Palestine Journal of Mathematics

Vol. 10 (Special Issue I)(2021) , 6–14

MAGNETOHYDRODYNAMIC MIXED CONVECTIVE FLOW IN A VERTICAL POROUS MICROCHANNEL WITH HEAT GENERATION/ABSORPTION

Manthesha and Patil Mallikarjun B

Communicated by Hanumagowda B. N.

MSC 2010 Classifications: 76R10, 76S05.

Keywords and phrases: Microchannel , Porous, Heat generation/absorption, Velocity Slip and Temperature Jump.

Abstract In this study, the effect of magnetic field on the mixed convective flow in a vertical parallel plate microchannel filled with porous medium in the presence of heat generation/absorption parameter is analysed. A viscous, incompressible, electrically conducting fluid is considered in a vertical microchannel. The governing nonlinear coupled equations are non-dimensionalised using dimensionless parameters and are solved numerically. Solutions for velocity profile, temperature profile, skin friction and nusselt number are calculated by considering the velocity slip and temperature jump conditions at the walls of microchannel. The flow with the influence of various parameters like rarefaction parameter, Hartman number, porous medium, heat generation/absorption parameter, fluid-wall interaction parameter is analysed graphically.

1 Introduction

The new applications of fluid flow and heat transfer in microchannel such as nuclear reactors, chemical processes, electronic cooling equipment's, biomedical applications, solar energy systems, heat exchangers, geothermal energy mining, DNA sequencing. This advanced application has motivated many researchers to study in this area.

The basic field equations, jump conditions and constitutive equations of simple microfluent are discussed by Cemal[1]. Tuckerman and Pease [2] investigated the high performance forced cooling of planer integrated circuits. Philips [3] presented a heat sink model and experimentally studied the microchannel heat sink and the applications of it. Tao[4] studied the fully developed laminar flow in a vertical channel by considering the both free and forced convection. Mala et al. [5] considered a microchannel between two parallel plates at constant and equal temperatures and studied the effects of EDL at the solid-liquid interface on liquid flow and heat transfer.

The effect of temperature-dependent viscosity on mixed convection boundary layer flow in a vertical flat plate was investigated by Md. Anwar Hossain and Md. Sajjad Munir [6]. Mete Avcl and Orhan Aylin studied the heat transfer of Newtonian fluid in a vertical microchannel by taking into account the effect of velocity slip and temperature jump at the walls of the channel [7] and drawn many important results with asymmetric wall heating at uniform heat fluxes [8]. The magnetohydrodynamic flow in a porous channel is considered and the heat transfer is studied by Hayat and Abbas [9]. Shokouhmand and Jafari [10] numerically analysed the problem of mixed convection in a vertical microchannel affected by an applied electrical potential with symmetric wall temperature. Mixed convection in vertical and inclined parallel plate microchannel was investigated by Sima Baheri et al. [11]. Mixed convective gaseous slip flows in an open-ended vertical parallel-plate channel with symmetric and asymmetric wall heat fluxes are numerically investigated by Hamid Niazmand and Behnam Rahimi [12]. Basant kumar Jha et al. [13] studied the hydrodynamic and thermal behaviour of laminar fully developed fluid in a parallel plate vertical microchannel.Shih-Jie Jian and Huei Chu Weng [14] investigated the role of second order slip in combined free and forced convection through vertical planar microchannel with asymmetric wall temperatures. Basant Jha et al. [15] analysed the steady natural convection flow in vertical annular microchannel with variable viscosity and concluded many interesting results. Basant Jha and Babatunde Aina [16] examined the hydrodynamic and thermal behaviour of steady fully developed mixed convection flow in a vertical parallel-plate micro-porous-channel in the presence of suction/injection with velocity slip and temperature jump at the boundaries. They extended their work with the study of MHD effects with electrically non-conducting infinite parallel plates [17]. Makinde and Tshehla [18] analysed the irreversibility of magnetohydrodynamic mixed convection of Cu-water nanofluid with suctionand injection at the walls and also studied the entropy production.

The entropy generation and irreversibility distribution are also analysed by Abiodun Ajibade and Thomas Onoja [19] due to mixed convection steady flow of incompressible viscous fluid through vertical porous channel. Basant Jha and Michael Oni [20] found exact solution of steady fully developed mixed convection flow of viscous incompressible fluid in a vertical channel having temperature dependent viscosity and asymmetric wall heating conditions. The steady hydromagnetic flow of a viscous, incompressible, perfectly conducting and heat absorbing fluid past a vertical flat plate under the influence of an aligned magnetic field was studied by Nandkeolyar [21]. The two-dimensional mixed convection boundary layer flow of carbon nanotubes and heat transfer properties over a stretching sheet with suction and slip effects was studied numerically by Nur Syazana Anuar et al. [22]. Hasan Nihal Zaidi et al. [23] scrutinizes the effects of thermal radiation, heat generation, and induced magnetic field on steady, fully developed hydro magnetic free convection flow of an incompressible viscous and electrically conducting couple stress fluid in a vertical channel. Hydromagnetic flow formation of conducting fluid in a vertical microchannel due combined effect of buoyancy forces and pressure gradient has been studied theoretically by Basant Jha et al. [24]. The transient mixed convective flow formation inside a vertical microchannel subjected to uneven wall zeta potentials in the presence of an electric body force is carried out theoretically by Michael Oni and Basant Jha [25]. Roopa and Gireesha [26] considered the electrically conducting couple stress fluid between two vertical channel plates with the aspects of exponential space and temperature dependent, radiative heat flux, heat generation and Joule heating and studied the irreversibility of it. Gireesha and Sindhu [27] considered the casson fluid in the presence of magnetic field in an annular microchannel and analysed the flow with the combined effect of heat generation/absorption parameter and porous parameter.

In this research paper a fully developed, laminar, electrically conducting, steady, incompressible flow is considered in a vertical microchannel filled with porous medium in the presence of heat generation/absorption parameter with effect of uniform magnetic field. The velocity, temperature of the fluid, skinfriction and nusselt number are analysed with the influence of different parameters such as Hartman number, porous parameter, mixed convection parameter, Brinkman number, wall ambient temperature, fluid-wall interaction parameter and heat generation/absorption parameter.

2 MATHEMATICAL ANALYSIS

Figure 1 illustrates the physical configuration of the considered model. Consider mixed convection in a microchannel placed between two parallel plates separated by the distance b. The fluid flow is assumed to be fully developed, incompressible, electrically conducting, steady, laminar flow having constant properties. Both the walls of the channel are maintained constant but different temperature T_1 and T_2 with $T_1 > T_2$ and filled with porous medium. The x-axis is parallel to the gravitational force and is in opposite direction to the gravity and Y-axis is perpendicular to the vertical microchannel. The magnetic fied of uniform strength $B(0, B_0, 0)$ is applied in orthogonal to the flow.

The equations governing the considered flow using the laws of conservations of mass, momentum and energy are given by

$$\nu\frac{d^2U}{dY^2} + g\beta_T(T - T_0) - \frac{\sigma_e B_0^2}{\rho_0}U - \frac{\nu}{K}U - \frac{1}{\rho_0}\frac{dp}{dx} = 0 \tag{2.1}$$

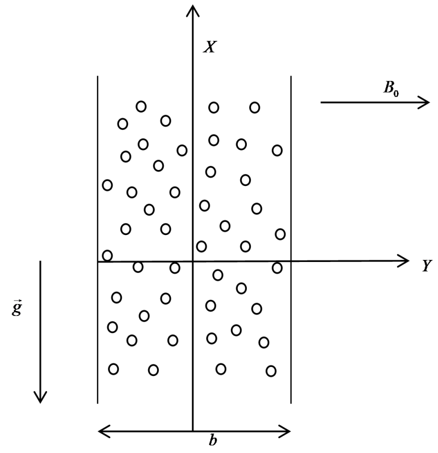

Figure 1. Physical configuration of the model

$$\alpha_1 \frac{d^2T}{dY^2} + \frac{\sigma_e B_0^2}{\rho_0 C_p} U^2 + \frac{\nu}{C_p K} U^2 \pm \frac{Q(T - T_0)}{\rho_0 C_p} = 0 \tag{2.2}$$

With the boundary conditions for velocity, temperature field at both the walls of the microchannel which are in dimensional form are given by

$$U(Y = 0) = \frac{2 - \sigma_\nu}{\sigma_\nu} \lambda \frac{dU}{dY}\bigg|_{Y=0} \tag{2.3}$$

$$U(Y = b) = \frac{2 - \sigma_\nu}{\sigma_\nu} \lambda \frac{dU}{dY}\bigg|_{Y=b} \tag{2.4}$$

$$T(Y = 0) = T_2 + \left(\frac{2 - \sigma_t}{\sigma_t}\right)\left(\frac{2\gamma_s}{\gamma_s + 1}\right)\left(\frac{\lambda}{Pr}\right) \frac{dU}{dY}\bigg|_{Y=0} \tag{2.5}$$

$$T(Y = b) = T_1 - \left(\frac{2 - \sigma_t}{\sigma_t}\right)\left(\frac{2\gamma_s}{\gamma_s + 1}\right)\left(\frac{\lambda}{Pr}\right) \frac{dU}{dY}\bigg|_{Y=b} \tag{2.6}$$

following are the dimensionless quantities:

$$Y = \frac{y}{b}, \quad \theta = \frac{T - T_0}{T_1 - T_0}, \quad U = \frac{u}{U_0}, \quad M^2 = \frac{\sigma_e B_0^2 b^2}{\mu}, \quad Gr = \frac{g\beta(T_1 - T_0)b^2}{\nu U_0},$$

$$\sigma^2 = \frac{b^2}{K}, \quad \phi = \frac{Qb^2}{K}, \quad Br = \frac{\mu U_0^2}{K\Delta T}, \quad Re = \frac{ub}{\nu}, \quad \frac{dp}{dx} = A, \quad \lambda_T = \frac{Gr}{Re} \tag{2.7}$$

where

$$U_0 = \frac{\rho g \beta (T_1 - T_2) b^2}{\mu}, \quad K = \alpha \rho_0 C_p$$

The dimensionless form of the governing equations using (2.7) in the presence of velocity slip and temperature jump under Boussinesq's approximation are:
Equation (2.1) takes the form

$$\frac{d^2u}{dy^2} - (M^2 + \sigma^2)u + \lambda_T \theta - A = 0 \tag{2.8}$$

Dimensionless form of the equation (2.2) is

$$\frac{d^2\theta}{dy^2} + Br(M^2 + \sigma^2)u^2 \pm \phi\theta = 0 \tag{2.9}$$

Using the dimensionless quantities (2.4), the dimensionless boundary conditions are:

$$u(0) = \beta_v K_n \frac{du}{dy}\bigg|_{y=0}, \quad u(1) = \beta_v K_n \frac{du}{dy}\bigg|_{y=1} \tag{2.10}$$

$$\theta(0) = \xi + \beta_v K_n l_n \frac{d\theta}{dy}\bigg|_{y=0}, \quad \theta(1) = 1 - \beta_v K_n l_n \frac{d\theta}{dy}\bigg|_{y=1} \tag{2.11}$$

Here $K_n, l_n, Pr, \gamma_s, \sigma_t, \sigma_v, \xi, b$ is Knudsen number, fluid-wall interaction parameter, Prandtl number, ratio of specific heats, tangential momentum coefficient, and thermal accommodation coefficients. its ranges, wall ambient temperature, width of the channel respectively. The value of β_v nearly equal to unity and the value of β_t varies from 1 to 100, many science and engineering applications have the values $l_n = 1.667, Pr = 0.71, \gamma_s = 1.4, \sigma_t = 1, \sigma_v = 1, \beta_t = 1.667, \beta_v = 1$

The two important properties of the fluid flowing in microchannel are rate of heat transfer and skin friction.

The rate of heat transfer which is expressed as the nusselt number (Nu) is

$$Nu = \frac{qb}{(T_1 - T_0)K} = \frac{d\theta(y)}{dy} \tag{2.12}$$

Therefore,

$$Nu_0 = \frac{d\theta}{dy}\bigg|_{y=0} \tag{2.13}$$

$$Nu_1 = \frac{d\theta}{dy}\bigg|_{y=1} \tag{2.14}$$

The skin friction (τ) on the microchannel walls is

$$\tau_0 = \frac{du}{dy}\bigg|_{y=0} \tag{2.15}$$

$$\tau_1 = \frac{du}{dy}\bigg|_{y=1} \tag{2.16}$$

3 Results and Discussion

The solution for the problem effect of porous medium on MHD natural convective flow in a vertical microchannel with heat generation/absorption is obtained numerically and solved using Finite difference method. The velocity profile is discussed under the effect of different parameters by using the graphs. The present work is done in the range $0 \leq \beta_v K_n \leq 0.1, 0 \leq l_n \leq 3, 0 \leq M \leq 2, 0 \leq \sigma \leq 2, 1 \leq \phi \leq 5$. $\lambda(\frac{Gr}{Re})$ is considered as the mixed convection parameter, $\lambda_T \to 0$ implies the forced convection and $\lambda_T \to \infty$ implies that natural convection is dominant.

Fig 2 is the graph of velocity profile for fluid-wall interaction parameter $l_n = 0, 0.5, 1, 1.5$ as the interaction parameter increases there is an enhancement in the temperature jump and reduction in the retardation force for the flow due to this there is an increase in the fluid velocity, from the figure it is observed that as the fluid-wall interaction parameter increases velocity of the fluid increases.

Fig 3 is the variation of temperature for the different values of fluid-wall interaction parameter $l_n = 0, 0.5, 1, 1.5$ fluid-wall interaction parameter influences the temperature and it increases the temperature jump and hence it is noticed from the figure that as the fluid-wall interaction parameter increases the temperature of the fluid moving in the microchannel.

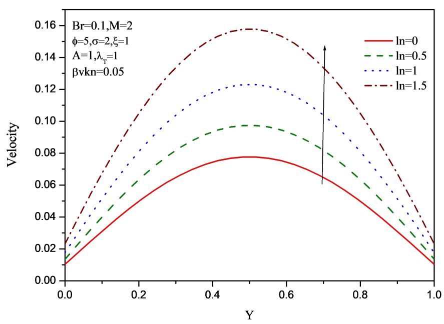

Figure 2. Velocity profiles for different values of ln

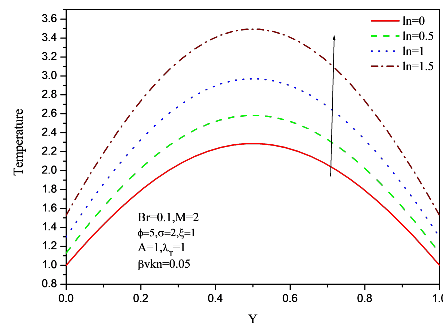

Figure 3. Temperature profiles for different values of ln

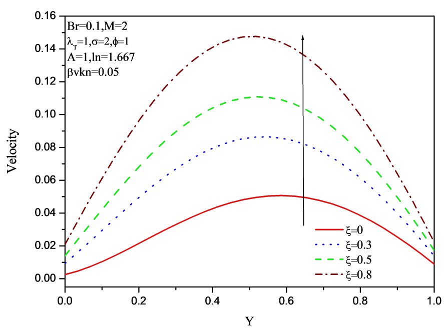

Figure 4. Velocity profiles for different values of ξ

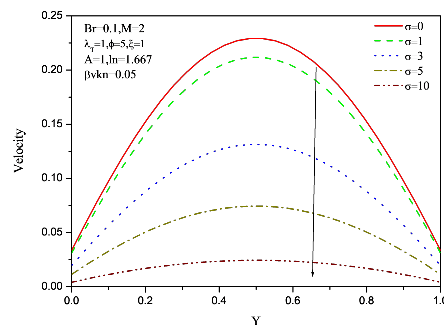

Figure 5. Velocity profiles for different values of σ

Figure 4 presents the velocity profile for the different values of wall ambient temperature parameter $\xi = 0, 0.3, 0.5, 0.8$ by the results it is observed that as the wall ambient temperature parameter influences the fluid velocity. From the figure it is observed that as the wall ambient temperature increases the velocity of the fluid increases.

Fig 5 displays the effect of porous medium on the velocity profile. Porous parameter $\sigma = 0, 1, 3, 5, 10$ decreases the fluid velocity. Porous parameter (σ) opposes the fluid flow, as the porous parameter of the medium increases there is an increase in the resistance for the flow of fluid in the channel, as a result of this we observe here that as the porous parameter increases there is a decrease in the fluid velocity.

Figure 6 presents the graph of effect of heat generation/absorption parameter $\phi = 0, 1, 3, 5$ on the fluid velocity. The heat generation in the fluid increases the conduction of the fluid particles, as the conduction increases that increase the fluid flow and also it is found that as there an increase in the heat absorption that reduces movement of the fluid particles, In this figure it is observed that as heat generation parameter increases the velocity of the fluid increases and as heat absorption increases velocity of the fluid decrease.

Figure 7 and figure 8 displays the variation of velocity and temperature for the different values of mixed convection parameter $\lambda_T = 0, 0.5, 1, 1.5$. As $\lambda_T \to 0$ the forced convection is dominant and when $\lambda_T \to \infty$ free convection is dominant. The velocity and temperature are observed for both the cases and it is found that as the mixed convection parameter increases it enhances the fluid velocity and supresses the fluid temperature.

Fig 9 displays the variation of temperature profile for the different values of wall ambient

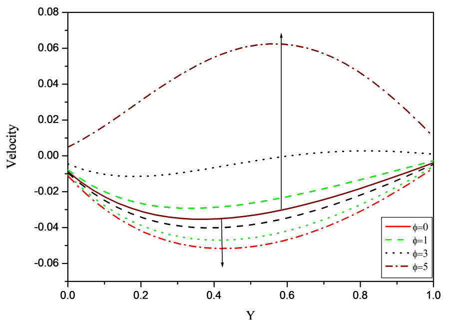

Figure 6. Velocity profiles for different values of ϕ

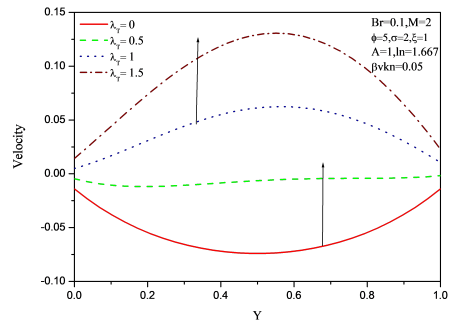

Figure 7. Velocity profiles for different values of λ_T

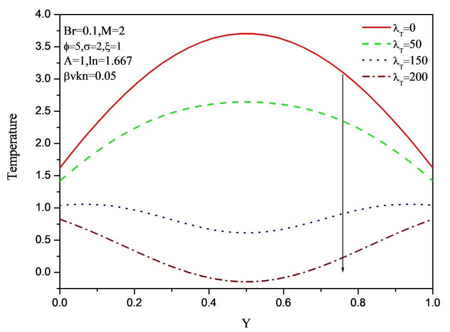

Figure 8. Temperature profiles for different values of λ_T

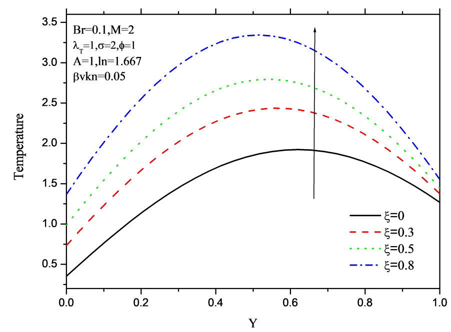

Figure 9. Temperature profiles for different values of ξ

temperature ξ. wall ambient temperature makes significant effect on the fluid temperature which is moving in the microchannel.Here it is observed that as the wall ambient temperature it increases the fluid temperature.

Figure 10 and figure 11 shows the variation of Skin friction for different values of porous parameter and ambient temperature . The skin friction is calculated and presented for $\xi = -1, 0, 1$ and $\lambda_T = 0, 1, 2$ and it is observed that There is a significant effect of mixed convection parameter on the skin friction. As the value of the mixed convection parameter increases and the fluid move away from the continuum regime $(\beta_v K_n)$ of the microchannel there is a increase in the value of the skin friction at $Y = 0$ and as the mixed convection parameter increases the value of the skinfriction decreases at $y = 1$.

Figure 12 and figure 13 shows the variation of Skin friction for different values of porous parameter σ and ambient temperature ξ. The skin friction is calculated and presented for $\xi = -1, 0, 1$ and $\sigma = 0, 1, 2$ and it is observed that There is a significant effect of porous medium on the skin friction. As the value of the porous parameter increases and the fluid move away from the continuum regime $(\beta_v K_n)$ of the microchannel there is a decrease in the value of the skin friction at $Y = 0$ wall and as the porous parameter increases the value of the skinfriction increases at $y = 1$. It is noted that magnitude of the skin friction at $Y = 0$ is larger than skinfriction at $Y = 1$.

Figure 14 and figure 15 shows the variation of Nusselt number for the different values of mixed convection parameter λ_T at $y = 0$ and at $y = 1$ respectively. The rate of heat transfer is calculated and displayed graphically for $\xi = -1, 0, 1$ and $\lambda_T = 0, 1, 2$. It is observed that the

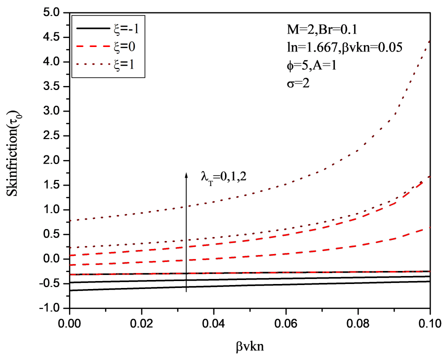

Figure 10. Skinfriction for different values of λ_T at $Y = 0$.

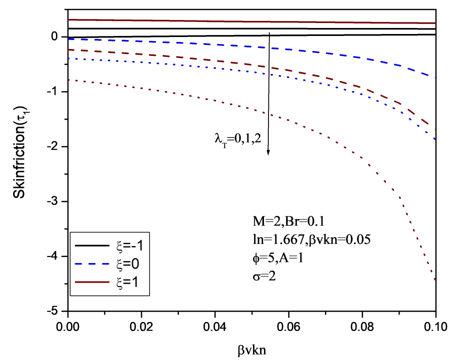

Figure 11. Skinfriction for different values of λ_T at $Y = 1$

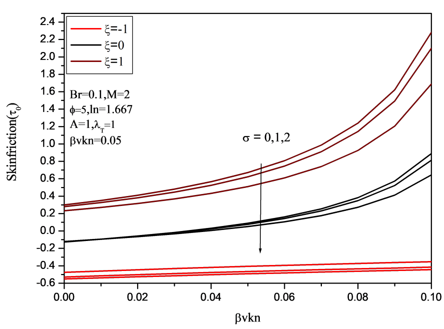

Figure 12. Skinfriction for different values of σ at $Y = 0$.

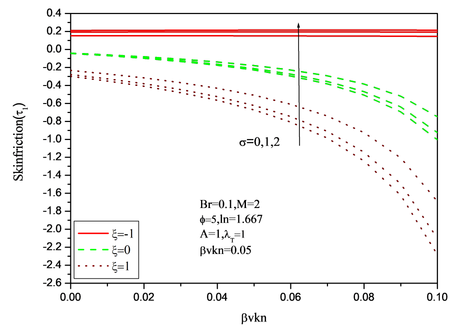

Figure 13. Skinfriction for different values ofσ at $Y = 1$.

magnitude of the nusselt number is high in case of $y = 1$ compare to nusselt number at $y = 0$. As the value mixed convection parameter and the wall ambient temperature increases there is an increase in the rate of heat transfer at $Y = 0$ and there is a decrease in the rate of heat transfer at the wall $Y = 1$.

4 Conclusion

The solution for fully developed mixed convective flow in a vertical channel filled with porous medium and in the presence of heat generation/absorption under the effect of magnetic field is studied numerically. A finite difference lobatto III code is written to the model. The fluid velocity, temperature, skinfriction and Nusselt number is investigated under the influences of Hartman number, porous parameter, mixed convection parameter, brinkman number, wall ambient temperature, fluid-wall interaction parameter and heat generation/absorption parameter. This analysis agrees with the study of Mete and Orhan [7] in the absence of $(M \to 0, \sigma \to 0, \phi \to 0)$.The findings of the study are:

- Fluid-wall interaction parameter, wall ambient temperature, mixed convection parameter and heat generation parameter enhances the fluid velocity and porous parameter and heat absorption parameter suppresses the fluid velocity.
- Fluid-wall interaction parameter, wall ambient temperature enhances the temperature of the fluid and mixed convection parameter suppresses the fluid temperature.
- Mixed convection parameter increases the skinfriction at $Y = 0$ wall and decreases the skinfriction at $Y = 1$ wall and porous parameter decreases the skinfriction at $Y = 0$ and

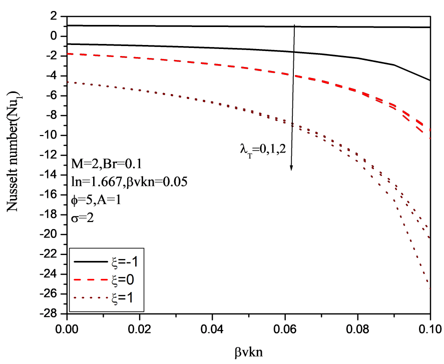

Figure 14. Nusselt number for different values of λ_T at $Y = 0$

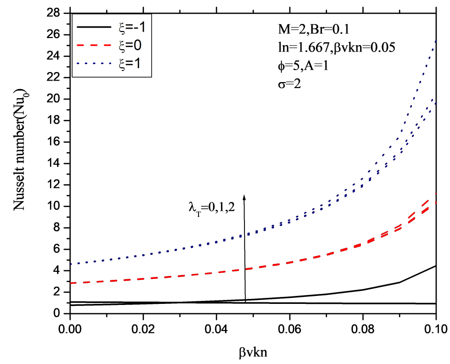

Figure 15. Nusselt number for different values of λ_T at $Y = 1$

increases the skinfriction at $Y = 1$.

- Nusselt number decreases with increase in the mixed convection parameter at $Y = 0$ and increases at $Y = 1$.

References

[1] Eringen A C, Simple Micro Fluids. International journal of Engineering, (1964) 205-217.

[2] Tuckerman D B, Pease RFW, High-Performance Heat Sinking For VLSI, IEEE Electron Device Letter, (1981).

[3] Philips R J, Microchannel Heat sinks. The Lincoin Laboratory Journal(1988).

[4] Tao L N, On Combined Free and Forced convection in Channels. Journal of Heat Transfer, (1960) 233-238.

[5] Mala G M, Dongqing li and Dale J D, Heat Transfer and fluid flow in microchannels. Journal of Heat Mass Transfer, (1997) 3079-3088.

[6] Md. Anwar Hossain and Md. Sajjad Munir, 2000, "Mixed convection flow from a vertical flat plate with temperature dependent viscosity" Int. J. Therm. Sci,. 39, 173–183.

[7] Mete Avcı and Orhan Aydın, 2007, "Mixed Convection in a Vertical Parallel Plate Microchannel" Transactions of the ASME, 129, 162-166.

[8] Mete Avcı and Orhan Aydın, 2007, "Mixed Convection in a Vertical Parallel Plate Microchannel With Asymmetric Wall Heat Fluxes", Journal of Heat Transfer, ASME, 129, 1091-1095.

[9] Hayat T and Abbas Z, Heat Transfer analysis on the MHD flow of a second grade fluid in a channel with porous medium. Chaos, Solitons and Fractals. (2008) 556-567.

[10] Shokouhmand H. and Jafari A., 2010, "Investigation of mixed convection in a vertical microchannel affected by EDL", Proceedings of the World Congress on Engineering II, London, U.K.

[11] Sima Baheri1, Seyedeh Zobeydeh Falaki1 and Reza Gharraei2 , 2012, "The effect of geometrical and flow parameters on mixed convection of developing flow in vertical and inclined microchannels", Proc IMechE Part C: J Mechanical Engineering Science 227(9) 1956–1964.

[12] Hamid Niazmand and Behnam Rahimi, 2012, "Mixed convection slip flows in a vertical parallel plate microchannel with symmetric and asymmetric wall heat fluxes", Transactions of the Canadian Society for Mechanical Engineering, 36(3), 207-218.

[13] Basanth Kumar Jha, Deborah Damarola, Abiodun O. and Ajibade, 2013, "Steady fully developed mixed convection flow in a vertical parallel plate microchannel with bilateral heating and filled with porous material", Proceedings of the Institution of Mechanical Engineers Part E Journal of Process Mechanical Engineering 1989-1996.

[14] Shih-Jie Jian and Huei Chu Weng, 2013, "Second-Order Mixed Convective Flow in a Long Vertical Microchannel", Journal of Heat Transfer, ASME, 135, 022506-1 to 022506-5.

[15] Basant K. Jha, Babatunde Aina and Zubairu Rilwanu, 2016, "Steady fully developed natural convection flow in a vertical annular microchannel having temperature dependent viscosity: An exact solution", Alexandria Engineering Journal.

[16] Basant K. Jha and Babatunde Aina, 2016, “Role of suction/injection on steady fully developed mixed convection flow in a vertical parallel plate microchannel”, Ain Shams Engineering Journal.

[17] Jha B.K. and Aina B., 2017, “Effect of induced magnetic field on MHD mixed convection flow in vertical microchannel”, Int. J. of Applied Mechanics and Engineering 22(3) 567-582.

[18] Makinde O. D. and Tshehla M.S., 2017, “Irreversibility Analysis of MHD Mixed Convection Channel Flow of Nanofluid with Suction and Injection”, Global Journal of Pure and Applied Mathematics, 13(9) 4851-4867.

[19] Abiodun O. Ajibade and Thomas U. Onoja, 2017, “Entropy generation and irreversibility analysis due to steady mixed convection flow in a vertical porous channel”, International Journal of Head and Technology 35(3), 433-446.

[20] Basant K. Jha and Michael O. Oni, 2018, “Mixed convection flow in a vertical channel with temperature dependent viscosity and flow reversal: An exact solution”, International Journal of Heat and Technology 36(2), 607-613.

[21] Nandkeolyar R., Narayana M., Motsa S. S. and Sibanda P., 2018, “Magnetohydrodynamic Mixed Convection Flow Due to A vertical Plate With Induced Magnetic Field”, Journal of Thermal Science and Engineering Applications.

[22] Nur Syazana Anuar, Norfifah Bachok, Norihan Md Arifin and Haliza Rosali, 2019, “Mixed Convection Flow and Heat Transfer of Carbon Nanotubes Over and Exponentially Stretching/Shrinking Sheet with Suction and Slip Effect”, Journal of Advanced Research in Fluid Mechanics and Thermal Science 59(2), 232-242.

[23] Hasan Nihal Zaidi, Mohammed Yousif, and S. Nazia Nasreen, 2020, “Effects of Thermal Radiation, Heat Generation, and Induced Magnetic Field on Hydromagnetic Free Convection Flow of Couple street Fluid in an Isoflux-Isothermal Vertical Channel”, Hindawi Journal of Applied Mathematics.

[24] Basant K. Jha and Peter B. Malgwi, 2020, “Hall and ion-slip effects on MHD mixed convection flow in a vertical microchannel with asymmetric wall heating”, wileyonlinelibrary.

[25] Michael O. Oni and Basant K. Jha, 2020, “Heat transfer analysis of mixed convection flow in a vertical microchannel with electrokinetic effect”, GEM - International Journal on Geomathematics.

[26] Roopa A. and Gireesha B. J., 2020, “Hall effects on MHD couple stress fluid flow through a Vertical microchannel subjected to heat generation: A numerical study”, Heat Transfer,1-21.

[27] Gireesha B. J. and Sindhu S., 2020, “MHD natural convection flow of Casson fluid in an annularmicrochannel containing porous medium with heat generation/absorption”, Nonlinear Engineering, 223–232.

Author information

Manthesha and Patil Mallikarjun B, Department of Studies and Research in Mathematics, Tumkur University - 572 103, India.
E-mail: msugoor127@gmail.com

Received: Dec 16, 2020.
Accepted: Feb 24, 2021.