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

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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
\[ \rho \left[ \frac{\partial}{\partial t} \nabla^2 \psi - \{ \psi, \nabla^2 \psi \} \right] = \left( \mu + \alpha_1 \frac{\partial}{\partial t} \right) \nabla^4 \psi - \alpha_1 \{ \psi, \nabla^4 \psi \} - \frac{\phi}{k} \left( \mu + \alpha_1 \frac{\partial}{\partial t} \right) \nabla^2 \psi. \] (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]
\[ \nabla p = -\frac{1}{k} \left( \mu + \alpha_1 \frac{\partial}{\partial t} \right) V_d, \] (2)
where \( V_d \) is the Darcian velocity which is described in terms of the usual velocity \( V \) as
\[ V_d = V \phi, \] (3)
where \( \phi \) is the porosity of the porous medium. Consequently, we can equate the Darcy’s resistance \( r \) and the pressure gradient \( \nabla p \), following [4, 5] i.e.
\[ r = -\frac{\phi}{k} \left( \mu + \alpha_1 \frac{\partial}{\partial t} \right) V. \] (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

\[
\psi(x, y) = \frac{(y - x)}{\rho - \alpha_1a^2} \left[ \mu a - \frac{1}{a} \frac{\mu \phi}{k} \right] + Be^{ax} + De^{ay},
\]

\[
u = \frac{1}{\rho - \alpha_1a^2} \left[ \mu a - \frac{1}{a} \frac{\mu \phi}{k} \right] + Dae^{ay}.
\]

\[
v = \frac{1}{\rho - \alpha_1a^2} \left[ \mu a - \frac{1}{a} \frac{\mu \phi}{k} \right] - Bae^{ax}.
\]

\[
p = p_0 - \rho a^2 - \mu Ba^3ye^{ax} + (\rho - \alpha_1a^2)[a^2Bye^{ax} + a^2DBe^{(x+y)}]
\]

\[
+ \alpha_1[B^2a^4e^{2ax} + D^2a^4e^{2ay} - DBa^4e^{a(x+y)}].
\]

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

\[
y = \frac{-Be^{ax} + x \epsilon + \Omega_1}{\epsilon} - \frac{1}{a} \text{ProductLog} \left[ \frac{Da}{\epsilon} e^{a(-Be^{ax} + x \epsilon + \Omega_1)/\epsilon} \right],
\]

where

\[
\epsilon = \frac{1}{1 - \Lambda a^2} \left[ \nu a - \frac{1}{a} \frac{\nu \phi}{k} \right], \quad \tilde{a} = \frac{1}{\rho - \alpha_1a^2} \left[ \mu a - \frac{1}{a} \frac{\mu \phi}{k} \right].
\]

and \( v = \mu/\rho \) is the kinematic viscosity, \( \Lambda = \alpha_1/\rho \) is the second-grade parameter, and ProductLog[z] gives the principal solution for \( w \) in \( z = we^w \).

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


