Proc. Indian Acad. Sci. (Math. Sci.) Vol. 117, No. 2, May 2007, pp. 283–285.

Corrigendum to: Inverse solutions for a second-grade fluid for porous medium channel and Hall current effects by Muhammad R Mohyuddin and Ehsan Ellahi Ashraf

MUHAMMAD R MOHYUDDIN[a] and AKHLAQ AHMAD[b]

[a]Department of Science in Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, 53100 Kuala Lumpur
[b]Department of Mathematics, Quaid-i-Azam University 45320, Islamabad 44000, Pakistan
E-mail: raheel@iiu.edu.my

MS received 27 June 2005; revised 6 November 2006

The main purpose of this Corrigendum is to make corrections/changes in Mohyuddin *et al* [2]. Reference [2] has the following errors:

1. The Hall effects in two-dimensional flow cannot be added, as was done in [2].
2. Darcy's law for unsteady flow through a porous medium is given incorrectly in [2].

These have been rectified as follows: Though the MHD effects in two-dimensional flow can be included as indicated in [1], we have not done it in this Corrigendum. References [3–5] have been followed to treat the porous medium correctly. Thus, the problem being treated is the same as that of [2], but without Hall effects.

Thus, eq. (2.19) in terms of the stream function modifies to

$$\rho\left[\frac{\partial}{\partial t}\nabla^2\psi - \{\psi, \nabla^2\psi\}\right] = \left(\mu + \alpha_1\frac{\partial}{\partial t}\right)\nabla^4\psi - \alpha_1\{\psi, \nabla^4\psi\} - \frac{\phi}{k}\left(\mu + \alpha_1\frac{\partial}{\partial t}\right)\nabla^2\psi. \tag{1}$$

Equation (1) is obtained by using a relation between the pressure gradient and the velocity of a second-grade fluid in a porous medium, given by [5]

$$\nabla p = -\frac{1}{k}\left(\mu + \alpha_1\frac{\partial}{\partial t}\right)\mathbf{V}_{\rm d}, \tag{2}$$

where $\mathbf{V}_{\rm d}$ is the Darcian velocity which is described in terms of the usual velocity $\mathbf{V}$ as

$$\mathbf{V}_{\rm d} = \mathbf{V}\phi, \tag{3}$$

where ϕ is the porosity of the porous medium. Consequently, we can equate the Darcy's resistance $\mathbf{r}$ and the pressure gradient ∇p, following [4, 5] i.e.

$$\mathbf{r} = -\frac{\phi}{k}\left(\mu + \alpha_1\frac{\partial}{\partial t}\right)\mathbf{V}. \tag{4}$$

The corresponding solutions in §3 of [2] and their respective graphs should be replaced accordingly. For example, the solution of subsection 3.1 for $\psi(x, y) = \xi(x)+\eta(y)$ in terms of the stream function, velocity field and pressure distribution (for $b = a$, $\rho \neq \alpha_1(a^2+b^2)$) is given by

$$\psi(x, y) = \frac{(y-x)}{\rho - \alpha_1 a^2}\left[\mu a - \frac{1}{a}\frac{\mu\phi}{k}\right] + B\mathrm{e}^{ax} + D\mathrm{e}^{ay}, \tag{5}$$

$$u = \frac{1}{\rho - \alpha_1 a^2}\left[\mu a - \frac{1}{a}\frac{\mu\phi}{k}\right] + Da\mathrm{e}^{ay}, \tag{6}$$

$$v = \frac{1}{\rho - \alpha_1 a^2}\left[\mu a - \frac{1}{a}\frac{\mu\phi}{k}\right] - Ba\mathrm{e}^{ax}, \tag{7}$$

$$p = p_0 - \rho\bar{a}^2 - \mu B a^3 y\mathrm{e}^{ax} + (\rho - \alpha_1 a^2)[a^2 B y\mathrm{e}^{ax} + a^2 DB\mathrm{e}^{a(x+y)}] + \alpha_1[B^2 a^4 \mathrm{e}^{2ax} + D^2 a^4 \mathrm{e}^{2ay} - DBa^4\mathrm{e}^{a(x+y)}]. \tag{8}$$

Whereas the streamline for $\psi = \Omega_1$ is given by the following functional form (by using *Mathematica* 5.0)

$$y = \frac{-B\mathrm{e}^{ax} + x\varepsilon + \Omega_1}{\varepsilon} - \frac{1}{a}\mathrm{ProductLog}\left[\frac{Da}{\varepsilon}\mathrm{e}^{a(-B\mathrm{e}^{ax}+x\varepsilon+\Omega_1)/\varepsilon}\right], \tag{9}$$

where

$$\varepsilon = \frac{1}{1-\Lambda a^2}\left[\nu a - \frac{1}{a}\frac{\nu\phi}{k}\right], \quad \bar{a} = \frac{1}{\rho - \alpha_1 a^2}\left[\mu a - \frac{1}{a}\frac{\mu\phi}{k}\right], \tag{10}$$

and $\nu = \mu/\rho$ is the kinematic viscosity, $\Lambda = \alpha_1/\rho$ is the second-grade parameter, and ProductLog[z] gives the principal solution for w in $z = w\mathrm{e}^w$.

Streamlines are shown in figure 1 for $B = D = a = 1$, $\mu/\rho = 0.5$, $\alpha_1/\rho = 0.1$, $k = 0.1$, $\phi = 0.5$ and $\psi = 15, 20, 25, 30, 40$.

Consequently, the solutions for all other cases of [2] will be changed accordingly.

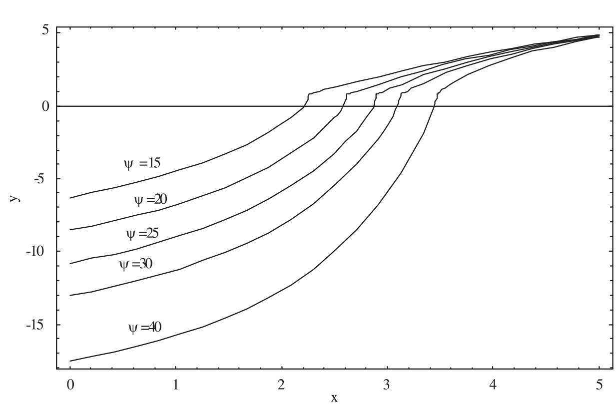

Figure 1.

References

[1] Chandna O P and Oku-Okpong E O, Unsteady second grade aligned MHD fluid flow, *Acta Mechanica*, **107** (2004) 1–18

[2] Mohyuddin Muhammad R and Ashraf Ehsan Ellahi, Inverse solutions for a second-grade fluid for a porous medium channel and Hall current effects, *Proc. Indian Acad. Sci.* **114(1)** (2004) 79–96

[3] Mohyuddin Muhammad R, Stokes' problem for an oscillating plate in a porous medium with Hall effects, *J. Porous Media* **9(3)** (2006) 195–205

[4] Nield D A and Adrian B, Convection in porous media, 2nd ed. (Berlin: Springer) (1999)

[5] Tan Wencheng, Stokes' first problem for an Oldroyd-B fluid in a porous half space, *Phys. Fluids* **17** (2005) 023101