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THE VISCOUS DISSIPATION EFFECTS ON THE MIXED CONVECTION BOUNDARY LAYER FLOW ON A HORIZONTAL CIRCULAR CYLINDER

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ABSTRACT. Present study consider the mathematical modeling for mixed convection boundary layer flow and heat transfer on a horizontal circular cylinder with viscous dissipation. The transformed partial differential equations are solved numerically by using an implicit finite-difference scheme known as the Keller-box method. Numerical solutions are obtained for the reduced Nusselt number, the local skin friction coefficient, the velocity and temperature profiles. The features of the flow characteristics for various values of the Prandtl number, Eckert number and mixed convection parameter are discussed. The results in this paper is original and important for the researchers working in the area of boundary layer flow and this can be used as reference and also as complement comparison purpose in future.
Keywords: Mixed Convection; Horizontal Circular Cylinder; Viscous Dissipation.

1. **Introduction.** Mixed convection actually is the combination of the free and the forced convection where mixed convection parameter λ take part as scalar to measure the influence of free and forced convection in a flow. Accordings to Pop and Ingham [1] and Kreith et al. [2], the forced convection is dominant when $\lambda \to 0$, while free convection take part as $\lambda \to \infty$. The application of mixed convection are widely used in engineering and industrial outputs for an example in engine and transmission cooling system such as cooling fins in car radiator, nuclear reactant power plant, airconditioner, refrigerator and many more. The geometry of the surface that are commonly used and studied by the researchers such as the cylinder surface, solid sphere, cone, stagnation region and stretching plate.
It is known that the momentum equation of forced convection boundary layer flow is first solved by Blasius [3]. The energy equation for this problem then solved by Fr&ssling [4]. It is worth to mention that, the constant wall temperature (CWT) is considered. Gebhart and Pera [5] done the experimental studies on long horizontal cylinders. The heat transfer of mixed convection on several type of fluid on various lengths of wires are reported. Merkin [6] solved the governing equations for the model of mixed convection on horizontal circular cylinder. The solution is obtained for $\Pr = 1$ and it is found that there exist a separation where there is no solution or the boundary layer equation are not valid after the separation point. Jain and Lohar [7] considered the unsteady case for this topic. The variations of mean Nusselt number with time are shown and discussed. Next, Nazar et al. [8] extended the works by Merkin [6] with micropolar fluid while Anwar et al. [9] considered viscoelastic fluid. Both problems are solved by using the Keller-box method. The point of separation for the boundary layer, effects of Prandtl number and mixed convection parameter are discussed in detail. Further, Salleh et al. [10] investigated this topic by considering the Newtonian heating as a boundary conditions. Other