SURFACE SHAPE OF A MAGNETIC FLUID BRIDGE BETWEEN PLATES IN THE FIELD OF AN ELECTROMAGNETIC COIL

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The transfer of elastic wave energy from the source to the object of influence is a general challenge in applied acoustics. Magnetic fluid (MF) can be used for the creation of an acoustic duct in the slot gap between the surfaces of the source and the object of influence [1]. In [2], the MF bridge between two horizontal plates is studied analytically in the magnetic field of a line conductor. In [3], the surface shape of a MF volume between horizontal plates in the field of an electromagnetic coil is calculated numerically. Under an applied magnetic field, the instability of the MF can occur, which leads to a change of the surface shape of the volume and to the appearance of cavities. These effects must be considered in designing systems with MF-based acoustic contacts.

In this paper, the surface shape of a MF volume between horizontal plates is studied theoretically and experimentally. In the experiment the magnetic field of a coil, situated above the upper plate, is changed quasi-statically by varying the current. It was shown that there are different ways of creating the MF bridge between plates. It is shown that different forms of the MF can exist for the same applied current. Additionally abrupt and hysteretic behavior of the MF volume was observed. The theoretical investigation of the problem was done based on the principle of minimum energy of the system under the condition of the MF volume conservation. Sufficient conditions to determine the surface shapes, on which the energy has a local minimum, were obtained. Numerical calculations were carried out for the experimental parameters. The experimental investigations confirm the theoretical predictions, Fig.1. The obtained results of the transformation of the MF volume in non-uniform magnetic fields can be used to design systems based on MF.

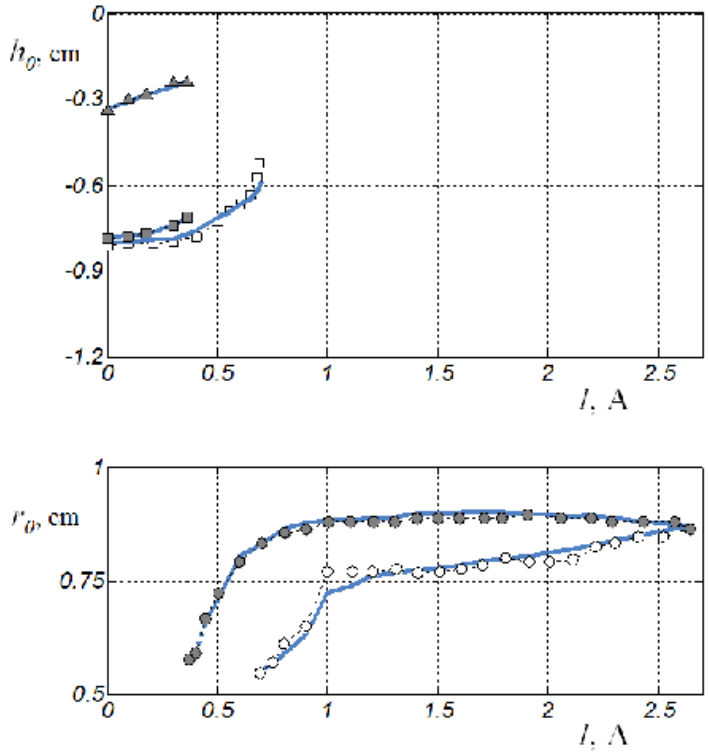

Figure: The dependencies of characteristic coordinates h_0 and r_0 on the current I obtained experimentally (markers) and numerically (solid lines) for an MF volume of 2 cm^3, when the current increases (white markers) and decreases (grey markers) quasi-statically. □ – the drop on the lower plate; Δ - the drop on the upper plate; ○ – the MF bridge between plates. h_0, $1.2 < h^0 < 0$ cm, is the distance from the top of the drop to the upper plate; $r^0 > 0$ is the radius of the contact spot of the MF bridge with the upper plate.

References

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