ABSTRACT

The present investigation aims to study experimentally and theoretically the problem of mixed convection heat transfer in a fully developed region of the uniform heated inclined cylinder for a laminar air flow.

The influence of Reynolds number and heat flux on the temperature and velocity profiles, and also on the temperature and local Nusselt number variations were theoretically investigated by means of numerical study for a fully developed upward air flow in the entrance region of an axial symmetric vertical cylinder. Whereas the governing equations were solved by a finite difference method and Gauss elimination technique in two directions (axial direction and radial direction).

The experimental part covered a wide range of heat flux and Reynolds number (heat flux varies from 152 W/m^2 to 812W/m^2, and Reynolds number varies from 518 to 2041) with different angles of cylinder inclination {0^0, 30°, 60°, and 90° for aiding flow and -30°, -60°, and -90° for opposing flow}. To achieve the hydrodynamically fully developed condition at the entrance region of the test section, a calming section made from aluminum with (L/D=22.2) is used for this purpose.

It was found from the experimental results that the surface temperature distribution along the cylinder in the horizontal position is lower than that in the inclined and vertical positions with mean approximated value of (12.6% for aiding flow case & 20.7% for opposing flow case), also the surface temperature distribution for aiding flow case is lower than that for opposing flow case with mean approximated value of 9.1%, and the local Nusselt number value increases as the Reynolds number increases, and the cylinder inclination decreases from the vertical position (both cases aiding and opposing flows) to the horizontal position with mean approximated value of 33% & 50% respectively, also the local Nusselt number value for the opposing flow is lower than that for the aiding flow with mean approximated value of 21.2% for the same Reynolds number and heat flux. For all positions, the average Nusselt number value increases as the average Rayliegh number and Reynolds number values increase with mean approximated value of 35%. In addition, the average Nusselt number value increases as the average Richardson number increases with the cylinder inclination decrease from the vertical position (both cases aiding and opposing flows) to the horizontal position. Empirical equations have been deduced for the average Nusselt number as a function of Rayliegh

number, and Reynolds number for all angles. Also, these equations performed as a function of Peclet number and Richardson number .

The experimental results for local Nusselt number variation were compared with other previous works and show similar trend and behavior. Also, the theoretical and the experimental results for local Nusselt number variations were compared between themselves and show similar trend and behavior.