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LIFT FORCE ACTING THE CYLINDER IN VISCOUS LIQUID UNDER VIBRATION

Abstract

The lift force acting on a cylindrical solid in a cavity filled with a viscous liquid and subjected to high-frequency horizontal vibration is experimentally investigated. An amplitude and a frequency of vibrations, liquid viscosity, relative density of the body and its diameter are varying. The dynamics of solid is studied using the high-speed camera of high resolution.

The horizontal translational vibrations of the cavity generate a repulsive force which is able to keep the heavy body at some distance from the cavity bottom and the light body at some distance from the ceiling. In both cases the body performs oscillations without touching the wall of the cavity. The vibrational repulsion force is significant at a distance comparable with the thickness of Stokes boundary layer and decays with increasing the distance. It is in a qualitative agreement with the results for spherical solids [Ivanova et al., 2008].

It is found that the lift force changes its direction at the distance more than Stokes layer thickness, the vibrational repulsion force is replaced by the attractive one. In the presence of intensive vibrations the light cylinder could get a stable position near the cavity bottom.

The dependence of the lift force (attractive and repulsive ones) on the distance between the solid and the boundary is investigated in the wide range of dimensionless frequency of vibrations. The experimental method consists in a direct measurement of the averaged lift force by its comparison with the body weight (in the suspended state).

In overcritical domain when the heavy or light body is suspended near the wall the threshold excitation of the body motion along the axis of vibration is found. The body performs a steady motion along the wall and changes its direction near the end-walls of the cavity. It is shown that the average motion is caused by the breakdown of the symmetry of the body oscillations. The oscillatory and average dynamics of light and heavy bodies are similar.

The found effects could be used for efficient vibrational control and management of solid inclusions in viscous liquids under micro gravity conditions.

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Bibliography

Ivanova A.A., Kozlov V.G., and Kuzaev A.F. Vibrational hydrodynamical interaction of sphere with cavity boundary. Fluid Dynamics. 43 (2008) 194–202.