Mathematical Model of Mixed Convection Boundary Layer Flow over a Horizontal Circular Cylinder Filled in a Jeffrey Fluid with Viscous Dissipation Effect

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Abstract

This paper delves into the problem of mixed convection boundary layer flow from a horizontal circular cylinder filled in a Jeffrey fluid with viscous dissipation effect. Both cases of cooled and heated cylinders are discussed. The governing equations which have been converted into a dimensionless form using the appropriate non-dimensional variables are solved numerically through the Keller-box method. A comparative study is performed and authentication of the present results with documented outcomes from formerly published works is excellently achieved. Tabular and graphical representations of the numerical results are executed for the specified distributions, considering the mixed convection parameter, Jeffrey fluid parameters and the Prandtl and Eckert numbers. Interestingly, boundary layer separation for mixed convection parameter happens for some positive (assisting flow) and negative (opposing flow) values. Strong assisting flow means the cylinder is heated, which causes the delay in boundary layer separation, whereas strong opposing flow means the cylinder is cooled, which conveys the separation point close to the lower stagnation point. Contradictory behaviours of both Jeffrey fluid parameters are observed over the velocity and temperature profiles together with the skin friction coefficient and Nusselt number. The increase of the Prandtl number leads to the decrement of the temperature profile, while the increase of the Eckert number results in the slight increment of the skin friction coefficient and decrement of the Nusselt number. Both velocity and temperature profiles of Eckert number show no effects at the lower stagnation point of the cylinder.

Keywords

Author Keywords: Boundary; horizontal circular cylinder; Jeffrey fluid; layer separation; viscous dissipation
KeyWords Plus: NON-NEWTONIAN FLUID; CONSTANT HEAT-FLUX; VISCOELASTIC FLUID; THERMAL-RADIATION; STRETCHING SHEET; POROUS-MEDIUM; NANOFLUID

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