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Magneto-shear flow past a cylinder of section bounded by two circular arcs

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Abstract

The two-dimensional non-uniform shear flow of an infinitely conducting inviscid, incompressible fluid past a cylinder having cross-section bounded by two circular arcs in presence of a magnetic field in the direction of the flow has been studied Introducing the stream function and the magnetic field function, the governing equations have been solved in terms of dipolar coordinates The nature of the velocity components and the magnetic field components are shown graphically to discuss their behaviour on the boundary of the cylinder The results have also been compared with that of a circular boundary in graphical form

Key words: Magneto-shear flow, circular arcs, stream function, magnetic field function, infinitely-conducting inviscid incompressible flow

1. Introduction

Stewartson[1] considered the motion of a perfectly conducting sphere through a conducting fluid in the presence of a strong magnetic field with the assumption of small magnetic Reynolds' number and small disturbances to the velocity and magnetic fields But it is shown that if the body and the fluid are both conducting, the assumption of small perturbation theory is invalid. On the other hand, the same theory has been justified to remain valid to consider the problem of steady motion of a non-conducting cylinder through an inviscid incompressible perfectly conducting fluid in presence of a strong magnetic field by Stewartson[2]. In a recent paper, Nigam[3] studied the problem of two-dimensional non-uniform flow of an infinitely conducting, inviscid incompressible fluid past a non-conducting circular air foil in presence of a magentic field parallel to the direction of fluid-flow. Sanyal and Roy Chowdhury[4,5] studied the problems of the same type of non-uniform flow in the presence of magentic field parallel to the diretion of flow past a cyloidal boundary and a loop of rose petals and discussed the nature of the velocity and the magnetic field function for different cases.

The purpose of the present paper is to study the problem of a two-dimensional non-uniform infinitely conducting, inviscid, incompressible fluid motion past a cylinder whose cross-section is bounded by two circular arcs in the presence of a magnetic field parallel to the direction of flow The governing equations have been solved by introducing the stream function and the magnetic field function and changing the system, from the cartesian co-ordinates into dipolar co-ordinates The expressions for the velocity components and the magnetic field function have been obtained in terms of new co-ordinate systems and the nature of the velocity components are shown graphically to discuss their behaviour on the boundary of the cylinder. It has been found that in special cases the results, with some changes in constants, agree with those of Nigam[3] and have been compared graphically with the present solutions

2. Fundamental equations

The governing equations for the steady inviscid, incompressible motion of conducting fluid in linearized form are[3]

$$U(y)\,\frac{\partial u}{\partial x} + v\,\frac{\mathrm{d}U(y)}{\mathrm{d}y} = -1/\rho\,\frac{\partial p}{\partial x} \tag{1}$$

$$U(y)\,\frac{\partial v}{\partial x} = -1/\rho\frac{\partial p}{\partial y} + \frac{H_0}{4\pi\rho}\left[\frac{\partial hy}{\partial x} - \frac{\partial hx}{\partial y}\right] \tag{2}$$

$$U(y)\,\frac{\partial hy}{\partial y} + hy\,\frac{\mathrm{d}U(y)}{\mathrm{d}y} - H_0\,\frac{\partial v}{\partial y} = -\frac{1}{4\pi\sigma}\,\nabla^2 hx \tag{3}$$

$$-\,U(y)\,\frac{\partial hy}{\partial x} - H_0\,\frac{\partial v}{\partial x} = -\frac{1}{4\pi\sigma}\,\nabla^2 hy \tag{4}$$

and the equation of continuity is

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{5}$$

For the infinite conductivity of the fluid motion the equations (3) and (4) reduce to

$$U(y)\,\frac{\partial hy}{\partial y} + hy\,\frac{\mathrm{d}U(y)}{\mathrm{d}y} = H_0\frac{\partial v}{\partial y}$$

and

$$U(y)\,\frac{\partial hy}{\partial x} = H_0\frac{\partial v}{\partial x}$$

We consider the case when $v \to 0$ and $hy \to 0$ at infinity Then the above equations on integration, lead to

$$U(y)\,hy = H_0 v \tag{6}$$

which implies that the stream lines and the magnetic lines are parallel.

We now introduce the flow field function ψ and the magnetic field function ϕ by the relations

$$u = \partial\psi/\partial y, \quad v = -\partial\psi/\partial x, \quad hx = \partial\phi/\partial y, \quad hy = -\partial\phi/\partial x \tag{7}$$

and take $U(y) = A + By$, where A is the uniform velocity and B the constant vorticity Eliminating p between (1) and (2) and using (5) and (7), we get

$$(A+By)\frac{\partial}{\partial x}(\nabla^2\psi) - \frac{H_0}{4\pi\rho}\;\frac{\partial}{\partial x}(\nabla^2\phi) = 0 \tag{8}$$

where

$$\nabla^2 \equiv \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$$

To solve equation (8), we assume that the presence of the boundary of the cylinder does not affect the vorticity in the flow field. This leads to the assumption[3] that

$$\nabla 2\psi = 0 \tag{9}$$

Therefore, equation (8) gives

$$\nabla 2\phi = \text{a function of } y = 0 \tag{10}$$

where the function of y is evaluated at large distances where the disturbed magnetic field vanishes.

3. The problem and its solution

Let us suppose that a cylinder of cross-section bounded by two circular arcs is placed in the undisturbed flow field $U(y)$ and a parallel uniform magnetic field H_0 in the direction of the x-axis The stream function ψ and the magnetic field function ϕ defined by (7) will satisfy equations (8), (9) and (10) provided that the disturbances are small and vanish at infinity.

We now introduce the dipolar co-ordinates by the transformation[6]

$$Z = -c \coth \tfrac{1}{2}\zeta$$

where $Z = x + iy$,

and $\zeta = \xi + i\eta$

and c is a real constant. Then we have

$$x = -\frac{c \sinh \xi}{\cosh \xi - \cos \eta} \quad y = \frac{c \sin \eta}{\cosh \xi - \cos \eta} \tag{11}$$

$$1/h^2 = \left|\frac{dZ}{d\zeta}\right|^2 = \frac{c^2}{(\cosh \xi - \cos \eta)^2}$$

It is clear that the curves $\xi =$ constant are co-axial circles in the xy - plane having $(\pm c, 0)$ as the real limiting points and the curves $\eta =$ constant are circular arcs in the same plane passing through the points $(\pm c, 0)$. The limits for ξ and η are $-\infty \leq \xi \leq \infty$, $-\pi \leq \eta \leq \pi$ respectively Since we are considering shear flow, the total normal velocity of the liquid on the boundary $\eta = \alpha$ and $\eta = -\beta$ (say) is zero

$$i.e., \quad [\, h\, \partial/\partial\xi\, (\psi + \psi_0)\,] = 0, \quad \text{on} \quad \eta = \alpha \;\&\; \eta = -\beta \tag{12}$$

where $\psi_0 = Ay + By^2$ is the undisturbed flow and $\eta = \alpha$ and $\eta = -\beta$ are the two boundaries of the cylinder

The regularity condition is that u and v vanish at infinity. To satisfy the boundary condition and the condition at infinity we take the solution of the equation (9) in the form[6]

$$\psi = \int_0^\infty [f(\lambda) \sinh \lambda\eta + g(\lambda) \cosh \lambda\eta] \cos \lambda\xi \, d\lambda \tag{13}$$

so that

$$\psi + \psi_0 = \int_0^\infty [\, f(\lambda) \sinh \lambda\eta + g(\lambda) \cosh \lambda\eta\,] \cos \lambda\xi \, d\lambda \, +$$

$$+ \frac{Ac \sin \eta}{\cosh \xi - \cos \eta} + \frac{B c^2 \sin^2 \eta}{(\cosh \xi - \cos \eta)^2} \tag{14}$$

Using the boundary conditions (12) we have

$$\frac{Ac \sin \alpha \sinh \xi}{(\cosh \xi - \cos \alpha)^2} + \frac{2 Bc^2 \sin^2 \alpha \sinh \xi}{(\cosh \xi - \cos \alpha)^3}$$

$$= -\int_0^\infty \lambda \,[\, f(\lambda) \sinh \lambda\alpha + g(\lambda) \cosh \lambda\alpha\,] \sin \lambda\xi \, d\lambda \tag{15}$$

$$\frac{Ac \sin \beta \sinh \xi}{(\cosh \xi - \cos \beta)^2} + \frac{2 Bc^2 \sin^2 \beta \sinh \xi}{(\cosh \xi - \cos \beta)^3}$$

$$= \int_0^\infty \lambda \,[\, f(\lambda) \sinh \lambda\beta - g(\lambda) \cosh \lambda\beta\,] \sin \lambda\xi \, d\lambda \tag{16}$$

Using the method discussed by Sen[6], we find that the values of $f(\lambda)$ and $f(\lambda)$ are given by

$$f(\lambda) = \frac{1}{\sinh \pi\lambda \sinh \lambda(\alpha+\beta)} \times$$

$$\times \Big(-2\,Ac\,\{ \cosh \lambda\beta \sinh \lambda(\pi-\alpha) + \cosh \lambda\alpha \sinh \lambda(\pi-\beta) \} +$$

$$+ 2\,Bc^2 [\cosh \lambda\alpha \{ \lambda \cosh \lambda(\pi-\beta) + \cot \beta \sinh \lambda(\pi-\beta) \}$$

$$- \cosh \lambda\beta \{ \lambda \cosh \lambda(\pi-\alpha) + \cot \alpha \sinh \lambda(\pi-\alpha) \}] \Big)$$

and

$$g(\lambda) = \frac{1}{\sinh \pi\lambda \sinh \lambda(\alpha+\beta)} \times$$

$$\times \Big(2\,Ac\,\{ \cosh \lambda\alpha \sinh \lambda(\pi-\beta) - \sinh \lambda\beta \sinh \lambda(\pi-\alpha) \} -$$

$$- 2\,Bc^2 [\sinh \lambda\beta \{ \lambda \cosh \lambda(\pi-\alpha) + \cot \alpha \sinh \lambda(\pi-\alpha) \} +$$

$$+ \sinh \lambda\alpha \{ \lambda \cosh \lambda(\pi-\beta) + \cot \beta \sinh \lambda(\pi-\beta) \}] \Big)$$

Making use the above values of $f(\lambda)$ and $g(\lambda)$ the value of ψ is given from (13) as

$$\psi = \int_0^\infty \Big[< -2\,Ac\,\{ \cosh \lambda\beta \sinh \lambda(\pi-\alpha) + \cosh \lambda\alpha \sinh \lambda(\pi-\beta) \} +$$

$$+ 2\,Bc^2 [\cosh \lambda\alpha \{ \lambda \cosh \lambda(\pi-\beta) + \cot \beta \sinh \lambda(\pi-\beta) \} - \cosh \lambda\beta \{ \lambda \cosh \lambda(\pi-\alpha) +$$

$$+ \cot \alpha \sinh \lambda(\pi-\alpha) \}] > \sinh \lambda\eta + < 2Ac\,\{$$

$$\{ \sinh \lambda\alpha \sinh \lambda(\pi-\beta) - \sinh \lambda\beta \sinh \lambda(\pi-\alpha) \} - 2\,Bc^2 [\sinh \lambda\alpha \{ \lambda \cosh \lambda(\pi-\beta)$$

$$+ \cot \beta \sinh \lambda(\pi-\beta) \} + \sinh \lambda\beta \{ \lambda \cosh \lambda(\pi-\alpha) + \cot \alpha \sinh \lambda(\pi-\alpha) \}] >$$

$$\times \cosh \lambda\eta \Big] \times \frac{\cos \lambda\xi \, d\lambda}{\sinh \pi\lambda \sinh \lambda(\alpha+\beta)} \Big] \tag{17}$$

Now the use of the transformations (11) and the equations (7) and (17) give the expressions for the velocity components in the following forms·

$$u = h^2 \int_0^\infty < (< -2\,Ac\,\{ \cosh \lambda\beta \sinh \lambda\,(\pi-\alpha) + \cosh \lambda\alpha \sinh \lambda\,(\pi-\beta) \} +$$

$$2\,Bc^2[\cosh \lambda\alpha \{ \lambda \cosh \lambda\,(\pi-\beta) +$$

$$+ \cot\beta \sinh \lambda\,(\pi-\beta) \} - \cosh \lambda\beta \{ \lambda \cosh \lambda\,(\pi-\alpha) + \cot\alpha \sinh \lambda\,(\pi-\alpha) \}] > \sinh \lambda\eta +$$

$$< 2\,Ac\,\{ \sinh \lambda\alpha \sinh \lambda\,(\pi-\beta) - \sinh \lambda\beta \sinh \lambda\,(\pi-\alpha) \} - 2\,Bc^2[\sinh \lambda\alpha \{ \lambda \cosh \lambda\,(\pi-\beta) +$$

$$+ \cot\beta \sinh \lambda\,(\pi-\beta) \} + \sinh \lambda\beta \{ \lambda \cosh \lambda\,(\pi-\alpha) + \cot\alpha \sinh \lambda\,(\pi-\alpha) \}] > \cosh \lambda\eta\ ) \times$$

$$\times \frac{\lambda\, c \sin \lambda\xi \sinh \xi \sin \eta}{\sinh \pi\lambda\,(\cosh \xi - \cos \eta)^2 \sinh \lambda\,(\alpha+\beta)}$$

$$+ (< -2\,Ac\,\{ \cosh \lambda\beta \sinh \lambda\,(\pi-\alpha) + \cosh \lambda\alpha \sinh \lambda\,(\pi-\beta) \} +$$

$$+ 2\,Bc^2 [\cosh \lambda\alpha \{ \lambda \cosh \lambda\,(\pi-\beta) + \cot\beta \sinh \lambda\,(\pi-\beta) \} -$$

$$- \cosh \lambda\beta \{ \lambda \cosh \lambda\,(\pi-\alpha) + \cot\alpha \sinh \lambda\,(\pi-\alpha) \}] > \cosh \lambda\eta + < 2\,Ac\,\{ \sinh \lambda\alpha \sinh \lambda$$

$$(\pi-\beta) -$$

$$- \sinh \lambda\beta \sinh \lambda\,(\pi-\alpha) \} - 2\,Bc^2 [\sinh \lambda\alpha \{ \lambda \cosh \lambda\,(\pi-\beta) + \cot\beta \sinh \lambda\,(\pi-\beta) \} +$$

$$+ \sinh \lambda\beta \{ \lambda \cosh \lambda\,(\pi-\alpha) + \cot\alpha \sinh \lambda\,(\pi-\alpha) \}] > \sinh \lambda\eta\ ) \times$$

$$\times \frac{\lambda\, c \cos \lambda\xi\,(\cosh \xi \cos \eta - 1)}{\sinh \pi\lambda\,(\cosh \xi - \cos \eta)^2 \sinh \lambda\,(\alpha+\beta)} > d\lambda \tag{18}$$

$$v = h^2 \int_0^\infty < (< -2\,Ac\,\{ \cosh \lambda\beta \sinh \lambda\,(\pi-\alpha) + \cosh \lambda\alpha \sinh \lambda\,(\pi-\beta) \} +$$

$$+ 2\,Bc^2[\cosh \lambda\alpha \{ \lambda \cosh \lambda\,(\pi-\beta) +$$

$$+ \cot\beta \sinh \lambda\,(\pi-\beta) \} - \cosh \lambda\beta \{ \lambda \cosh \lambda\,(\pi-\alpha) + \cot\alpha \sinh \lambda\,(\pi-\alpha) \}] > \times \sinh \lambda\eta +$$

$$< 2\,Ac\,\{ \sinh \lambda\alpha \sinh \lambda\,(\pi-\beta) - \sinh \lambda\beta \sinh \lambda\,(\pi-\alpha) \} - 2\,Bc^2[\sinh \lambda\alpha \{ \cosh \lambda\,(\pi-\beta) +$$

$$+ \cot\beta \sinh \lambda\,(\pi-\beta) \} + \sinh \lambda\beta \{ \lambda \cosh \lambda\,(\pi-\alpha) + \cot\alpha \sinh \lambda\,(\pi-\alpha) \}] > \cosh \lambda\eta\ ) \times$$

$$\frac{\lambda\, c\, (\cosh\xi\cos\eta - 1)\sin\lambda\xi}{\sinh\pi\lambda\,(\cosh\xi - \cos\eta)^2\sinh\lambda(\alpha+\beta)} - \times$$

$$\times\,(\,<-2\,Ac\,\{\cosh\lambda\beta\sinh\lambda(\pi-\alpha) + \cosh\lambda\alpha\sinh\lambda(\pi-\beta)\} +$$

$$+\,2\,Bc^2\,[\cosh\lambda\alpha\,\{\lambda\cosh\lambda(\pi-\beta) + \cot\beta\sinh\lambda(\pi-\beta)\} -$$

$$-\cosh\lambda\beta\,\{\lambda\cosh\lambda(\pi-\alpha) + \cot\alpha\sinh\lambda(\pi-\alpha)\}\,]>\cosh\lambda\eta + <2\,Ac\,\{\sinh\lambda\alpha\sinh\lambda$$

$$(\pi-\beta) -$$

$$-\sinh\lambda\beta\sinh\lambda(\pi-\alpha)\} - 2\,Bc^2\,[\sinh\lambda\alpha\,\{\lambda\cosh\lambda(\pi-\beta) + \cot\beta\sinh\lambda(\pi-\beta)\} +$$

$$+\sinh\lambda\beta\,\{\lambda\cosh\lambda(\pi-\alpha) + \cot\alpha\sinh\lambda(\pi-\alpha)\}\,]>\sinh\lambda\eta\,)\,\times$$

$$\times\,\frac{\lambda\, c\,\sin\eta\sinh\xi\cos\lambda\xi}{\sinh\pi\lambda\,(\cosh\xi - \cos\eta)^2\sinh\lambda(\alpha+\beta)} > d\lambda \tag{19}$$

Using the above value of v the expression for hy can easily be obtained from (6) where

$$hy = \frac{H_0}{A + By}\; v \tag{20}$$

Again, from the relation $\partial hx/\partial x + \partial hy/\partial y = 0$ and the value of hy, as obtained from (20), the expression for hx is found to be

$$h_x = -\frac{BH_0}{(A + By)^2}\;\psi + \frac{H_0}{A + By}\; u \tag{21}$$

It can be easily shown that equation (11) will be satisfied by the values of hx and hy. Now by using the values of hx and hy we get the total normal and tangential components of the magnetic field in the following forms:

Total normal component

$$H_N = -\frac{ch}{(\cosh\xi - \cos\eta)^2}\,[\,hy\,(\cosh\xi\cos\eta - 1) + hx\,(\sin\eta\sinh\xi)\,] \tag{22}$$

and the total tangential component

$$H_T = \frac{ch}{(\cosh\xi - \cos\eta)^2}\,[\,hx\,(\cosh\xi\cos\eta - 1) - hy\,(\sin\eta\sinh\xi)\,] \tag{23}$$

4. Particular cases: Constant shear flow past a circular cylinder

If we now make $\eta \to \pi/2$ and $-\pi/2$ in (11) then the region bounded by two circular arcs becomes a circle of radius C In this limit, the results given in (18) to (23), with some changes in notations, are in good agreement with those of Nigam[3] For example, the expression for hy is given by

$$hy = \frac{H_0}{A + BC \operatorname{sech} \xi} \left[2 A \operatorname{sech} \xi \tanh \xi + Bc \left(3 \operatorname{sech}^2 \xi - \tanh^2 \xi\right) \tanh \xi\right]$$

where on the boundary $x = a \cos \theta = -c \tan h\xi$, $y = a \sin \theta = c \sec h\xi$

5. Numerical results

For numerical calculation, we first find out the values of ψ, $\partial\psi/\partial\xi$ and $\partial\psi/\partial\eta$ and for this we assume $A/Bc = 2$, $Bc^2 = 1$, $\alpha = \beta = \eta = 3\pi/4$ so that from (17) we get

$$\psi = -2 Bc^2 \int_0^\infty \left[\sinh \pi\lambda/4 + \lambda \cosh \pi\lambda/4\right] \frac{\cos \lambda\xi}{\sinh \pi\lambda} d\lambda$$

$$\frac{\partial\psi}{\partial\xi} = 2 BC^2 \int_0^\infty \left[\sinh \frac{\pi\lambda}{4} + \lambda \cosh \frac{\pi\lambda}{4}\right] \frac{\lambda \sin \lambda\xi}{\sinh \lambda\xi} d\lambda$$

$$\frac{\partial\psi}{\partial\eta} - 4 BC^2 \int_0^\infty \left[2 \coth^2 \frac{3\pi\lambda}{4} \sinh \frac{\pi\lambda}{4} + \lambda \cosh \frac{\pi\lambda}{4} - \sinh \frac{\pi\lambda}{4} \right[\times$$

$$\times \frac{\lambda \tanh 3\pi\lambda/4 \cos \lambda\xi \, d\lambda}{\sinh \pi\lambda}$$

We give below the tables for ψ, $\partial\psi/\partial\xi$ and $\partial\psi/\partial\eta$ for different limits of integration which are calculated by the main computer (EC-1033) system. The ranges are 0 to 80, 0 to 85, 0 to 90 and 0 to 95.

To show the nature of the velocity distributions, we take the values of ψ, $\partial\psi/\partial\xi$ and $\partial\psi/\partial\eta$ in the range of 0 to 95

The values of ψ, $\partial\psi/\partial\xi$ and $\partial\psi/\partial\eta$ are calculated by the Gauss's quadrature formula at 10 points.

The distributions of the velocity components u, v magnetic fields hx, hy and the total normal and tangential components of the magnetic fields H_N, H_T on the boundary of the circular arcs for different values of ξ have been shown in fig. 1 to 6 by continuous curves The correspond-

ξ	ψ	$\partial\psi/\partial\xi$	$\partial\Psi/\partial\eta$
0	— 0 93741417 E00	0 0	— 0.19753771 E01
1	— 0 93228132 E00	0 10254854 E00	— 0 19642878 E01
2	— 0.91694772 E00	0.20380664 E00	— 0 19312382 E01
3	— 0 89160413 E00	0.30254841 E00	— 0 18768501 E01
.4	— 0 85655898 E00	0.39765894 E00	— 0 18020668 E01
5	— 0 81222594 E00	0.48815966 E00	— 0 17080450 E01
6	— 0 75910926 E00	0 57320237 E00	— 0 15960436 E01
7	— 0 69779277 E00	0 65203875 E00	— 0 14673452 E01
8	— 0 62893122 E00	0 72397947 E00	— 0 13232193 E01
9	— 0 55324882 E00	0 78835249 E00	— 0 11649523 E01

0	— 0 88513875 E00	0.0	— 0 19759979 E01
1	— 0 87968379 E00	0 10898048 E00	— 0 19636545 E01
2	— 0.86339122 E00	0 21651095 E00	— 0 19268436 E01
3	— 0 83647662 E00	0 32119542 E00	— 0 18661919 E01
4	— 0.79929024 E00	0 42173141 E00	— 0 17826738 E01
.5	— 0 75230801 E00	0 51693279 E00	— 0.16775246 E01
6	— 0 69611758 E00	0 60572833 E00	— 0 15521593 E01
7	— 0 63140827 E00	0.68714213 E00	— 0 14081154 E01
8	— 0 55896521 E00	0 76027048 E00	— 0 12470341 E01
9	— 0 47965902 E00	0 82426125 E00	— 0 10706825 E01

0	— 0.83119875 E00	0 0	— 0 19608021 E01
.1	— 0 82546520 E00	0 11453331 E00	— 0 19471779 E01
.2	— 0 80834705 E00	0 22741991 E00	— 0 19065380 E01
3	— 0 78008926 E00	0 33706117 E00	— 0 18395576 E01
4	— 0 74109334 E00	0 44194221 E00	— 0 17473030 E01
5	— 0 69190663 E00	0 54065788 E00	— 0 16311712 E01
6	— 0 63321054 E00	0 63191503 E00	— 0 14928141 E01
7	— 0 56581163 E00	0 71452773 E00	— 0 13341112 E01
8	— 0 49062932 E00	0 78740901 E00	— 0 11571436 E01
9	— 0 40868783 E00	0 84956557 E00	— 0 96420681 E00

0	— 0 77674466 E00	0 0	— 0 19314766 E01
1	— 0 77677997 E00	0.11912614 E00	— 0 19165869 E01
2	— 0 75298184 E00	0.23638207 E00	— 0.18721800 E01
.3	— 0.72362703 E00	0 34994316 E00	— 0 17990103 E01
4	— 0 68317419 E00	0 45806849 E00	— 0 16982861 E01
5	— 0 63224941 E00	0 55912709 E00	— 0 15716238 E01
6	— 0 57163477 E00	0 65161210 E00	— 0 14209938 E01
7	— 0.50225854 E00	0 73414576 E00	— 0 12486696 E01
.8	— 0.42517889 E00	0 80548507 E00	— 0 10572195 E01
9	— 0.34157211 E00	0 86453086 E00	— 0 84949285 E00

ing results are compared with those of Nigam[3] and are denoted by dotted line. For numerical calculation it is assumed that $BC = 1$ and $A/BC = 2$. It is clear from figs.1 and 2 that the velocity distributions u and v are continuous. The component u reaches its maximum value

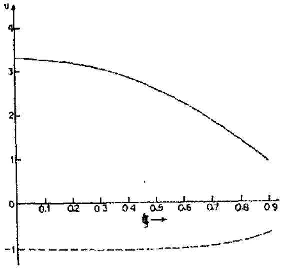

FIG. 1

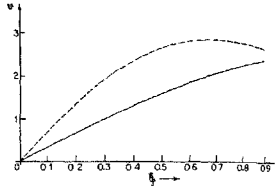

FIG 2

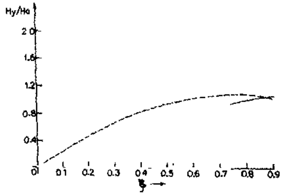

FIG. 3

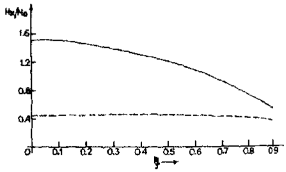

FIG. 4

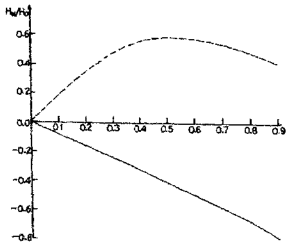

FIG. 5

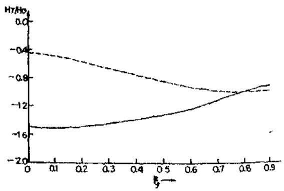

FIG. 6

for $\xi = 0$ for the circular arcs and minimum for $\xi = 0.9$ but never zero within the given range of ξ. However, Nigam[3] gives a negative representation and it is maximum for $\xi = 0.9$ and minimum for $\xi = 0$ and almost like flatter. In fig. 2 the velocity distribution v is minimum (zero) for $\xi = 0$ and then increases with the values of ξ and reaches its maximum value for $\xi = 0.9$ for our problem. On the other hand, for a circular cylinder v minimizes to zero at $\xi = 0$ and then rises to its maximum for $\xi = 0.6$, then again decreases to $\xi = 0.9$ The magnetic field distributions hx and hy are shown in figs. 3 and 4. It is obvious that hy attains its minimum value zero for $\xi = 0$ and then increases and reaches its maximum value for $\xi = 0.9$ while for the circular boundary its behaviour is similar to that curve up to $\xi = 0.8$ and then decreases. The character hx as shown in fig 4 shows that hx is maximum for $\xi = 0$ and then decreases and gives its minimum value for $\xi = 0.9$ and the dotted curve gives almost the same values within the limitation of ξ However, the total normal component H_N gives a negative representation and it is zero and maximum for $\xi = 0$ and then decreases to its minimum value for $\xi = 0.9$ But, for the circular cylinder H_N is zero and minimum for $\xi = 0$ and increases up to $\xi = 0.6$ and then decreases. Lastly, the total tangential component H_T in fig. 6 is minimum for $\xi = 0$ and maximum for $\xi = 0.9$ and the dotted curve is just the reverse and it is maximum for $\xi = 0$ and minimum for $\xi = 0.9$

Notations

$U(y)$	undisturbed velocity,
H_0	undisturbed uniform magnetic field in the directio of x-axis,
$u, v\ (\ll U(y))$	disturbed velocity components in the directions of x,y-axes,
$hx, hy\ (\ll H_0)$	disturbed magnetic field components in the directions of x,y-axes.
p	pressure,
ρ	density,
σ	conductivity of the fluid

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