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Comment on FLUCTUATING HYDRO-MAGNETIC NATURAL CONVECTION FLOW PAST A MAGNETIZED VERTICAL SURFACE IN THE PRESENCE OF THERMAL RADIATION paper by M. Ashraf, S. Asghar, and M. A. Hossain

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by

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In the present comment, we point out the error found in the above referenced paper.

Key words: *magnetohydrodynamics, Induced magnetic field, radiation, magnetic Prandtl number*

In the paper (Ashraf *et al*., [1]), the fluctuating hydro-magnetic natural convection flow of electrically conducting viscous incompressible and optically thick fluid past a magnetized vertical surface radiative flux by using finite difference method and perturbation technique has been studied. The work is interesting but has serious disadvantage which will be analyzed here.

An important new thing in this work is the assumption that, except for the applied external uniform magnetic field, the electrically conducting fluid induces a new magnetic field. However, the importance of the induced magnetic field depends on the magnetic Reynolds number which is defined as [2]:

$$\mathrm{R_m} = \mu\sigma u l \tag{1}$$

where μ is the magnetic permeability, σ – the fluid electrical conductivity, u – the characteristic velocity of the flow, and l – the characteristic length scale. When the magnetic Reynolds number is much smaller than unity ($\mathrm{R_m} \ll 1$) the induced magnetic field is negligible and the imposed external magnetic field is unaffected by the moving conducting fluid [2]. In most laboratory experiments or industrial processes $\mathrm{R_m}$ is very low, usually less than 10^{-2} [3]. In contrast, when the magnetic Reynolds number is equal to or greater than unity ($\mathrm{R_m} \gg 1$) the induced magnetic field is important and should be taken into account. Indeed certain applications, such as advanced schemes for the control of magneto-gas dynamic flows around hypersonic vehicles, involve values of $\mathrm{R_m}$ of the order 1 to 10 [3].

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In the above work, the authors took into account the induced magnetic field without any reference to the magnetic Reynolds number which is the suitable criterion.

The presented results are for Prandtl number (Pr) = 0.71, which is corresponding to air at 20 °C. Let us calculate here R_m for Prandtl number (Pr) = 0.71. Air electrical conductivity at 20 °C is $3 \cdot 10^{-15}$ to $8 \cdot 10^{-15}/\Omega m$ [4], whereas air magnetic permeability is $1.257 \cdot 10^{-6}$ Vs/Am, [5]. For a typical velocity u =1.0 m/s and a typical length scale l = 0.1 m, the magnetic Reynolds number (dimensionless) is:

$$R_m \cong 3.8 \cdot 10^{-22} \tag{2}$$

Instead of using the above magnetic Reynolds number, the authors used the parameter Pm named as Magnetic Prandtl number (dimensionless):

$$\mathrm{Pm} = \frac{\nu}{\gamma} = \sigma\mu\nu \tag{3}$$

where σ is the fluid electrical conductivity, μ – the magnetic permeability, and ν – the fluid kinematic viscosity. The results are for Prandtl number (Pr) = 0.71 and magnetic Prandtl numbers (Pm) = 0.1, 0.3, 0.5, 0.7, and 0.8.

Let us calculate the Pm for air at 20 °C. The air kinematic viscosity at 20 °C is $1.827 \cdot 10^{-5}$ m^2/s [6] and we have:

$$\mathrm{Pm} \cong 6.9 \cdot 10^{-6} \tag{4}$$

In conclusion, for the fluid (air, Pr = 0.71 at 20 °C), the magnetic Reynolds number as well as the magnetic Prandtl number is very small and completely different from the values used in the results. Air cannot induce a significant magnetic field and the results presented in the above paper do not have any practical value.

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