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Influence of presence of inclined centered baffle and corrugation frequency on natural convection heat transfer flow of air inside a square enclosure with corrugated side walls

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ABSTRACT

The main objective of this study is to investigate the effect of presence of insulated inclined centered baffle and corrugation frequency on the steady natural convection in a sinusoidal corrugated enclosure. The present study is based on such a configuration where the two vertical sinusoidal walls are maintained at constant low temperature whereas a constant heat flux source whose length is 80% of the width of the enclosure is discretely embedded in the bottom wall. The remaining parts of the bottom wall and the top wall are adiabatic. The finite volume method has been used to solve the governing Navier–Stokes and the energy conservation equations of the fluid medium in the enclosure in order to investigate the effects of baffle inclination angles, corrugation frequencies and Grashof numbers on the fluid flow and heat transfer in the enclosure. The values of the governing parameters are the Grashof number Gr (10^3–10^6), the corrugation frequencies CF (1, 2 and 3), baffle inclination angles ($0^\circ \leq \Phi \leq 150^\circ$) and Prandtl number Pr (0.71). Results are presented in the form of streamline and isotherm plots. The results of this investigation are illustrated that the average Nusselt number increases with increase in both the Grashof number and corrugation frequency for different baffle inclination angles and the presence of inclined baffle and increasing the corrugation frequency have significant effects on the average Nusselt numbers, streamlines and isotherms inside the enclosure. The obtained numerical results have been compared with literature ones, and it gives a reliable agreement.

1. Introduction

The phenomena of natural convection in the recent years have been the topics of many researches, because it doesn't require energy source, as the air fan and it is maintenance free, safe, simple and low cost. This topic stems from its importance in engineering and natural applications. Such applications include cooling of electronic devices, lubrication, drying technology food processing and cooling of nuclear reactors. In many applications, for some reasons, the enclosure one or more walls, are corrugated or not flat or the enclosure is partitioned by baffle(s). Based on the baffle(s) presence inside different shape enclosures [1–15] and the enclosure walls geometry without baffle(s) [16–29], the published works in literature can be classified into two categories;

In the first category, Varol et al. [1] analyzed numerically the natural convection heat transfer from a protruding heater located in a triangular enclosure. It was found that all parameters related with geometrical dimensions of the heater are effective on streamlines and isotherms. Ampofo [2] conducted an experimental study of low level turbulent natural convection in an air filled vertical partitioned square enclosure. The experimental results can form a benchmark data and will be useful for validation of computational fluid dynamic code. Also Nada [3] investigated experimentally the natural convection heat transfer and fluid flow in horizontal and vertical narrow enclosures with heated rectangular finned plate at a wide range of Rayleigh numbers for different values of spacing and fin length. The results gave an optimum fin spacing at which Nusselt number and finned surface effectiveness were maximum. A numerical study of natural convection in square and inclined rectangular enclosures containing vertical and horizontal baffle(s) were performed by Kandaswamy et al. [4] and Altac and Kurtul [5], respectively. The studies were performed for different values of Grashof number and Rayleigh number respectively. Ghassemi et al. [6] and Ambarita et al. [7] investigated numerically the flow field and heat transfer for differentially heated square enclosure. They considered two insulated baffles attached to its isothermal vertical [6], and adiabatic horizontal walls [7]. The

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