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Numerical Investigation Of transient Natural Convection In partitioned cavity filled with water

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Abstract

Transient natural convection in partitioned cavity filled with water is investigated numerically in this paper. The fluid flow and the heat transfer expressed in terms of continuity, linear momentum and energy equations were calculated by using the finite volume method.
Prandtl number and Rayleigh number are fixed at 6.64 and $3,77x10^9$, respectively, and the partition length of L/4. To approach the physical reality experience, calculations were performed in a cavity with the same size and same priority of the fluid with the temperature imposed on the cooled wall is equal to the average temperature T_m, also another calculations with the temperature imposed on the horizontal walls is equal to the average temperature T_m .
The achieved results demonstrating the effects of the partition for the heat transfer and the thermal boundary layer are shown and discussed, it illustrate that the existence of the partition on the hot wall influences both heat transfer and fluid flow.

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Keywords: Natural Convection, unsteady regime; partial partitions; Rayleigh Number; Nusselt Number; Partitions Length

1. Introduction

Natural convection has fascinated a big pact of interest from researchers since its presence both in nature and engineering applications. Natural convection flows in a differentially heated cavity are typically came upon in various industrial applications. A review of the literature demonstrates that there are a variety of studies on heat

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transfer in cavities without and with partition.

Patterson et al [1] studied unsteady natural convection in a rectangular cavity with instantaneous cooling and heating of two opposite vertical sidewalls. They concluded that the flow had a strong dependence on the Prandtl number and cavity aspect ratio.

Xu et al [2] observed using a shadowgraph technique the transition of the thermal boundary layer from start-up to a quasi-steady state in a side-heated cavity at the Raleigh number of 3.8×10^9. They concluded that the fin length significantly impacts on the transient thermal flow around the fin and heat transfer through the finned sidewall in the early stage of the transient flow development.

Yucel et al [3] analysed numerically a laminar natural convection in enclosures with fins attached to an active wall indicating that with increasing number of fins the heat transfer first reaches a maximum and then approaches a constant, which is not affected by the number of fins.

Nomenclature

g	gravitational acceleration (m/s^2)	U	velocity component in x direction (m/s)
h	convective heat transfer coefficient (W/m^2 K)	V	velocity component in y-direction (m/s)
H	height of the enclosure (m)	W	partition thickness
l	partition length (m)	x, y	Cartesian coordinates (m)
L	width of the enclosure (m)	Greek symbols	
Nu	Nusselt number	τ	dimensionless time
p	pressure (N/m2)	k	thermal conductivity of fluid (W/m k)
Pr	Prandtl number	α	thermal diffusivity (m2/s)
Ra	Rayleigh number	β	coefficient of volumetric expansion (1/K)
T	temperature (K)	μ	dynamic viscosity (N s/m2)
T_h	temperature of the hot surface (K)	ρ	fluid density (kg/m3)
T_c	temperature of the cold surface (K)	Subscripts	
T_0	initial temperature (K)	C	Cold
T_m	average temperature (k)	H	Hot
ΔT	Temperature variation, $T_h - T_c$ (k)	0	Initial

Kolsi et al [4] in their study of the two-dimensional laminar natural convective transient flow characteristics in a differentially heated air-filled tall cavity revealed that as the Rayleigh number increases the flow becomes unstable.

Effects on natural convective heat transfer through porous media in cavity due to top surface partial convection were showed by **Pakdee et al [5],** they found that the heat transfer coefficient, Rayleigh number affect considerably the characteristics of flow and heat transfer mechanisms and the flow pattern is found to have a local effect on the heat convection rate.

Paul et al [6] treated the Effect of an adiabatic fin on natural convection heat transfer in a triangular enclosure by numerical simulations.

Frederick et al [7] reported in their study that the heat transfer through the finned sidewall is reduced as the fin length increases due to the depression of the natural convection flows adjacent to the finned sidewall.

the transition from a steady to an unsteady flow induced by an adiabatic fin on the side walls was also carried out by Therefore **Xu et al [8]** demonstrated that the fin may induce the transition to an unsteady flow and the critical Rayleigh number for the occurrence of the transition is between 3.72×10^6 and 3.73×10^6.

The purpose of this study is to analysis the unsteady natural convection in a differentially heated cavity with a partition on the hot wall with different properties. The differentially heated cavity used is the same of **Xu et al [9].** The thermal and flow behavior and heat transfer characteristics have been studied for a partition length of L/4. The working fluid media is water with Prandtl number of 6.64 and Rayleigh number of 3.77×10^9 $10^6 \leq Ra \leq 3.77 \times 10^9$. To approach the physical reality experience, calculations were performed in a cavity with the same size and same priority of the fluid with the temperature imposed on the cooled wall is equal to the average temperature T_m, also another calculations with the temperature imposed in the horizontal walls is equal to the average temperature T_m . Moreover results were obtained while copper walls were added on the sidewall