A direct numerical simulation study on the mean velocity and temperature in mixed convection from an open cavity

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ABSTRACT

Mixed convection and heat transfer over open cavities have been the subject of extensive research for many years due to their importance in various engineering systems. The presence of such type of geometry is of interest because of the convective heat transfer that occurs between the cavity and the forced flow stream of air (e.g., electronic devices, see [1,2,4]).

This work deals with the mixed convective flow over a three-dimensional cubical open cavity heated from the right-hand side vertical wall at constant temperature T_H and the left-hand side vertical wall is cooled at ambient temperature T_∞. A three-dimensional incompressible finite volume flow solver, see [2], was used in this study. The effects over the velocity and temperature distribution of the buoyancy forces acting perpendicular to the mainstream flow, are studied for Reynolds numbers between 100 and 1000, Prandtl number $Pr = 0.71$ and high Gr numbers, to obtain a phenomenological description of the mixed convection inside and outside the cavity and the combined effects of the natural and forced convection. For both high Re and Gr the flow becomes three-dimensional and unsteady. The mixed convection effects dominate the flow transport mechanism and push the recirculating zone further upstream and the flow becomes unsteady with Kelvin-Helmholtz instabilities at the shear layer. A time-averaged analysis on the mean velocity and temperature was performed and several results are reported concerning simulations of flows in laminar and incipients transitional regimes and detection of vortical structures as well as the changes in flow and shear layer charactersitics.

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