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Study of Natural Convection Heat Transfer in Different Shapes

Ritika Tripathi[1], Bharti Sharma[2], Pooja Kumari[3]
[1,2,3]*Mechanical Engineering, B.T.K.I.T Dwarahat*

Abstract— This paper presents a review of studies on natural convection heat transfer in different shapes. In vertical tube a vertical copper tube having constant cross section area is used for representing the medium through which natural convection of water takes place. On two evenly heated vertically arranged horizontal cylinders with a diameter of 54mm in water. The change in nusselt number on the upper cylinder compared to a single cylinder is presented for seven Rayleigh numbers. Laminar boundary layer equations for natural convection from the outer surface of a vertical cylinder with a uniform temperature. Correlation for the local natural convection heat transfer from a vertical cylinder with the uniform surface temperature and the uniform heat flux.

Keywords—Natural Convection, Heat Transfer, Horizontal Cylinders, Vertical Cylinders,Nusselt Number

I. INTRODUCTION

The convection is mode of heat transfer in which the energy is transported by moving fluid particles. The convection heat transfer comprises of two mechanisms. First is transfer of energy due to random molecular motion (diffusion) and second is the energy transfer by bulk or macroscopic motion of the fluid (advection).The molecules of fluid are moving collectively or as aggregates thus carry energy from high temperature region to low temperature region. Thus the faster the fluid motion, the greater the convection heat transfer.

In absence of any bulk fluid motion, the heat transfer occurs by pure conduction .Hence heat transfer rate increases in presence of temperature gradient .The convection heat transfer is due to superposition of energy transfer by random motion of the molecules and by bulk motion of the fluid. The natural or free convection is a process, in which the fluid motion results from heat transfer. When a fluid heated or cooled, its density changes and the buoyancy effects produce a natural circulation in the affected region, which causes itself the rise of warmer fluid and the fall of colder fluid, therefore, energy transfers from hotter region to colder region and such process is repeated as long as the temperature difference in the fluid exists.

To understand the mechanism of natural convection, let us consider the natural convection in from a heated vertical flat plate placed in a quiescent fluid. The surface temperature of the flat plate T_W, is higher than the temperature of the quiescent fluid T_∞, the fluid that is in contact with the heated vertical plate is heated and its density decreases. The heated lighter fluid flows up and fluid from the neighbor moves in. the temperature in a thin layer of the fluid near the heated vertical plate is higher than the quiescent fluid temperature T_∞ and a thermal boundary layer is formed. As the fluid near the heated vertical plate rises , a velocity boundary also formed.

Natural convection heat transfer has always been of particular interest among heat transfer problems. In natural convection, fluid motion incused by natural means such as buoyancy due to density variation resulting from temperature distribution. Natural convection plays vital role in heat transfer in case of many applications such as electrical components, heat exchangers and many other places many experimental studies have been performed during the last three decades and interesting results have been presented.

II. OTHER STUDIES

Many studies for natural convection heat transfer from a vertical cylinder and horizontal cylinder have been carried out. Sparrow and Gregg[4] obtained a numerical solution of the laminar boundary layer equations for natural convection from the outer surface of a vertical cylinder with a uniform temperature and established and quantitative criterion for determining the conditions under which the heat transfer from a cylinder agreed with the flat plate results within 5 % error.

Leferve and Ede[6] executed the integral method to the laminar boundary layer equations in cylindrical coordinates. The numerical results were almost in agreement with those by sparrow and Gregg.

Fujii and Uehara[2] presented the correlation for the local natural convection heat transfer from a vertical cylinder with the uniform surface temperature and the uniform heat flux . this correlation based on the boundary layer approximation was expressed in

comparison with the theoretical solutions for a vertical plate.

Marsters[1] studies natural convection heat transfer from arrays of vertically arranged heated copper cylinders in air were the number of cylinders in the arrays,the dissipated heat, and the spacing between the cylinders were varied. Marsters[1] reported that for closely spaced cylinders, the Nusselt numbers for the cylinder in the array were reduced with up to 50% compared to the single cylinder. However, for large spacings the Nusselt numbers were increased with up to 30%.

Khanorkar and Thombre[3] studies CFD analysis in vertical tube a vertical copper tube having constant cross section area is used for representing the medium through which natural convection of water takes place. In this present work study and analysis of natural convection flow of water through vertical pipe is done. In this study includes what is the effect of the physical parameters of tube like diameter, length and heat flux on the outlet flow parameters like velocity and temperature.

Jensen[5] presents an experimental investigation conducted on two evenly heated vertically arranged horizontal cylinders with a diameter of 54mm in water. The change in nusselt number on the upper cylinder compared to a single cylinder is presented for seven Rayleigh numbers ranging from 1.82E7 to 2.55E8 for vertical separation distances S = 1.5D,2D,3D,4D and 5D.

III. CONCLUDING REMARK

From the above study it is concluded ,in case of horizontal cylinders mass transfer coefficient were highest ,gradually decrease with increasing inclination angle and were lowest for vertical cylinder. on two evenly heated vertically arranged horizontal cylinders velocity fluctuations are about two times larger than for a single cylinder the total kinetic energy level above the second cylinder is larger than above a single cylinder. Physical parameters in analysis of natural convection flow through vertical pipe in this study we found that outlet temperature, outlet velocity that is going to be increased as tube length is increased as tube length is increased but as diameter of pipe is increased outlet temperature is increased but velocity is decreased.

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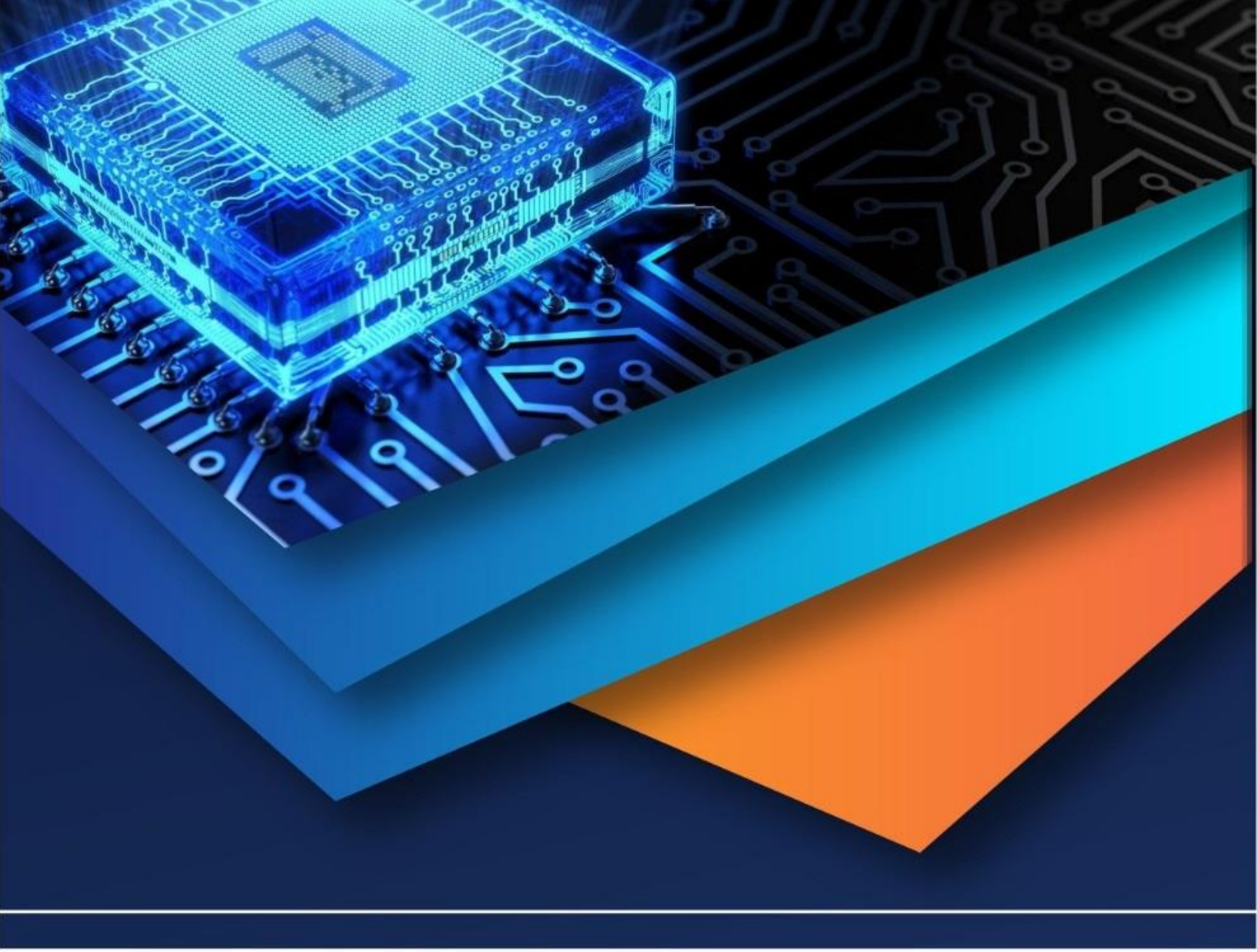

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