MHD FLOW THROUGH PERMEABLE MEDIUM OF TWO CO-AXIAL PERMEABLE CIRCULAR CYLINDER

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ABSTRACT

In this study, we have inspected the azimuthal speed, cross stream speed, pressure, hub speed, speed potential, stream work, complex potential, stream line of MHD course through porous vehicle of two co-hub penetrable roundabout chambers. Diagrams have also been explored in pressure and pivotal speed and weight and cross stream speed.

Glossary of Terms

K = Porosity parameter

x = Axial coordinate

u = Axial velocity

υ = Kinematic velocity

p = Pressure

μ = Coefficient of viscosity

Φ = Velocity potential

ϕ = Azimuthal coordinate

B_0 = Magnetic field

ω = Azimuthal velocity

σ = Electrical conductivity

W = Complex potential

r = Radial coordinate

Ψ = Stream function

v = Cross flow velocity

ρ = Density of the fluid

1. INTRODUCTION

Liquid move through permeable media broadly exists in nature and counterfeit materials, and its hypothesis has been utilized in a wide range of logical and innovative fields, for example, soil mechanics, oil designing, mineral building, ecological building, geothermal building, water supply building, concoction industry, small scale machine, etc.

Many researchers has been contributes in this direction such as Attia and Ahmed (2005) contemplated the insecure course through polarized viscoplastic (Bingham) liquid in a roundabout channel. Tsangaris et al. (2007) analyzed shaky gooey laminar stream in a straight channel. They got a precise answer for time evolving imbuement/suction at porous divider. Srinivas and Saxena et al. (2009) examined the impact of MHD visco-flexible liquid stream, consider Rivlin Ericksen model, through a round chamber limited by a porous bed. Cox and slope (2011) have assessed the Newtonian liquid through carbon nanotubes with a Navier slip at the limit. Singh at al. (2011) saw that expansion in the Prandtl, Grashof, and Reynolds quantities of penetrability expands the speed of the fundamental stream, while an increment in the suction parameter diminishes the primary stream. Ramana Murthy et al. (2012) examined micropolar stream produced by a permeable chamber demonstrating rotatory movements. They found that drag reduces numerically when the suction parameter increases. Sheikholeslami et al. (2013) examined the examination of pressing shaky nanofluids stream utilizing ADM. Sheikholeslami and Ganji (2014) have examined the magnetohydrodynamic stream in a penetrable channel loaded up with nanofluids. Abbas and Zenkour (2014) centered the two dimensional summed up thermoelastic communications in an interminable fiber-strengthened anisotropic plate containing a round pit with no unwinding time. Sheikholeslami and Ellahi (2015) examined the three dimensional mesoscoping reenactment of attractive field impact on normal convection of nanofluids. Ramana Murthy (2016) have analyzed divider suction impacts is immiscible couple pressure stream between two homogenous porous dividers. They perceived that liquid speed increases with Darcy number. Singh and Raghav (2017) studied two dimensional consistent MHD blended convection and mass exchange stream of an incompressible, thick, and electrically directing liquid past a rashly begun vast vertical permeable plate within the sight of warm radiation, huge variable suction and thermophoresis. Barik et al. (2018) considered the impact of versatility, suction/infusion, permeable grid, delta stream Reynolds number on the progression of a visco-flexible liquid through a permeable funnel. Nagaraju and Garvandha (2019) considered a systematic examination of two-dimensional warmth move conduct of an axisymmetric incompressible dissipative thick liquid stream in round channel.

2. MATHEMATICAL FORLULATION OF THE PROBLEM

Administering the Navier-Stokes conditions of movement in round and cylindrical polar co-ordinates diminishes to

$$\frac{\partial v}{\partial t}+v\frac{\partial v}{\partial r}+\frac{\omega}{r}\frac{\partial v}{\partial \phi}-\frac{\omega^2}{r}=-Mu-\frac{\upsilon}{K}u-\frac{1}{\rho}\frac{\partial p}{\partial r}+\upsilon\left[\frac{\partial^2 v}{\partial r^2}+\frac{1}{r}\frac{\partial v}{\partial r}-\frac{v}{r^2}+\frac{1}{r^2}\frac{\partial^2 v}{\partial \phi^2}-\frac{2}{r^2}\frac{\partial \omega}{\partial \phi}\right] \quad (1)$$

$$\frac{\partial \omega}{\partial t}+v\frac{\partial \omega}{\partial r}+\frac{\omega}{r}\frac{\partial \omega}{\partial \phi}+\frac{v\omega}{r}=-\frac{1}{r\rho}\frac{\partial p}{\partial \phi}+\upsilon\left[\frac{\partial^2 \omega}{\partial r^2}+\frac{1}{r}\frac{\partial \omega}{\partial r}-\frac{\omega}{r}+\frac{1}{r^2}\frac{\partial^2 \omega}{\partial \phi^2}+\frac{2}{r^2}\frac{\partial v}{\partial \phi}\right] \qquad (2)$$

$$\frac{\partial u}{\partial t}+v\frac{\partial u}{\partial r}+\frac{\omega}{r}\frac{\partial u}{\partial \phi}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\upsilon\left[\frac{\partial^2 u}{\partial r^2}+\frac{1}{r}\frac{\partial u}{\partial r}+\frac{1}{r^2}\frac{\partial^2 u}{\partial \phi^2}\right] \qquad (3)$$

Where $M=\frac{\sigma B_0{}^2}{\rho}$

and the equation of the continuity is

$$\frac{\partial v}{\partial r}+\frac{v}{r}+\frac{1}{r}\frac{\partial \omega}{\partial \phi}=0 \qquad (4)$$

3. SOLUTION OF THE PROBELM

For the flow between two co-axial porous circular cylinder

$$\omega=0 \qquad (5)$$

and for rotational symmetry

$$\frac{\partial v}{\partial \phi}=0 \qquad (6)$$

Under these condition, equation (2) becomes an identity and the equations (1), (3) and (4) assumes the forms,

$$\frac{\partial v}{\partial t}+v\frac{\partial v}{\partial r}=-Mu-\frac{\upsilon}{K}u-\frac{1}{\rho}\frac{\partial p}{\partial r}+\upsilon\left[\frac{\partial^2 v}{\partial r^2}+\frac{1}{r}\frac{\partial v}{\partial r}-\frac{v}{r^2}\right] \qquad (7)$$

$$\frac{\partial u}{\partial t}+v\frac{\partial u}{\partial r}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\upsilon\left[\frac{\partial^2 u}{\partial r^2}+\frac{1}{r}\frac{\partial u}{\partial r}\right] \qquad (8)$$

and $$\frac{\partial v}{\partial r}+\frac{v}{r}=0 \qquad (9)$$

From equation (9), we get

$$vr=c_1 \text{ (say)} \qquad (10)$$

The boundary conditions are $r=1, v=1$ (11)

Using boundary condition, we get

$$v=\frac{1}{r} \qquad (12)$$

Using equation (12), equation (7) becomes

$$\left(M+\frac{\upsilon}{K}\right)\int u dr=-\frac{1}{2r^2}-\frac{p}{\rho}+c_2 \quad (13)$$

If $\upsilon=1, p=p(r)$ and u independent of t, then equation (8) reduces to

$$\frac{\partial^2 u}{\partial r^2}=0 \quad (14)$$

$$u=c_3 r+c_4 \quad (15)$$

The boundary conditions are

$$\left.\begin{array}{l} r=0, u=0 \\ r=1, u=1 \end{array}\right\} \quad (16)$$

Using the boundary conditions, we get

$$u=r \quad (17)$$

From equations (13) and (17) and neglecting c_2

$$p=\rho\left[-\frac{1}{2r^2}-\frac{1}{2}\left(M+\frac{1}{K}\right)r^2\right] \quad (18)$$

Taking $\rho=1$, equation (18) becomes,

$$p=\left[-\frac{1}{2r^2}-\frac{1}{2}\left(M+\frac{1}{K}\right)r^2\right] \quad (19)$$

For velocity potential, we have

$$u=-\frac{\partial\Phi}{\partial r}, \qquad v=-\frac{1}{r}\frac{\partial\Phi}{\partial\theta}$$

when $$u=-\frac{\partial\Phi}{\partial r}; \qquad r=-\frac{\partial\Phi}{\partial r}$$

$$\Phi=-\frac{r^2}{2} \quad (20)$$

When $$v=-\frac{1}{r}\frac{\partial\Phi}{\partial\theta}; \qquad \frac{1}{r}=-\frac{1}{r}\frac{\partial\Phi}{\partial\theta}$$

$$\Phi=-\theta \quad (21)$$

For stream function, we have

$$\frac{\partial \psi}{\partial r} = -\frac{1}{r}\frac{\partial \Phi}{\partial \theta}, \qquad \frac{1}{r}\frac{\partial \psi}{\partial \theta} = \frac{\partial \Phi}{\partial r}$$

when $\Phi = -\theta$ and $\frac{\partial \psi}{\partial r} = -\frac{1}{r}\frac{\partial \Phi}{\partial \theta}$, we get

$$\psi = \log r \tag{22}$$

When $\Phi = -\frac{r^2}{2}$ and $\frac{1}{r}\frac{\partial \Psi}{\partial \theta} = \frac{\partial \Phi}{\partial r}$, we get

$$\Psi = -r^2\theta \tag{23}$$

For complex potential, we have

$$W = \Phi + i\Psi$$

From equations (20) and (23), we get

$$W = -r^2\left(\frac{1}{2} + i\theta\right) \tag{24}$$

From equations (21) and (22), we get

$$W = -\theta + i\log r \tag{25}$$

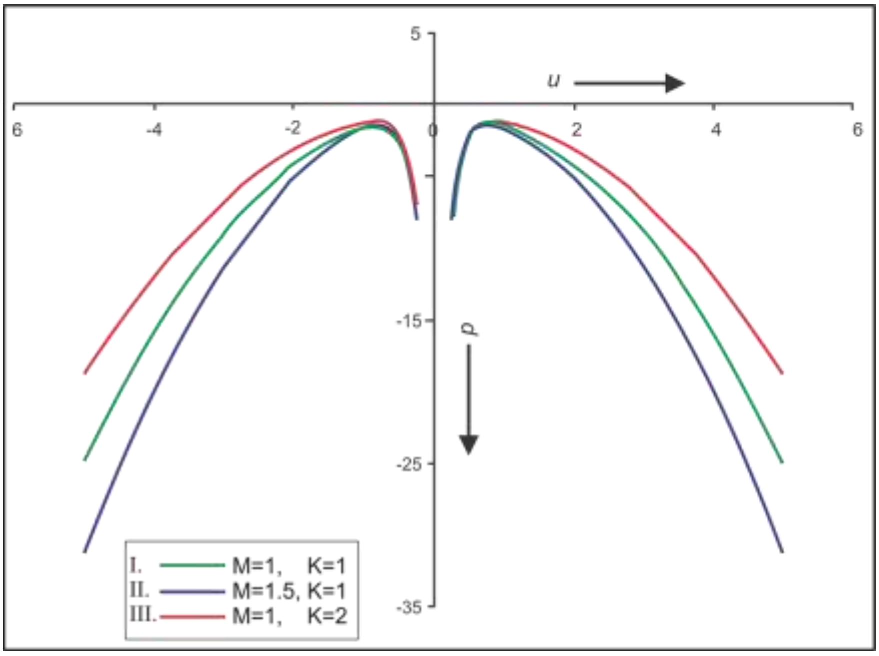
For stream line, we have

$$\frac{dr}{u} = \frac{rd\theta}{v}$$

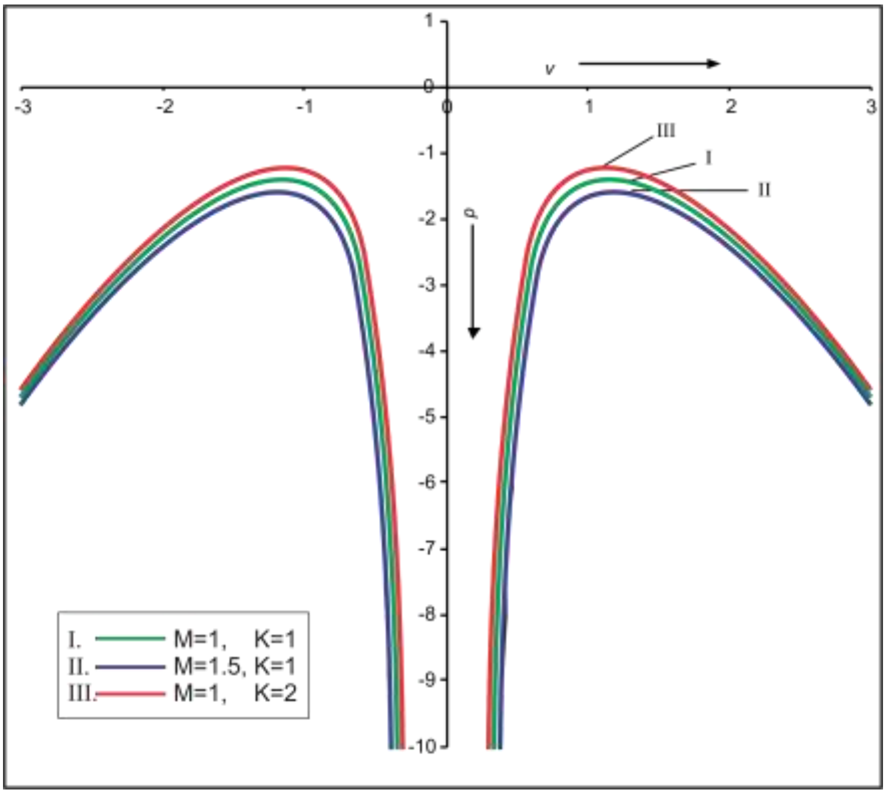
Then, we get

$$-\frac{1}{2r^2} = \theta + constent \tag{26}$$

4. RESULTS AND DISCUSSION



Graph 1: Variation in pressure with axial velocity for different values of M & K



Graph 2: Variation in Pressure with cross flows velocity for different values of M & K

In the current issue we have explored, the azimuthal speed, cross stream speed, pressure, pivotal speed, speed potential, stream work, complex potential, stream line of MHD move through permeable mechanism of two co-hub permeable roundabout chambers given by condition (5), (12), (17), (19), (20), (21), (22), (23), (24), (25), (26) individually. Diagram in the middle of weight and hub speed and chart in the middle of weight and cross stream speed for various estimations of M and K have additionally introduced in Graph 1 and graph 2 individually.

In graph 1, Weight is checked at various estimation of M like 1, 1.5 and diverse porosity parameter K like 1, 2 from charts it appears as M increments at steady porosity parameter K, pressure diminishes, it is looked at by diagram I and II, just as K increments at consistent M pressure builds, It is thought about by chart I and III. It is likewise appears pressure increments up to 1 where then it diminishes and there is balance in variety of weight against .

While In graph 2, Weight is checked at various estimation of M like 1, 1.2 and distinctive porosity parameter K like 1, 2 from diagrams it appears as M increments at consistent porosity parameter K, pressure diminishes, it is analyzed by chart I and II, just as K increments at steady M pressure expands, It is thought about by chart I and III. It is likewise appears pressure increments up to 1 where then it diminishes and there is balance in variety of weight against.

5. CLOSING COMMENTS

In the investigation of MHD course through permeable mechanism of two co-pivotal permeable roundabout chamber thinking about various numerical estimations of M and K, we finish up our outcomes as:

(i) Pressure v/s pivotal speed diminishes for expanding estimations of M and increments for expanding estimations of K.

(ii) Pressure v/s cross stream speed diminishes for expanding estimations of M and increments for expanding estimations of K.

(iii) The weight increments against u up to 1, where $u > 0$ then it begin diminishing. There is evenness in the diagrams.

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