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PENDULUM THERMAL VIBRATIONAL CONVECTION IN A VERTICAL ANNULUS OF FINITE HEIGHT

Abstract

Thermal vibrational convection in the case of combined translational-rotational vibrations of the cavity (pendulum vibration - a typical example) [1] is qualitatively different from the case of translational vibrations [2]. The presence of "isothermal" component of the oscillatory fluid velocity associated with the rotational component of vibration produces vibrational force which is proportional to the density inhomogeneity. This mechanism is characterized by a vibrational Coriolis number Rk. It dominates [3] over the classical mechanism of vibrational convection in case of translational vibration [2] (characterized by vibrational Rayleigh number Rv). The influence of external force field on the vibrational convection in vertical annulus with the boundaries of different temperatures, subject to high frequency torsional oscillations about its axis is experimentally investigated. The annulus has a longitudinal partition forcing the fluid to oscillate together with the cavity. The study focuses on the influence of the relative layer height and the fluid properties (Prandtl number) on the excitation and structure of thermal vibrational convection. It was found that the gravitational convective motion exerts a strong stabilizing effect on the vibrational convection excitation. The stabilization grows with Prandtl number and a decrease of the layer height. It is shown that the vibroconvective stability is characterized by the vibration parameter Rk and dimensionless complex, which is a ratio of the gravitational Rayleigh number and the relative layer height. In the plane of these parameters the results of experiments performed with different liquids in the layers of varying thickness and relative heights are consistent with each other. In the limiting case of large relative height the results are fully consistent with the theory [1]. Note that in our experiment the role of classic mechanism of vibrational convection is not important, Rk/Rv>10. It is concluded that the static force field oriented along the layer has a stabilizing effect on the thermovibrational convection due to the creation of stable thermal stratification of liquid.

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Bibliography

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