Study of Heat Transport in Magnetorheological Fluids using the Thermal-Wave Resonant Cavity and its Relationship with the Viscosity

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Magnetorheological (MR) materials have the characteristic that their physical properties can be changed applying an external magnetic field. This is possible because they are formed by a non-magnetizable matrix in which micrometric particles are immersed. The magnetic field induces ordering of the microparticles, generating changes in the physical properties. The most of the studies have been focused on the effects of the magnetic field on the mechanical properties; however the effect of the aligning on the thermal properties as well as the relationship of the thermal transport and viscosity has not been fully understood. In this work, two types of magnetic fluids were studied using carbonyl iron particles in two matrices: silicone oil and silicone rubber. Thermal diffusivity and thermal conductivity of these magnetic fluids are determined using the thermal wave resonant cavity when the fluid is subjected to uniform magnetic fields at different intensities. The dynamic viscosity was also measured and the relationship with the concentration of the particles and the magnetic field strength was investigated. The results show that when the content of carbonyl iron particles is increased in the material, the thermal conductivity and thermal diffusivity are incremented and when the magnetic field intensity increases the thermal conductivity and thermal diffusivity increases even more. A functional dependence of the thermal conductivity and dynamic viscosity was found. Additionally we have shown that using high viscosity materials, the order induced in the micro particles can be kept for a long time and therefore the increase in thermal conductivity can also be maintained.