MHD Flow and Heat Transfer of a Micropolar Fluid Over a Nonlinear Stretching Surface With Variable Surface Heat Flux and Heat Generation

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An analysis has been carried out to study magnetohydrodynamic boundary layer flow and heat transfer of an electrically conducting micropolar fluid over a nonlinear stretching surface with variable wall heat flux in the presence of heat generation/absorption and a non-uniform transverse magnetic field. The governing system of partial differential equations is first transformed into a system of ordinary differential equations using similarity transformation. The transformed equations are solved numerically. Results for the dimensionless velocity, micro-rotation, and temperature profiles are displayed graphically delineating the effects of various parameters characterising the flow. The results show that the velocity profile decreases as the magnetic parameter and the velocity exponent increase, while it increases as the material parameter increases. The results show also that the temperature profile increases as the magnetic parameter, the velocity exponent, and the heat generation parameter increase. Furthermore, the temperature profile decreases as the material parameter, the heat absorption parameter, and the Prandtl number increase.

Une analyse a été réalisée pour étudier magnétohydrodynamique écoulement de couche limite et transfert de chaleur d'un conducteur électrique fluide micropolaire sur une surface s'étendant avec la chaleur paroi variable flux en présence de chaleur génération / absorption. Le système qui régit des équations aux dérivées partielles est d'abord transformé en un système de équations différentielles ordinaires en utilisant similitude de transformation. Les équations sont résolues numériquement. Résultats pour la vitesse sans dimension , micro-rotation et profils de température sont affichés graphique définissant les effets de divers paramètres caractérisant l'écoulement. Les résultats montrent que le profil de vitesse diminue à mesure que le champ magnétique paramètres et l'exposant de la vitesse augmentent , alors qu'il augmente à mesure que les augmentations de paramètres du matériau. L' résultats montrent également que le profil de température augmente à mesure que la paramètre magnétique, l'exposant de vitesse et la génération de chaleur paramètre augmentent. En outre, le profil de température diminue à mesure que la paramètre du matériau, la chaleur paramètre d'absorption et le nombre de Prandtl augmentent.

Keywords: MHD, micropolar fluids, heat generation/absorption, variable heat flux, nonlinear stretching surface

INTRODUCTION

The theory of micropolar fluids is expected to provide a mathematical model, which can be used to describe the behaviour of non-Newtonian fluids in many practical applications. These applications include the mathematical model for polymeric fluids, colloidal fluids, real fluids with suspensions, liquid crystal, animal blood, and exotic lubricants, as examples, for which the classical Navier–Stokes theory is inadequate. The theory of micropolar and thermomicropolar fluids was introduced by Eringen (1966, 1972). The micropolar fluid theory has been applied extensively for studying many complicated fluid motions which studied by many authors such as Kline and Allen (1969); Ariman (1971); Lee and Eringen (1971a,b); Ariman et al. (1973, 1974); Akay and Kaye (1985); Misra et al. (1992); Lok et al. (2006); and Ishak et al. (2006a, 2007). On the other hand the study of magnetohydrodynamic flow of an electrically conducting fluid over a stretching sheet has gained considerable interest because of its applications in industry. For example in the extrusion of a polymer sheet from a die, the sheet is sometimes stretched. During this process, the properties of the final products depend considerably on the rate of cooling. By drawing such sheet in an electrically conducting fluid subjected to a magnetic field, the rate of cooling can be controlled and the final product can be obtained with desired characteristics. Crane (1970) presented an exact similarity solution in closed analytical form for the laminar boundary layer flow of an incompressible, steady viscous fluid over a stretching surface with a velocity varying linearly

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