Influence of viscous dissipation on the flow and heat transfer of a Jeffrey fluid towards horizontal circular cylinder with free convection: A numerical study

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Abstract

This paper focuses on the numerical solution of free convection boundary layer flow past a horizontal circular cylinder in non-Newtonian Jeffrey fluid. The impact of viscous dissipation is discussed. The non-dimensional variables and non-similar transformations are implemented to transform the dimensional partial differential equations into two nonlinear partial differential equations (PDEs). Then, the implicit, unconditionally stable and well-tested Keller-box method is used to solve the PDEs by adding an extra boundary condition at infinity. The impacts of emerging parameters such as ratio of relaxation to retardation times, Deborah number, Prandtl number and Eckert number towards the quantities of physical interest are deliberated through graphical representation. The critical point for Prandtl number and ratio of relaxation to retardation times are investigated to achieve the physically acceptable solutions. It appears from this study that a rise in ratio of relaxation to retardation times tends to boost the velocity profile while declining the temperature profile. The opposite trend of graph is observed for the Deborah number where an increase in Deborah number give rise to decrement in velocity profile but increment in temperature profile. For increasing values of the Eckert number, the skin friction coefficient is found to increase while the Nusselt number is decreased. This study also reveals that for different values of Eckert number, the non-Newtonian Jeffrey fluid pronounces an effective heat transfer rate in comparison to Newtonian fluid.

Keywords

Author Keywords: Non-Newtonian Jeffrey fluid; free convection; viscous dissipation effect; horizontal circular cylinder
KeyWords Plus: BOUNDARY-LAYER-FLOW; NATURAL-CONVECTION; STRETCHING SHEET; GENERATION; NANOFLUID; RADIATION

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