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Pendular thermovibrational convection

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The report summarizes the results of theoretical and experimental investigation of thermovibrational convection in cavities subject to high frequency pendular vibration. As follows from the theory [1] the effect of combined translational-rotational vibrations (pendular is the typical one) qualitatively differs from the case of translational vibration (classical thermovibrational convection) due to additional mechanism of averaged convection excitation. Theoretical and experimental studies [1, 2] demonstrate this vibrational mechanism to play the governing role in many cases. This mechanism is of especial importance because the vibrations usually contain some nontranslational component. In plan layers, due to specific form of pulsating velocity component connected with the rotary cavity oscillations, the action of this mechanism is similar to static force field and results in renormalization of gravity (imitates the gravity in weightlessness, increases or compensates its role on the Earth).

The new investigations concern the theoretical and experimental study of thermovibrational convection in plane layer of liquid with uniform internal heat release subject to three dimensional oscillations of spherical pendulum. The experiments include also the limiting cases of indefinitely long pendulum (it corresponds to translational vibrations of circular polarization) and the case of zero pendulum length (3D rotational oscillations about the cavity center). The experimental results of vibrational convection excitation are in good agreement with theoretically predicted in high frequency case. At moderate dimensionless frequencies of vibration, when the thickness of Stokes boundary layers is relatively large, the critical intensification of heat transfer below the threshold of thermovibrational convection is found in experiments. It is proved to be connected with the instability of Stokes layers and formation of regular 3D system of vortexes.

The role of the ends of the cavities in case of nontranslational vibrations, mean flows generation and heat-mass transfer intensification in the end areas [3, 4] are also analyzed. Experimental studies were performed in wide interval of dimensionless frequencies including the limiting cases of low and high frequencies and found the excitation of intensive mean flows due to Schlichting mechanism of mean vorticity generation in nonuniform Stokes layers.

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