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Oscillatory three-dimensional natural convection in a rectangular cavity of liquid metal under magnetic field

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Abstract

We numerically study the three-dimensional magnetohydrodynamics (MHD) stability of oscillatory natural convection flow in a rectangular cavity, with free top surface, filled with a liquid metal, having an aspect ratio equal to $A=L/H=5$, and subjected to a transversal temperature gradient and a uniform magnetic field oriented in x-, and z- directions. The finite volume method was used in order to solve the equations of continuity, momentum, energy, and potential. The stability diagram obtained in this study highlights the dependence of the critical value of the Grashof number Gr_{crit}, with the increase of the Hartmann number Ha for two orientations of the magnetic field. This study confirms the possibility of stabilization of a liquid metal flow in natural convection by application of a magnetic field.

Key words: *Natural convection, Magnetic field, Oscillatory, Cavity, Liquid metal*

1. Introduction

Natural convection of a conducting fluid of electricity contained in a cavity represents an adequate research subject, because of its presence in many industrial processes, especially during the process of crystal growth (Tagawa and Ozoe, 1997). The widespread use of this process in electronic and optical applications had, for consequence, an extended research towards the comprehension and the control of the natural convection in these systems.

With the application of an external magnetic field, it is possible to act on the flows without any physical contact, and thus to remove the fluctuations to control heat and mass transfers, in order to improve the quality of the crystal. For this purpose, the damping magnetic to control the flow induced by a temperature variation was used in several industrials applications (Tagawa and Ozoe, 1997; Benhadid and Henry, 1997; Bessaih *et al.*, 1999; Juel *et al.*, 1999; Aleksandrova and Molokov, 2004; Hof *et al.*, 2005; Gelfgat and Bar-Yoseph, 2001; Xu and Stock, 2006; Benissaad1 and Mohamed, 2006; Berrahil and Bessaïh, 2008). Tagawa and Ozoe (1997) numerically studied three-dimensional natural convection of a liquid metal in a cubic enclosure, under the action of a magnetic field

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