Mixed Convection in a Rectangular Enclosure with Temperature-Dependent Viscosity and Viscous Dissipation

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Abstract The problem of laminar opposing mixed convection inside a two-dimensional rectangular enclosure with asymmetrical heating is studied numerically using the vorticity-stream function formulation of the Navier-Stokes and energy equations. The model considers viscous dissipation and viscosity is assumed to vary with temperature according to an exponential relation, while other fluid properties are considered constant. Numerical experiments have been performed for fixed values of the geometrical parameters, Reynolds number of $Re = 20$, Prandtl number of $Pr = 3{,}060$, a range of Richardson numbers from 0 to 10, and Brinkman numbers ranging between 0 to 40. Streamlines, temperature contours, maximum fluid temperature and average Nusselt number at both walls are obtained. The results show that combined viscous dissipation and variable fluid viscosity can be important in the overall flow and heat transfer characteristics.

1 Introduction

Mixed convection studies in rectangular enclosures are important in many industrial applications for the design of compact heat exchangers, solar collectors, cooling of electronic equipment and other thermal devices. A comprehensive review of this subject can be found in Aung (1987). However, most efforts have focused on studying the effect of combined forced and free convection for different channel geometries, boundary and operating conditions based on the hypothesis that the effect of viscous

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J. Klapp et al. (eds.), *Selected Topics of Computational and Experimental Fluid Mechanics*, Environmental Science and Engineering,
DOI 10.1007/978-3-319-11487-3_15