Convection in a rectangular enclosure with internally heated porous medium

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1. INTRODUCTION & OBJECTIVE

Hydrodynamics equations allow a pattern of flow that gives stationary solutions by a specific range of parameters characterizing them. The problems of Hydrodynamics stability occur due to the change of stable from the unstable flows. The formal solution to the stability problem was first given by Chandrasekhar (1981). The problem of the onset of thermal instability in a fluid heated from below gives mathematical and physical aspects of the hydrodynamics stability. Thermal instability was first recognized by Bénard (1900), and the phenomenon of thermal convection by Count Rumford (1797) and James Thomson (1882). Beck (1972) studied Convection in a Box of Porous Material Saturated with fluid and showed that the critical Rayleigh numbers given by linear and energy methods coincide. Giangi (1999) investigated experimental results obtained on a conjugate heat transfer problem with internal heat conductivity of the non-isothermal walls to improve the capability of the numerical method, and the results have been compared with the simulations obtained for the idealized case of perfectly adiabatic side walls, and with experimental findings. (Harfash, 2014) examined the problem of penetrative convection in a fluid-saturated porous medium. The linear instability theory and nonlinear energy theory are derived, and then critical Rayleigh numbers are obtained numerically. Convection heat transfer induced by internal heat generation has wide applications in high-performance insulation for buildings and cold storage, the insulation of high-temperature gas-cooled reactor vessels, geophysics, ocean dynamics, and regenerative heat exchangers containing porous materials, and exothermic chemical reactions in packed-bed reactors and energy-related engineering problems and hence, made this topic of considerable attention. This paper deals with Convection in a Box of Porous Material Saturated with fluid with internal heat generation. The stability of fluid saturating a porous medium with constant internal heat generation with an effect of lateral walls is examined, and a critical Rayleigh number is obtained using linear and non-linear theory.

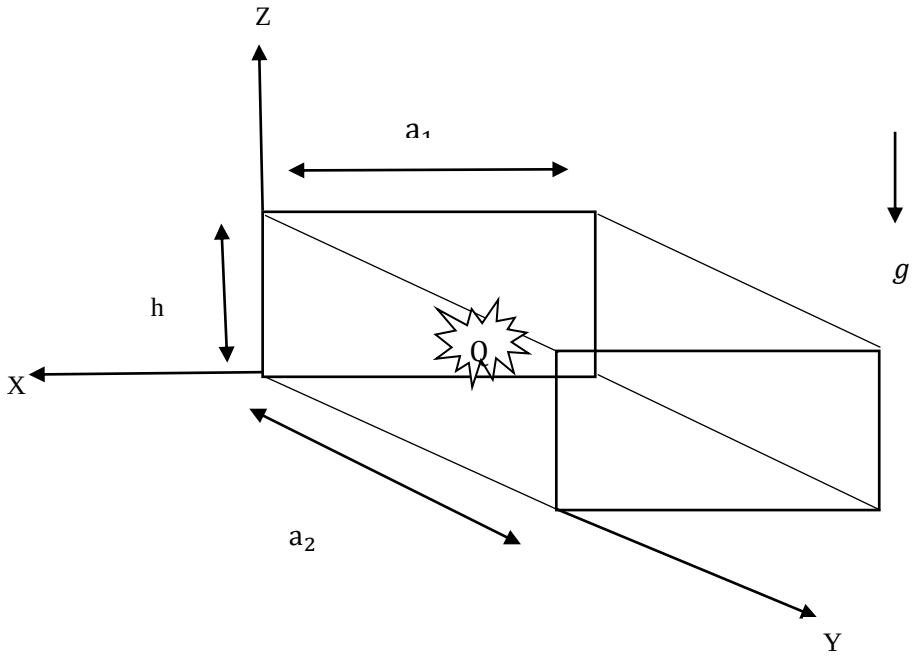

Fig.1. A rectangular box in 3D.

2. RESULTS & HIGHLIGHTS

We studied the stability of a fluid saturating a porous medium with constant internal heat generation. The critical value of a Rayleigh number is calculated, which decides the stability of a layer of fluid heated from below using linear and nonlinear methods. The walls are perfect heat conductors, the fluid properties are constants, and the Boussinesq approximation is valid are the basic assumptions in these analyses**.** In the linear method, the equations are analyzed using normal modes of assigned wavenumber, and for the nonlinear, the energy method is applicable**.** The steady state solution of velocity, pressure, and temperature is dependent on the z-axis and other non-dimensional parameters. It is observed that the critical Rayleigh number obtained from linear and energy methods are identical.

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