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Flow Analysis of Magnetic Fluid around a Permanent Magnet in Magnetic Fluid Damper

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Magnetic fluid is a kind of magnetic functional material. In a gradient magnetic field, a permanent magnet can be suspended in the magnetic fluid by the second-order buoyancy due to the magnetic force. Based on this principle, the passive magnetic fluid damper is proposed. Much work has been researched in the field of magnetic fluid and magnetic fluid damper [1-2]. However, there is no comprehensive theoretical model for this kind of damper. This paper establishes the energy dissipation model considering the magnetic field and liquid flow. The magnetic fluid damper is composed of a non-magnetic cylindrical container, magnetic fluid and a cylindrical permanent magnet. The container is filled with magnetic fluid and sealed. The permanent magnet immersed in the magnetic fluid is forced not only by buoyancy of liquid but also by the magnetic force, which is called second-order buoyancy. Based on the Bernoulli equation, the velocity of magnetic fluid and the energy dissipation can be calculated. The flow loss is related to the viscosity of the magnetic fluid, the remanence of the permanent magnet, and the sizes of the damper. The three dimensional simulation model of the magnetic fluid damper is also built. The magnetic field distribution of the permanent magnet can be calculated. The results show that this damper can work with no external magnetic field and is suitable for low-frequency vibration of some longer objects in spacecraft.
[1] Y I Dikanskii, A G Ispiryan, et al, "On the nature of the maximum in the temperature dependence of magnetic liquid susceptibility,"Technical Physics, vol. 60, no. 8, pp. 1204-1207, 2015.
[2] K I Ohno, T Sawada. "An effect of vertical sloshing on a fluid pressure and a surface displacement in a tuned magnetic fluid damper,"Int J Appl Electromagnet Mech, vol.33, no. 3, pp. 1411-1416, 2010.

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