Subcritical Convection in Square Box with Internal Heat Generation

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ABSTRACT

The paper presents the numerical study for natural convection induced by internal heating of the viscous incompressible fluid in the square box. While classical Rayleigh-Benard problem is symmetric with respect to the center plane of the layer, the case under consideration is distinguished by asymmetric conduction temperature profile. Since [1]-[3] it is well established that asymmetric properties enhance the stability of a convection pattern in the form of hexagonal cells. In addition the static state is unstable to finite amplitude disturbances at Rayleigh numbers below the critical point predicted by linear theory.

Computer simulation for the onset of convection in the fluid with internal heating has been performed in scope of 3D time dependent problem statement. The process is considered in a square box of the size $5\pi \times 5\pi \times 1$ and described by Navier-Stokes equation for Boussinesq fluid and heat transfer equation [4],[5]. Results of computer simulation allow

- to determine the dependence of critical Rayleigh number of the rate of internal heating generation;
- to study the evolution of the motion kinetic energy versus Rayleigh number;
- to observe finite amplitude subcritical convection in the form of hexagonal cells;
- to analyze the direction of flow circulation in hexagonal cells;
- to compare theoretical, experimental and numerical data and to discuss a certain inconsistency in theoretical [2],[6] and experimental results [3],[7].

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