Simulation and Visualization of Magnetic Particles Behavior in Magnetorheological Fluid Shear Flows under Impressed Magnetic Field

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ABSTRACT

A magnetorheological fluid is one of magnetic functional fluids which react against impressed magnetic field. When magnetic field is applied to the magnetorheological fluid, suspended micron-size magnetic particles form chain-like clusters arranged in the field direction. Such microstructure affects on the macroscopic properties such as viscosity. Thus, it is important to investigate distribution and behavior of magnetic particles in the fluid. Behavior of magnetic particles in magnetorheological fluids has been examined by using numerical simulations such as the simplified Stokesian dynamics method [1-3] and the hybrid method of lattice Boltzmann method, immersed boundary method and the discrete particle method [4].

In this study,distribution of micron-size magnetic particles in a magnetorheological fluid is investigated using both numerical simulations and visualization experiment. A hybrid code based on a combination of the HSMAC method, the immersed boundary method and the discrete particle method is developed to simulate the behaviour of suspended particles in the magnetorheological fluid. The calculations have been performed for simulating behavior of magnetic particles in the shear flows between two parallel plates. The simulation results were compared with the results of visualization experiments. The magnetic field was impressed perpendicular to the shear flow.

Chain-like clusters are formed along the field direction and the clusters are broken around the center of clusters due to the shear. The upper broken half cluster switches its connection to the next lower half cluster.

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