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NEW TYPE OF THERMAL CONVECTION IN THE ROTATING ANNULUS

Abstract

The thermal convection in a horizontal annulus rotating about its axis is studied experimentally. It is found that thermal convection could be excited not only in case of heating the external boundary (well known centrifugal convection), but also in case when the interior boundary of the annulus has higher temperature. Main attention is given to this case when the centrifugal force plays strong stabilizing role. The convection is excited in a threshold manner at decreasing the rotation velocity and is followed by growth of a heat flux through the annulus. The first transition is characterized by the excitation of periodic system of the 2D convective rolls parallel to the rotation axis, the second – the excitation of the vortexes periodic along the axis. In comparison with the centrifugal convection the wavelength of convective structures in case of heating the annulus from inside are few times larger.

It is shown that the convection in rotating annulus is determined by two different mechanisms. The first is well-known centrifugal mechanism. In the annulus heated from inside it plays the stabilizing role. The second is thermovibrational one. It is related to the oscillations of nonisothermal fluid in the cavity frame. In the considered case the oscillations are produced by the gravity force which performs steady rotation in the cavity frame. In general case the theoretical description of vibrational convection in rotating cavities was done in [Kozlov] – the equations were obtained by method of averaging.

Thus the convection in the cavity rotating in the external force field is determined by two mechanisms and characterized by two dimensionless parameters, the modified vibrational parameter and centrifugal Rayleigh number. The threshold of excitation of thermal convection is investigated depending on the rotation velocity and the temperature difference, the structure of convective flows and heat transfer in overcritical area are studied.

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Bibliography

Kozlov V.G. Thermal vibrational convection in rotating cavities. Fluid Dynamics. 39 (2004) 3–11.