thermal conductivity is measured by the thermal property analyser and the sedimentation of MR fluids is measured using glass tubes without any excitation for a long time. The measured thermal conductivity is then compared with theoretical models such as Maxwell model at various CIP concentrations. In addition, in order to show the effectiveness of MR fluids synthesized in this work, the thermal conductivity of MRF-132DG which is commercially available is measured and compared with those of the prepared samples. It is observed that the thermal conductivity of the samples is much better than MRF-132DG showing the 148% increment with 40 vol% of the magnetic particles. It is also observed that the sedimentation rate of the prepared MR fluid samples is less than that of MRF-132DG showing 9% reduction with 40 vol% of the magnetic particles. The mixture optimized sample with high conductivity and low sedimentation was also obtained. The magnetization of the sample recorded an enhancement of 70.5% when compared to MRF-132DG. Furthermore, the shear yield stress of the sample were also increased with and without the influence of magnetic field.

Keywords: magnetorheological fluid, thermal conductivity, sedimentation rate, copper additive, aluminium additive, nano-sized particle