Discussion: "Magnetohydrodynamic Flow Past a Vertical Plate With Radiative Heat Transfer" (Shateyi, S., Sibanda, P., and Motsa, S. S., 2007, ASME J. Heat Transfer, 129, pp. 1708–1713)

Asterios Pantokratoras
School of Engineering,
Democritus University of Thrace,
67100 Xanthi, Greece
e-mail: apantokr@civil.duth.gr

In the above paper (Shateyi et al. [1]) the authors treat the boundary layer flow along a vertical semi-infinite, isothermal plate of an electrically conducting fluid. The flow is influenced by a horizontal magnetic field taking into account the Hall effects. In the energy equation the radiation has been included. The boundary layer equations are transformed from the x, y coordinates into ξ, η and subsequently are solved numerically using the Blottner method. However, there are some significant errors in the above paper which are presented below:

The momentum equations used by the authors are (Eqs. 1(b) and 1(c) in their paper)

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\nu\frac{\partial^2 u}{\partial y^2}+g\beta(T-T_\infty)-\frac{\sigma B_0{}^2}{\rho(1+m^2)}(mu+w) \tag{1}$$

$$u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}=\nu\frac{\partial^2 w}{\partial y^2}-\frac{\sigma B_0{}^2}{\rho(1+m^2)}(mw-u) \tag{2}$$

where u, v, and w are the velocity components in x, y, and z directions, T is the fluid temperature, β is the volumetric expansion coefficient, ν is the fluid kinematic viscosity, ρ is the fluid density, σ is the fluid electrical conductivity, B_0 is the magnetic induction and m is the Hall parameter. However, the last terms in the above two equations are wrong and the correct forms of Eqs. (1) and (2) are as follows (Hossain and Arbad [2], Pop and Watanabe [3], Saha et al. [4])

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\nu\frac{\partial^2 u}{\partial y^2}+g\beta(T-T_\infty)-\frac{\sigma B_0{}^2}{\rho(1+m^2)}(u+mw) \tag{3}$$

$$u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}=\nu\frac{\partial^2 w}{\partial y^2}-\frac{\sigma B_0{}^2}{\rho(1+m^2)}(w-mu) \tag{4}$$

Taking into account that the Hall parameter m has been varied between 0.1 and 5 in the above work it is clear that the presented results and the conclusions are wrong.

Except that, there is a serious problem with some figures. The characteristics of the variation of velocity, temperature or any other substance transported inside a boundary layer are well established and known from 1950. Velocity and temperature profiles approach the ambient fluid conditions asymptotically. Asymptotically means that the velocity and temperature gradient at large distance from the plate is zero. Some velocity and temperature profiles that approach the ambient conditions correctly (asymptotically) in a boundary layer flow are shown, for example, on p. 72 by Jaluria [5]. However, this does not happen in the above work. One temperature profile in Fig. 2(a), all temperature profiles in Fig. 4(b), two temperature profiles in Fig. 5(a), one temperature profile in Fig. 5(b), two temperature profiles in Fig. 6(a), and two temperature profiles in Fig. 8(b) do not approach the horizontal axis asymptotically. Especially, the profiles in Fig. 4(b) are almost straight lines and such profiles do not exist in boundary layer flow. The above-mentioned profiles are truncated due to a small calculation domain used. The calculation domain was not sufficient to capture the real shape of all profiles and a wider calculation domain should be used. This is an error made frequently in the literature (see Pantokratoras [6]).

It is known in magnetohydrodynamics that the free convection along a vertical, isothermal plate under the action of a horizontal magnetic field with constant induction does not admit similarity solution. This is also mentioned in the above work (p. 1709). In a nonsimilar problem, like the present one, the velocity and temperature changes along the plate. However, this does not happen in the present problem. Although the transformed equations (5) are functions of the streamwise coordinate ξ, none of the figures contain any ξ. To what distance ξ correspond the presented profiles? No information is given.

Finally the captions in Figs. 6–8 are wrong.

References

[1] Shateyi, P., Sibanda, P., and Motsa, S. S., 2007, "Magnetohydrodynamic Flow Past a Vertical Plate With Radiative Heat Transfer," ASME J. Heat Transfer, **129**, pp. 1708–1713.
[2] Hossain, M. A., and Arbad, O., 1988, "A Numerical Study of the Unsteady MHD Free Convection With Hall Current," Astrophys. Space Sci., **141**, pp. 281–291.
[3] Pop, I., and Watanabe, T., 1994, "Hall Effects on Magnetohydrodynamic Free Convection About a Semi-Infinite Vertical Flat Plate," Int. J. Eng. Sci., **32**, pp. 1903–1994.
[4] Saha, L. K., Hossain, M. A., and Gorla, R. S. R., 2007, "Effect of Hall Current on the MHD Laminar Natural Convection Flow From a Vertical Permeable Flat Plate With Uniform Surface Temperature," Int. J. Therm. Sci., **46**, pp. 790–801.
[5] Jaluria, Y., 1980, *Natural Convection Heat and Mass Transfer*, Pergamon Press, Oxford.
[6] Pantokratoras, A., 2007, "A Common Error Made in Investigation of Boundary Layer Flows," Appl. Math. Model. (in press).

Manuscript received February 21, 2008; final manuscript received May 16, 2008; published online January 5, 2009. Review conducted by Gautam Biswas.

