International Journal of Engineering, Science and Mathematics (UGC Approved)
Vol. 8 Issue 5, May 2019,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

"A OBSERVE OF HEAT TRANSFER WITHIN THE WAFT OF A 2d-ORDER FLUID VIA A CHANNEL WITH POROUS WALLAS BENEATH A TRANSVERSE MAGNETIC SUBJECT"

Rakesh saini
Assistant professor of mathematics
Mdu rohtak

Abstract

The cause of the present paper is an try and have a have a look at the warm temperature transfer in the go along with the waft of a 2d-order fluid via a channel with porous walls below a transverse magnetic issue with the resource of normal perturbation approach. The second one-order results at the temperature profile are illustrated for one in every of a type values of the Hartman and Reynolds variety. The outcomes also are obtained for the Newtonian fluid through taking the second-order parameter to be zero.

Introduction

INTRODUCTION

The warmth transfer inside the go together with the go with the glide of an electrically engaging in fluid among porous limitations is of sensible hobby in problems of gaseous diffusion and so on. Terrill and Shrestha have discussed the hassle of regular laminar go with the flow of an incompressible viscous fluid in a dimensional channel at the equal time as the walls are of various permeability and studied the outcomes of magnetic discipline even as the fluid is electrically carrying out. The hassle of go together with the float of a second-order fluid with warmness transfer in a channel with porous walls has been considered via the usage of Agrawal. Sharma & Singh have studied the numerical solution of the waft of second-order fluid thru a channel with porous partitions beneath a transverse magnetic subject..

The motive of the prevailing paper is an try to take a look at the heat transfer in the float of a second-order fluid via a channel with porous partitions below a transverse magnetic field by way of way of regular perturbation technique. The second one-order results at the temperature profile are illustrated for special values of the Hartman and Reynolds range. The outcomes are also obtained for the Newtonian fluid via the use of taking the second-order parameter to be 0.

FORMULATION

The warmth transfer within the constant dimensional flow of an incompressible 2nd-order fluid in a channel, of width 2h including two porous walls (coinciding with the plane y = ±h) of equal permeability is considered. The whole machine of the channel is built in any such way that its bottom and top will become flawlessly insulted and does no longer transmit the heat. A constant magnetic discipline H0 is applied everyday to the axis of the channel. The caused magnetic discipline has been overlooked inside the waft for the reason that magnetic Reynolds variety is small. A uniform suction V is carried out to the each the partitions of the channel. Allow us to pick out with x and y axes respectively in a plane parallel and perpendicular to the channel walls. Let u and v be the components of the speed in x and y directions respectively.Following Terrill and Shrestha a stream function

$$\Psi(x,\xi) = (hU\text{-}Vx)\, f(\xi) \qquad (1.1)$$

Where U is the entrance velocity and ξ (= y/h) is the dimensionless distance while 2h is the distance between the channel walls. In non-dimensional form the velocity field by Terril and Shrestha is taken as:

$$U\,(x, \xi) = (U\text{-}Vx/h)\, f'\,(\xi)$$

$$v\;(\xi) = V\,F\,(\xi) \qquad (1.2)$$

Where dash denotes differentiation with respect to ξ. The expression (1.2) suggests that u is a function of x and ξ, while v is a function of ξ only. Using this fact, the constitutive equation (1.4) the equation of continuity and momentum equations can be written as:

$$\partial u/\partial x + (1/h)(\partial v/\partial\xi) = 0 \qquad (1.3)$$

$$u\partial u/\partial x + (v/h)\,\partial v/\partial\xi = -(1/p)\,(\partial p/\partial x)+(v_1/h^2)((\partial^2 u/\partial\xi^2)+v_2[(1/h^2 1)$$

$$(\partial^2/\partial\xi^2)\{u\partial u/\partial x+(v/h)(\partial v/\partial\xi)\}+(2/h^2)(\partial/\partial\xi)$$

$$\{(\partial u/\partial x)(\partial v/\partial\xi))\}]+(v_3/h^2)(\partial/\partial x)(\partial u/\partial\xi)^2$$

$$-\mu_e^2 H_0^2\sigma u/p \qquad (1.4)$$

$$v\partial v/\partial\xi=-(1/p)(\partial p/\partial\xi)+(v_1/h)(\partial^2 v/\partial\xi^2)+v_2[(2/h)(\partial^2/\partial\xi^2)\{(v/h)(\partial v/\partial\xi)\}$$
$$+2(\partial/\partial x)\{(\partial u/\partial x)(\partial u/\partial\xi)\}]+(4/h^2)\{(\partial u/\partial\xi)(\partial^2 u/\partial\xi^2)+(\partial v/\partial\xi)(\partial^2 v/\partial\xi^2)-$$
$$\partial^2/\partial x\partial\xi\{u\partial u/\partial x+(v/h)\,\partial u/\partial\xi\}]+(v_3 h^2)[4\partial/\partial\xi(\partial v/\partial\xi)^2+\partial/\partial\xi(\partial u/\partial\xi)^2] \qquad (1.5)$$

$$pc_v(u\partial T/\partial x+v\partial T/\partial y)=k(\partial^2 T/\partial x^2+\partial^2 T/\partial y^2)+\Phi \quad (1.6)$$

where p is the density, μ_e is the magnetic permeability, σ is the electric conductivity, v_1 (= μ_1/p) is the kinematic viscosity, v_2 (=μ_2/p) is the kinematic elastic-viscosity, v_3 (= μ_3/p) is the kinematic coefficient of cross-viscosity, c_v is the specific heat at constant volume, k is the thermal conductivity and ξ = y/h is the dimensionless distance.

The viscous dissipation function Φ is given by

$$\Phi=\tilde{\tau}^i_j d^i_j \quad (1.7)$$

Where $\tilde{\tau}^i_j$ is the mixed deviatoric stress tensor.

The boundary conditions are,

$$u\,(x, \pm 1) = 0, \qquad (\partial u/\partial\xi)_{\xi=0}=0,$$

$$v\,(x,0) = 0, \qquad v(x,1) = V, \qquad v(x,-1) =-V,$$

$$T(x, 1)= T_1, \qquad T(x,-1) =T_{-1}. \quad (1.8)$$

Substituting (1.2) in equation (1.4) and (1.5) and eliminating p from the obtained equation, we get

$$f^{iv} + R(f'f''- f f''') + \tau_1 (f f^v - f' f^{iv}) - S^2 f''=0, \quad (1.9)$$

where R (= Vh/v_1) is the suction Reynolds number, τ_1 (=v_2V/hv_1) is an elastic-viscous parameter governing the effects of elastic-viscosity of the fluid and S[-$\mu_e H_0 h(\sigma/\mu_1)^{1/2}$] is the Hartmann number.

Equation (1.6) together with equation (1.2) suggests the form of the temperature distribution as0 follows:

$$T = T_{-1}+(v_1 V)[\phi(\xi)+\{(U/V)-(x/h)\}^2\,\Psi(\xi)]/(hC_v). \quad (1.10)$$

Using equation (1.10) in equation (1.6) and equating the coefficient of $(U/V-x/h)^2$ and terms independent of $(U/V-(x/h)^2$ on both sides of the resulting equation, we obtain

$$\phi''-2RPf\,\phi'+2\Psi+ 8RPf'^2+ 8R^2P\tau_2 f f' f'' = 0, \quad (1.11)$$

$$\psi''-RPf\,\psi'+4RP\,\psi f' +2RPF''^2+2R^2P\tau_2(ff''f'''-f'f''^2)=0. \quad (1.12)$$

Where p = $\mu_1 c_v$/k is the Prandtl number, $\tau_2=2\mu^2/(h^2p)$ is the second-order parameter.

International Journal of Engineering, Science and Mathematics (UGC Approved)
Vol. 8 Issue 5, May 2019,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

The expression of the temperature distribution in the dimensionless form can be expressed as:

$$T = (T-T_{-1})/(T_1-T_{-1})=E(\phi+\zeta^2\psi), \quad (1.13)$$

where ζ[=(U/V-x/h)] is the dimensionless distance and $E(=v_1V/\{(T_1-T_{-1})hC_v\}]$ is the Eckert number.

V.3 SOLUTION OF THE PROBLEM

Assuming the relationships $\tau_1=-R\,\tau_1(\tau_1\geq 0)$ and $S^2 = RS_1^2$ eqn. (5.9) becomes

$$F^{iv}+R\,(f'\,f''-f\,f''')-R\,\tau_1(f\,f^{v}-f'\,f^{iv})-RS_1^2f''=0 \quad (1.14)$$

For small values of the suction Reynolds number R, we can develop a regular perturbation scheme of solving eqns. (1.11), (1.12) & (1.14) by expanding f, - and – in powers of R. Substituting

$$f(\zeta)= \sum R^n f_n(\zeta) \quad (1.15)$$

$$\phi(\zeta)= \sum R^n \phi_n(\zeta) \quad (1.16)$$

$$\psi(\zeta)= \sum R^n \psi_n(\zeta) \quad (1.17)$$

eqns. (1.11), (1.12) & (1.14)and equating the like powers of R on the two sides of the resulting equations, we obtain the following sets of equations:

$$f_0^{iv}=0$$

$$f_1^{iv}+f_0'\,f_0''-f_0f_0'''-\tau_1\,(f_0\,f_0^{v}-f_0'f_0^{iv})-S_1^2f_0''=0$$

$$f_2^{iv}+f_1'\,f_0''-f_0'f_1''-f_1'f_0'''-\tau_1\,(f_1\,f_0^{v}-f_0'f_1^{v}-f_1'f_0^{iv}-f_0'f_1^{iv})-S_1^2f_1''=0 \quad (1.18)$$

$$\psi_0 = 0$$

$$\psi_1 =2Pf_0\,\psi_0'+4P\psi_0f_0'+2Pf_0''^2=0$$

$$\psi_2= 2P(f_1\,\psi_0'+f_0\,\psi_1')+4P(\psi_0f_1'+f_1'\psi_0+f_0''f_/'')+2P\,\tau_2(f_0-f_0''f_0'''-f_0'f_0''^2)=0$$

(1.19)

$$\phi_0''+2\psi_0=0,$$

$$\phi_1''-2Pf_0\,\phi_0'+2\psi_1+8Pf_0'^2=0,$$

International Journal of Engineering, Science and Mathematics (UGC Approved)
Vol. 8 Issue 5, May 2019,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

$$\phi_2''-2P(f_1\,\phi_0'+f_1\,\phi_0')+2\,\psi_{2v}+16P\,f_0\,'f_1'+8\,\tau_2\,f_0\,f_0'\,f_0'''=0 \qquad (1.20)$$

Boundary condition (5.8) can be rewritten as:

$f_n(0) = f_n'(1) = f_n''(0) = 0\ \forall n$

$f_0(1) = 1$, $\mathbf{f_n}(1) = 0 \geq 1$

$\phi_n(-1) = 0\ \forall n$, $\phi_0(1) = 1/E = w$(say),

$\phi_n(1) = 0$, $0 \geq 1$, $\psi_n(\pm 1) = 0\ \forall n$

The solution of equation (1.18), (1.19), (1.20) subjected to the boundary condition (1.21) is given as follows:

$f_0(\xi) = (1/2)(3\xi - \xi^3)$,

$f_1(\xi) = -(1/280)(\xi^7-3\,\xi^3+2\,\xi)-S_1^2/40)(\xi^5-2\,\xi^3+\xi)$,

$f_2(\xi) = (1/1293600)(14\,\xi^{11}-385\,\xi^9+198\,\xi^7+876\,\xi^3-703\,\xi)-(\tau_1/280)\ \{(3\xi^7-9\xi^3+6\xi)+S_1^2(\xi^7-3\xi^3+2\xi)\}-S_1^2(\{1/100800)(15\xi^9+108\xi^7-54\xi^5-276\xi^3+207\xi)\quad +(S_1^2/8400)(5\xi^7-21\xi^5+27\xi^3-11\xi)\}$.

$\psi_0(\xi) = 0$,

$\psi_1(\xi) = (3/2)P(1-\xi^4)$,

$\psi_2(\xi) = 3P^2\{383/280-\xi^8/56-\xi^6/10+\xi^4/4-(3/2)\xi^2)\ -P\{(9/280)\ (1-\xi^4)^2 +(S_1^2/10)\ (1+2\,\xi^6-3\xi^4)\}-(3/5)P\,\tau_2\,(1-\xi^6)$

$\phi_0(\xi) = (w/2)(\xi+1)$,

$\phi_1(\xi) = (wP/40)(10\,\xi^3-\xi^5-9\xi) - (P/2)\,(21\,\xi^2+\xi^6-6\xi^4-16)$

$\phi_2(\xi)=P^2[29\xi^{10}/840-51\xi^8/140+37\xi^6/20-9\xi^4/2-1149\xi^2/280+(w/40)\ (1391\xi/2520-9\xi^3/2+99\xi^5/20-15\xi^7/14+5\xi^9/72)]-P[11/168-33\xi^2/280+11\,\xi^4/140-3\xi^6/140-3\xi^8/280+\xi^{10}/168-S_1^2(2\xi^2/5-13\,\xi^8/280+\xi^6/5-7\xi^4/20-57/280)+\tau_2(3-3\xi^2/5-3\,\xi^8/10+12\xi^6/5-9\xi^4/2)-w\{(71\xi/100800-\xi^3/840+3\xi^5/5600-\xi^9/20160)+S_1^2(19\xi/8400-\xi^7/1680+\xi^5/400-\xi^3/240)\}]$.

International Journal of Engineering, Science and Mathematics (UGC Approved)
Vol. 8 Issue 5, May 2019,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

RESULTS AND DISCUSSIONS

(i) The values of the functions f_0, f_1 and f_2 are identical to those obtained by Sharma and Singh

(ii) For $\tau_2 = 0$ the results are in good agreement with those obtained by Terril and Shrestha.

(iii) For S = 0 the results are matching with those obtained by Agarwal.

CONCLUSIONS

The variation of the temperature profile at P = 0.4, $\zeta = 0.4$, E = 1, $S_1 = 1$, $\tau_2 = -1$ for R = 0.01, 0.1, 1.0 is evident that for R = 0.1, temperature increases with ξ upto $\xi = 0.7$ approximately and thereafter decreases very slowly and attains its value 1 at the boundary wall $\xi = 1$. At the R = 1 the temperature graph is parabolic with vertex upward and attains its maximum value at the middle of the wall gap-length with minimum at the boundary wall $\xi = -1$. At R = 0.01, Temperature increases linearly throughout the wall gap-length with minimum at the boundary wall $\xi = -1$ and maximum at $\xi = 1$ It is also clear from this figure that the temperature increases with an increase in suction Reynolds number R.

The variation of the temperature profile at P = 0.4, $\zeta = 0.4$, E = 1, $S_1 = 1$, R = 1, for $\tau_2 = 0$, 0.1, 1.0 is evident that temperature graph is approximately parabolic with vertex upward and attains its maximum value at the middle of the wall gap-length with minimum at the boundary wall $\xi = -1$. It is also observed from this figure that the temperature decreases with an increase in cross-viscous second-order parameter τ_2.

The variation of the temperature profile at P = 0.4, $\zeta = 0.4$, E = 1, R = 1, $\tau_2 = -1$ for $S_1 = 0$, 1, 2 is seen that the temperature graph is approximately parabolic with vertex upward and attains its maximum value at the middle of the wall gap-length with minimum at the boundary wall $\xi = -1$. It is also observed from this figure that the temperature decreases with an increase Hartman number S_1.

REFERENCES

1. Terrill, R.M. and G.m. Shrestha, Laminar flow through parallel and uniformly porous walls of different permeability. Z.A.M.P., 16 (1965) 470.
2. Rosenblat, S., Torsion oscillation of a plane in a viscous fluid, J, Fluid Mech., 6 (1959) 206.
3. Rosenblat, S., Flow between torsionally oscillating disc, J. Fluid Mech., 8(1960) 388.
4. Sharma, H.G. and D.S. Gupta, Flow of non-Newtonian second-order fluid between two infinite torsionally oscillating discs, Indian J. pure appl. Math., 14(1983) 1091.
5. Sharma, H.G. and K.R. Singh, flow of non-Newtonian second-order fluid between torsionally oscillating discs with uniform suction and injection, Indian J. Pure appl. Math., 17(7), 931-942, July(1986).
6. Hayat, T (Park-QAZAM) (with Abbas, Q, (Pak-QAZAM) Khan, Masood (Pak-QAZAM) Siddiqui A.M. (I-PASY), Non-Newtonian flows over an oscillating Plate with variable suction. Arch. Mech. 55(2003).
7. Chawla, S.S., Flow past a torsionally oscillation plane, Z Anglew Math Phy 45(1994) no-6, 986-990 (76D)
8. N. Riley and M.F. Wybrow, The flow induced by torsional oscillation of an elliptic cylinder, J. Fluid Mech (1996) 279
9. H. M. Bluck Burn, A study of two dimensional flow past of an oscillating cylinder. J. Fluid Mech (1999) 255.
10. Terril, R.M., Laminar flow in a uniformly porous channel with an applied transverse magnetic field. Appl. Sci. Res. B12 (1965) 203.
11. R.S. Agarwal, Ph.D. Thesis submitted to university of Roorkee, India 1966.
12. H.G. Sharma and K.R. Singh, numerical solution of the flow of second-order fluid through a channel with porous walls under a transverse magnetic field Indian J. pure app. Math., 17 (10): 1231-1241, 1986.
13. Sharma, S.K. and R.S. Agrawal, Heat Transfer from an enclosed rotating disc, Appl. Scient. Res. 16, 204-214 (1966).
14. Singh K.R. and H.G. Sharma, Heat Transfer in the flow of a second-order fluid between two enclosed rotating discs. Int J. Heat Mass transfer, 28 (1985), no-1, 304-309.
15. Sharma, H.G and K.R. Singh, Heat Transfer in the flow of a second-order fluid between torsionally oscillating discs, Indian J. Pure appl. Math., 16(9), 1044-1050, sep(1985).