Thermal Radiation Effect on Unsteady MHD Free Convection Flow Past a Vertical Plate with Temperature-dependent Viscosity

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This article investigates the influence of radiation and temperature-dependent viscosity on the problem of unsteady MHD flow and heat transfer of an electrically conducting fluid past an infinite vertical porous plate taking into account the effect of viscous dissipation. The governing equations are converted into a system of nonlinear ordinary differential equations via a local similarity parameter which is taken as a function of time. The resulting system of coupled nonlinear ordinary differential equations is solved numerically using the fourth order Runge–Kutta integration scheme with the shooting method. The numerical results for the velocity and the temperature are displayed graphically showing the effects of various parameters. The results show that increasing the Eckert number and decreasing the viscosity of air leads to a rise in the velocity, while increasing in the magnetic or the radiation parameters is associated with a decrease in the velocity. Also, an increase in the Eckert number leads to an increase in the temperature, whereas an increase in radiation parameter leads to a decrease in the temperature.

On a étudié dans cet article l'influence de la radiation et de la viscosité thermodépendante sur le problème d'écoulement MHD instable et le transfert de chaleur dans le cas d'un fluide électriquement conducteur à travers un plateau poreux vertical infini en tenant compte de l'effet de la dissipation visqueuse. Les équations gouvernantes ont été converties en un système d'équations différentielles ordinaires non linéaires grâce à un paramètre de similarité local considéré comme variable dans le temps. Le système d'équations différentielles ordinaires non linéaires couplées ainsi obtenu a été résolu numériquement à l'aide d'un schéma d'intégration de Runge–Kutta de quatrième ordre par la méthode de tir. Les résultats numériques de vitesse et de température sont illustrés par des graphiques montrant les effets des divers paramètres. Ces résultats montrent que l'augmentation du nombre d'Eckert et la diminution de la viscosité de l'air conduisent à une augmentation de la vitesse, tandis que l'augmentation des paramètres magnétiques ou de radiation est associée à une diminution de la vitesse. De même, une augmentation du nombre d'Eckert conduit à une augmentation de la température, tandis qu'une augmentation du paramètre de radiation mène à une diminution de la température.

Keywords: MHD unsteady flow, free convection, radiation, variable viscosity, viscous dissipation

INTRODUCTION

The problem of MHD free convection flow of an electrically conducting fluid past a vertical plate under the influence of a magnetic field has many applications in different areas, such as astrophysics, geophysics and engineering as shown by Cramer and Pai (1973). From the technological point of view, MHD free-convection flows have also great significance for the applications in the fields of stellar and planetary magnetospheres, aeronautics chemical engineering, and electronics. The effect of magnetic field on free convection flow of electrically conducting fluids past a plate studied by many authors such as Gupta (1962), Singh and Cowling (1963), Soundalgekar (1972), Raptis et al. (1981), Sacheti et al. (1994), Sattar and Alam (1995), Sharma and Pankaj (1995), Sreekanth et al. (2001), Singh et al. (2003), Sahoo et al. (2003), and Alam et al. (2007a,b).

In all of the above-mentioned studies the viscosity of the fluid was assumed to be constant. However, it is known that the physical property may change significantly with temperature. To accurately predict the flow behaviour, it is necessary to take into account this variation of viscosity with temperature. The effects

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