Numerical Study of the Turbulent Natural Convection in a Trapezoidal Cavity: Influence of the Inclination of the Lateral Walls

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Abstract— In this paper, we study the heat transfer in turbulent natural convection in a two- dimensional cavity with a trapezoidal section and isoscales filled out of air with as height H =2.5 m. In these conditions, the side walls are differentially heated while the horizontal walls are adiabatic. The k-ε turbulence model with a small Reynolds number was integrated in our calculation code. The governing equations of the problem were solved numerically by the commercial CFD code Fluent; which is based on the finite volume method and the Boussinesq approximation. The elaborated model is validated from the experimental results in the case of the turbulent flow in a square cavity. Then, the study was related primarily to the influence of the slope of the side walls of the cavity on the dynamic behavior and the heat transfer within the cavity.

Keywords— turbulent natural convection, number of thermal Rayleigh, approximation of Boussinesq, isosceles trapezoidal cavity, slopes.

I. INTRODUCTION

THE studies of the natural convection in confined cavity have constituted for several years, the object of several research, because of its implication in many natural phenomena and industrialists applications. The majority of anterior works, interesting in the problem of the natural convection, concern the cases of regular enclosures form. Few studies were devoted to irregular forms, although the irregular geometry occurs in several applications to practical interest. Work concerning of the nonrectangular cavities was provided.

Salari et al. [1] studied numerical analysis of a 3D turbulent and transitional natural convection with different turbulence and transition models in a trapezoidal enclosure. The turbulent steady two-dimensional natural convection between inclined isothermal plates has been investigated numerically by Said et al. [2]. Their results indicated that the channel overall average Nusselt number is reduced, the rate of reduction increases as the inclination angle is increased and the overall average Nusselt number at different inclination angles can be presented by a single correlation. The relation between the Noll formulation of the principle of material frame indifference and the principle of turbulent frame indifference in large eddy simulation, is revised by Gallerano et al. [3]. A new rule for the formalization of turbulent closure relations is proposed. The generalized SGS turbulent stress tensor is related exclusively to the generalized SGS turbulent kinetic energy, which is calculated by means of its balance equation, and the modified Leonard tensor. Cannata et al. [4] proposed a numerical model for turbidity currents, based on two-phase flow motion equations. In particular, we proposed three different formalizations of the two-phase flow motion equations. The most general formalization presented is valid for high concentration values. A more simplified formalization introduces the hypothesis of diluted concentrations. The two-phase flow motion equations are presented in an integral form in time-dependent curvilinear coordinates. The proposed numerical model has been compared with several experimental validation tests. Furthermore, the numerical model has been used to reproduce the case study of Pieve di Cadore reservoir, under several inflow conditions; the possibility of the formation a turbidity current during several different flood events, has been investigated..Salat et al. [5] investigated experimentally and numerically the turbulent natural convection flow developed in a differentially heated cavity, submitted to a temperature difference between the active vertical walls equal to 15 K resulting in a characteristic Rayleigh number equal to 1.5 10^9. Both 2D and 3D LES and 3D DNS are performed. Time-averaged quantities and turbulent statistics in the median vertical plane are presented and compared. Ridouane et al. [6] addressed the turbulent natural convection of air confined in an isosceles triangular enclosure representing conventional attic spaces of houses and buildings with pitched roofs and horizontally suspended ceilings. Turbulence is modeled by a low-Reynolds-number k–ε model. Sheremet et al. [7] investigated the natural convection flow and heat transfer in a triangular cavity filled with a micropolar fluid Thier work studied the effects of the vortex viscosity parameter and micro-gyration parameter in a triangular cavity filled with a micropolar fluid on the fluid flow and heat transfer. Varol et al. [8] analyzed numerically the natural convection heat transfer in a triangle enclosure with flush mounted heater on vertical wall. Finite difference

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