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EFFECT OF TANGENTIAL EXTERNAL FORCE FIELD ON THERMAL CONVECTION IN A ROTATING PLANE LAYER

Abstract

External force field transversal to the rotation axis produces the tidal oscillations of rotating hydrodynamic systems if its density is non homogeneous. In case of multiphase system it results in excitation of intensive average flows and differential rotation of phase inclusions (vibrational hydrodynamic top [1]), in case of nonisothermal liquid – average thermal convection [2]. Thermal convection in a tilted plane layer rotating about an axis oriented perpendicular to its plane is experimentally investigated in present work. In this case the gravity field has two components in the cavity frame: normal to the plane (steady in the rotating system) and tangential (rotating in the cavity frame). Both convective mechanisms, the classical convective and the average thermovibrational one manifest themselves in this case. The threshold of convection excitation and the structure of supercritical flows are studied.

In case of the horizontal layer orientation (classical case of gravitational convection) the results are in good agreement with known theoretical and experimental ones [3, 4].

The influence of the inclination angle on thermal convection occurrence and structure of supercritical flows is studied. It is found that relatively small deviation of layer orientation from the horizon results in stabilization of quasi-equilibrium. The change of convective mechanisms is accompanied by change of convective structure and heat transfer at some critical angle. At larger angle the thermovibrational mechanism replaces the Rayleigh convective mechanism. The threshold of quasi-equilibrium stability and heat transfer in the supercritical region are plotted against the dimensionless parameters: gravitational Rayleigh number, thermovibrational parameter and dimensionless rotation velocity. It is found that the excitation of the average thermal convection is possible even at negative values of gravitational Rayleigh number (heating of layer from the upper plane).

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References

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