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Research Article

Wave Convection Regimes in an Inclined Layer of Nano Fluid

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Abstract

The experimental investigation of thermogravitational convection has been carried out for an inclined layer of nanofluid heated from below. It is shown that when the Rayleigh convection arises in the dependence of inclination angles and temperature drops are observed the regimes of traveling rolls with the cross-roll instability, the attenuation of secondary flow partially or throughout the layer, climbing and gliding dislocations. The maps of flow regimes have been built; the convective heat transfer has been investigated.

***Keywords**: convection; magnetic fluid; wave regimes; heat transfer.*

Introduction

Studying of artificial nanofluids representing colloidal dispersions of ferromagnetic nanoparticles suspended in a liquid carrier was started in the 1930s (Elmore W. C. 1938) The interest to magnetic colloids increased considerably in the 60s , when their industrial production became to be possible . To date, many monographs and reviews are devoted to study properties and applications of magnetic nanofluids in various areas (Blum E. J. *et al*, 1989; Odenbach S., 2009).

In magnetic colloids the average particle size of solid phase, e.g., magnetite, is about 10 nm. As liquid carriers normally kerosene, various synthetic oils and water are used. For prevention of aggregation due to the dipole – dipole interaction between single – named particles, they are coated with a stabilizing layer of surface – active agent.

It should be noted that convective motions of a single liquid in an inclined layer, embosomed between two parallel planar surfaces, kept at constant different temperatures, have studied in reasonable detail, both theoretically and experimentally (Gershuni G. Z.,*et al* ,1989 ; Pivovarov D. E.,*et al* ,2009) and the references therein . In nanofluids unlike single – component fluids at the instability of a primary rising – drop flow the irregular spatially – temporal behavior has been detected (Bozhko A. A., *et al* ,2003; Bozhko A. A., *et al* ,2009) . Unlike developed turbulence this behavior observed in a number of liquid and gas systems (Kolodner P. ,*et al* ,1988 ; Donzelli G., *et al* ,2009) near the instability threshold of the basic state, is placed to so – called spatially – temporal chaos where in convective structures the characteristic wave number is kept.

Experimental procedure

The design of a convection chamber and the measurement procedure were significantly influenced by the fact that the used in the experiments nanofluid on basis of magnetite is opaque in layers with thickness more than tenths of a millimeter. This fact does not allow to use the methods of visualize marks and particles, as well as the laser Doppler navigator for direct determination of velocity fields and pictures of convective flows. For this reason optical methods recording refractive index fields and related temperature and concentration fields in transparent fluids cannot be used. As a result, conventional methods of studying of convection are narrowed to measure temperature fields and heat flows.

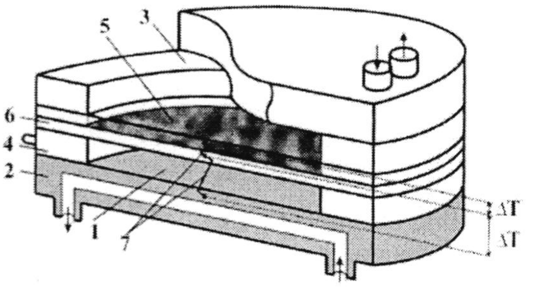

Fig. 1 Convention chamber: 1 – nanofluid; 2 ,3 – cooper and plexiglass heat exchangers; 4 – annular frame; 5 – thermal sensitive liquid – crystalline film; 6 – protective plate; 7 – thermocouples.

On basis of these factors for studying of convection in plane layers after a series of exploratory experiments the construction of a convection chamber was chosen, shown on figure 1. Measuring cell 1 having disk shape, with