ALEXANDRIA UNIVERSITY
FACULTY OF ENGINEERING

LAMINAR MIXED CONVECTION INSIDE A SQUARE ENCLOSURE WITH DISCRETE HEAT SOURCES AND VENTILATION PORTS

A THESIS

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By

Eng.: Noha Alaa El-Din Mohamed Saad El-Din Abd-ElRazek

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ABSTRACT

The aim of this study is to investigate numerically the laminar mixed convection inside square enclosure with three discrete heat sources. The three discrete heat sources are embedded on three vertical boards situated on the bottom wall of the enclosure. An external airflow enters the enclosure through an inlet port at the bottom of the vertical right wall, and exits from outlet port at the upper half of the enclosure. The laminar mixed convection inside square enclosure with discrete heat sources is an important problem in heat transfer and also in fluid flow due to its theoretical interest and its wide engineering applications. The study gives comprehensive reviews for the most important previous investigations on laminar and turbulent, natural and forced convection heat transfer inside rectangular and square, open and closed enclosures.

Differential equations governing the continuity, momentum and thermal energy together with their boundary conditions in the three-dimensional Cartesian coordinates were reduced to be in two dimensional form. The fluid inside the cavity space will be considered a Newtonian, incompressible fluid (constant property fluid) except for the density in the buoyancy force component existing in the momentum equations. The laminar flow regime is considered under steady state conditions.

A mathematical model is constructed and numerically solved. The finite volume technique developed by patankar and Spalding [23] is used, which is based on the discretization of the governing equations using the central differencing in space. A uniform grid is taken in both the horizontal and vertical directions. The discretization equations are solved by the Gauss-Seidel method. The iteration method used in this program is a line by line procedure. A computer program validation of the present study is presented by comparing the obtained results with other published works and a good agreement was found.

The study covers a wide range of Richardson number Ri, $0.01 \leq Ri \leq 100$, spacing between boards S, $0.1 \leq S \leq 0.4$ and boards height H_b, $0.25 \leq H_b \leq 0.75$. And considered three different outlet port positions as (outlet A, outlet B and outlet C), and also three different arrangements of the three boards as (left position, centre position and right position). Through this investigation, the following parameters are kept constant: the thermal Grashof number Gr

is taken 10^4, the prandtl number is taken 0.7 for air, the board thickness is 0.02 of the enclosure width and the size of inlet and outlet ports are the same and equal 0.3 of the enclosure height. All walls and boards surfaces are considered adiabatic, with a constant heat flux from discrete heat sources, constant cold temperature of air inlet and fully developed boundary condition at outlet port.

The results are obtained in terms of streamlines and isothermal lines. And the effects of different dimensionless groups on streamlines and isothermal lines are discussed. In addition, both local and average Nusselt numbers are presented. Finally the results obtained through the different investigation steps are collected and reported, also recommendations and some of studying points that we hope to be studied in the future are listed.