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Effect of Slip Condition on Thin Layer Flow on an Upright Cylinder for Drainage of Electrically Conducting Power Law Fluid

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Abstract: The effect of slip Condition on an upright cylinder for thin film flow for problem of electrically conducting power law fluid being a drainage has been calculated. From momentum equation, the nonlinear differential equation has been obtained by utilizing Perturbation method. Declarations on behalf of velocity, flow rate and average velocity arrangements have been taken. The graphical results is deliberated and analyzed for various parameters of concern for velocity profile. The Newtonian and Power law MHD arrangement without slip condition is retrieved from this proposed model on substitution β=0 and also satisfy without MHD solution for taking ε=0

Keywords: Thin film flow; power law electrically conducting fluid; Slip condition, Perturbation solution.

1. INTRODUCTION

The quandary of flow with slip-stream is very critical in this time of present day science, development and infeasible running industrialization. The constituent part nearby a strong surface no lengthier considers the velocity of the surface in various certifiable applications. At the surface of a particle causes a determinate tangential velocity; in this situation it skims on the particle. This current organism is named as slip flow regime and their force can't be overlooked. Slippage of fluid marvel placed at stable limits show up in numerous applications, for example, small scale channels or Nano directs and in utilization wherever a slight layer of "light oils" is connected toward the moving-plates on the other hand at the same time surface remains covered with unique covering, for example, thick monolayer of hydrophobic octa-decyltrichlorosilane (Derek, *et al.,* 2002), i.e. grease of mechanical gadget wherever a dainty layer of oil is connected to the surface slipping more than each other.

In the historical backdrop of liquid course through channels, Navier examined a limit state of liquid slip at strong surface such that $v_z = -\beta S_{rz}\big|_{r=R}$, where β is the slip coefficient, S_{rz} is part of extra stress tensor and v_z is the velocity along *z-axis*. For a situation $\beta = 0$ lists that there is no slip at the limit.

Hither, included subject, material be measured as generalized Newtonian fluids using the thickness occupation following to power law Magneto hydrodynamics fluid. To the best of our insight the perturbation arrangement have not yet been accounted for somewhere else.

In the present letter, the approximate series solution of the governing differential equations are obtained, subject to appropriate boundary conditions. In interpretation of their velocity profile, volume flux, and average velocity are calculated. Section number two involve the resulting differential equations of power law electrically conducting fluid. Inside section number three under attention problem is communicated and solution of the problem and in section number four results as well as discussion. Concluding remarks are presented within section number five.

2 BASIC EQUATIONS

From Essential governing equations for incompressible power law electrically conducting fluid flow disregarding the warm impacts are from

$$0 = \frac{\eta}{r}\frac{d}{dr}\left(r\left(\frac{dw}{dr}\right)^{n}\right) + \rho g - \sigma B_0^2 w(r) \qquad (1)$$

Above differential equation is the "non-linear differential equation", the related preconditions for slip conditions are same as from the geometry of (Farooq, *et al.,* 2013),

$$at \quad r = R + \delta; \qquad \frac{dw}{dr} = 0\,, \qquad (2)$$

$$at \quad r = R; \qquad w = -\beta\eta\left(\frac{dw}{dr}\right)^{n}. \qquad (3)$$

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Perturbation Solution

The velocity description $w(r,\varepsilon)$ as it may be stated by a "power series" for taking assumption $\varepsilon = \frac{\sigma B_0^2}{\eta}$ be a small parameter and which is given by,

$w(r,\varepsilon) \approx w_0 + \varepsilon w_1 + \varepsilon^2 w_2 \ldots$ (4)

Using equation (4) into (1) and equations (2) –(3) then by comparing the like terms concerning ε we get the consecutive arrangement of problems together with like preconditions.

"Zeroth order problem"

$$\varepsilon^0: \frac{1}{r}\frac{d}{dr}\left(r\left(\frac{dw_o}{dr}\right)^n\right) = -\frac{\rho g}{\eta} \quad (5)$$

Usingpreconditions,

$$\frac{dw_o}{dr} = 0 \quad at \quad r = R+\delta, \quad (6)$$

$$w_o = -\beta\eta\left(\frac{dw_o}{dr}\right)^n \quad at\, r = R \quad (7)$$

"First order problem"

$$\frac{1}{r}\frac{d}{dr}\left(rn\left(\frac{dw_o}{dr}\right)^{n-1}\frac{dw_1}{dr}\right) - w_o = 0 \quad (8)$$

Through boundary conditions,

$$w_1 = -\beta\eta\left(n\left(\frac{dw_o}{dr}\right)^{n-1}\frac{dw_1}{dr}\right) \quad at \quad r = R. \quad (9)$$

$$\frac{dw_1}{dr} = 0 \quad at \quad r = R+\delta \quad (10)$$

Now two belongings arise:

Case-I: Newtonian fluid for substitution n = 1

Case-II: Power Law fluid for taking n ≠ 1

2.1 "Solution for the Newtonian MHD fluid"

2.1.1 "Velocity Profile"

"Zeroth order Solution":

Solution of the zeroth order from equation no: (5) by applying preconditions equation (6) as well as (7) is:

$$w_o = \frac{\beta\rho g}{2R}(R^2+(R+\delta)^2) - \frac{\rho g}{4\eta}\left(r^2 - R^2 + 2(R+\delta)^2 ln\left(\frac{r}{R}\right)\right) \quad (11)$$

"First-order solution":

By use equation (11) into (8) and focus to conditions (9) and (10), then first order solution will be,

$$w_1 = -\frac{\beta\eta}{R}\left[\left(R^2-(R+\delta)^2\right)\left(\frac{\rho g}{4}\left(R^2+(R+\delta)^2\right)\right)\left(\frac{\beta}{R}+\frac{1}{2\eta}\right) - \frac{\rho g}{16\eta}\left\{R^4-(R+\delta)^4\left(1+4\ln\left(\frac{R+\delta}{R}\right)\right)\right\}\right] \quad (12)$$
$$+\frac{(r^2-R^2)}{2}\left\{\frac{\beta\rho g}{4R}\left(R^2+(R+\delta)^2\right) - \frac{\rho g}{32\eta}\left(r^2-3R^2-8(R+\delta)^2\right)\right\} - (R+\delta)^2\ln\left(\frac{r}{R}\right)$$
$$\left\{\frac{\beta\rho g}{4R}\left(R^2+(R+\delta)^2\right) - \frac{\rho g}{16\eta}\left(1-2R^2+4(R+\delta)^2\ln\left(\frac{R+\delta}{R}\right) - 2(R+\delta)^2 - 2r^2\right)\right\}$$

Therefore the "perturbation solution" precise up to first order:

$$w(r) = \frac{\beta\rho g}{2R}\left(R^2+(R+\delta)^2\right) + \frac{\rho g}{4\eta}\left(r^2-R^2-2(R+\delta)^2\ln\left(\frac{r}{R}\right)\right) - \frac{\beta\eta\varepsilon}{R}$$
$$\left[\left(R^2-(R+\delta)^2\right)\left(\frac{\rho g}{4}\left(R^2+(R+\delta)^2\right)\right)\left(\frac{\beta}{R}+\frac{1}{2\eta}\right) - \frac{\rho g}{16\eta}\left\{R^4-(R+\delta)^4\left(1+4\ln\left(\frac{R+\delta}{R}\right)\right)\right\}\right] \quad (13)$$
$$+\frac{(r^2-R^2)}{2}\left\{\frac{\beta\rho g}{4R}\left(R^2+(R+\delta)^2\right) - \frac{\rho g}{32\eta}\left(r^2-3R^2-8(R+\delta)^2\right)\right\} - (R+\delta)^2\ln\left(\frac{r}{R}\right)$$
$$\left\{\frac{\beta\rho g}{4R}\left(R^2+(R+\delta)^2\right) - \frac{\rho g}{16\eta}\left(1-2R^2+4(R+\delta)^2\ln\left(\frac{R+\delta}{R}\right) - 2(R+\delta)^2 - 2r^2\right)\right\}$$

At this point if we set $\varepsilon = 0$ in (13), we regain the solution with Newtonian fluid without MHD and if we set slip parameter equal to zero we get the result with no slip condition with MHD and if both equal to zero then results will become without MHD with no slip condition (Memon, *et al.,* 2014).

2.1.2 "Volume Flow Rate"

Affecting volumetric flow rate$Q$, be specified as

$$Q = \int_0^{2\pi}\int_R^{R+\delta} rw(r)drd\theta = 2\pi\int_R^{R+\delta} rw(r)dr \quad (14)$$

For the usage of equation (13) into (14), once get;

$$Q = \pi \left[\begin{array}{l} -\frac{\beta\rho g}{2R}\left((R+\delta)^4 - R^4\right) - \frac{\rho g}{8\eta}\left(\left((R+\delta)^4 - R^4\right) - 2R^3\left((R+\delta)^2 - R^2\right) - 2(R+\delta)^2\left(2(R+\delta)^2\right)\ln\left(\frac{R+\delta}{R}\right)\right. \\ \left. -\left((R+\delta)^2 - R^2\right)\right) - \frac{\beta\eta\varepsilon}{R}\left(-\left(R^2-(R+\delta)^2\right)\left(\frac{\rho g}{4}\left(R^2+(R+\delta)^2\right)\right)\left(\frac{\beta}{R}+\frac{1}{2\eta}\right) - \frac{\rho g\left((R+\delta)^2 - R^2\right)}{16\eta}\right. \\ \left.\left(R^4-(R+\delta)^4\right)\left(1+4\ln\left(\frac{R+\delta}{R}\right)\right)\right) + \varepsilon\left(\frac{\left((R+\delta)^4 - R^4\right)}{4} - \frac{R^2\left((R+\delta)^2 - R^2\right)}{2}\right) \\ \left\{\frac{\beta\rho g}{4R}\left(R^2+(R+\delta)^2\right) - \frac{\rho g}{32\eta}\left(-3R^2 - 8(R+\delta)^2\right)\right\} - \varepsilon\frac{\rho g}{32\eta}\left(\frac{\left((R+\delta)^6 - R^6\right)}{6} - \frac{R^2\left((R+\delta)^4 - R^4\right)}{4}\right) \\ +\frac{\rho g\varepsilon}{8\eta}(R+\delta)^2\left\{\left(\frac{\beta\rho g}{4R}\left(R^2+(R+\delta)^2\right) + 1 - 2R^2 + 4(R+\delta)^2\ln\left(\frac{R+\delta}{R}\right) - 2(R+\delta)^2\right)\right. \\ \left.\left(\frac{(R+\delta)^2}{2}\right)\ln\left(\frac{R+\delta}{R}\right) - \frac{\left((R+\delta)^2 - R^2\right)}{4}\right\} + \frac{\rho g\varepsilon}{8\eta}(R+\delta)^2 \times \left(\frac{(R+\delta)^4}{2}\ln\left(\frac{R+\delta}{R}\right) - \frac{\left((R+\delta)^4 - R^4\right)}{4}\right) \end{array} \right] \quad (15)$$

2.1.3 “Average velocity”

Average velocity $\bar{V}$ for thin film flow is can be obtain as the formula:

$$\bar{V} = \frac{Q}{\pi((R+\delta)^2 - R^2)} \quad (16)$$

2.2 “Solution for power law MHD fluid”

2.2.1 “Velocity Profile”

“Zeroth order solution”:

Appling binomial series as well as using preconditions (6) and (7) solution of equation (5) will be,

$$w_o = -\frac{\beta\rho g}{2}\left(\frac{(R+\delta)^2}{R} - R\right) + \left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}} \sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}(-1)^k \frac{(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left(r^{2k-\frac{1}{n}+1} - R^{2k-\frac{1}{n}+1}\right) \quad (17)$$

“First order solution”:

Substitute equation (17) into equation (8) after applying equation (9) and (10) once we get;

$$\begin{array}{l} w_1 = -\frac{\beta\eta}{2}\left(\frac{\beta\rho g}{2R}\left((R+\delta)^2 - R^2\right)\right)\left((R+\delta)^2 - R^2\right) - \beta\eta\left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left\{\frac{1}{2k-\frac{1}{n}+3}\right. \\ \left.\left(R^{2k-\frac{1}{n}+3} - (R+\delta)^{2k-\frac{1}{n}+3}\right) - \frac{R^{2k-\frac{1}{n}+1}}{2}\left(R^2 - (R+\delta)^2\right)\right\} - \frac{1}{n}\left(\frac{\rho g}{2\eta}\right)^{\frac{1-n}{n}}\left[\left(-\frac{U_o}{2} + \frac{\beta\rho g}{4R}\left(R^2 - (R+\delta)^2\right)\right)\right. \\ \sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left(r^{2k-\frac{1}{n}+1} - R^{2k-\frac{1}{n}+1}\right) + \left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\sum_{l=0}^{\infty}\binom{\frac{1}{n}}{k}\binom{\frac{1-n}{n}}{l}\frac{(-1)^{(k+l)}(R+\delta)^{\frac{4}{n}-2k-2l-2}}{2k-\frac{1}{n}+1}\left\{\frac{1}{2k-\frac{1}{n}+3}\right. \\ \left.\left.\left(\frac{r^{2k+2l-\frac{2}{n}+4} - (R)^{2k+2l-\frac{2}{n}+4}}{2k+2l-\frac{2}{n}+4} - \frac{(R+\delta)^{2k-\frac{1}{n}-3}}{2l-\frac{1}{n}+1}\left(r^{2l-\frac{1}{n}+1} - R^{2l-\frac{1}{n}+1}\right)\right) - \frac{R^{2k-\frac{1}{n}+1}}{2}\left(\frac{r^{2l-\frac{1}{n}+3} - R^{2l-\frac{1}{n}+3}}{2l-\frac{1}{n}+3} - \frac{(R+\delta)^2}{\left(2l-\frac{1}{n}+1\right)^2}\left(r^{2l-\frac{1}{n}+1} - R^{2l-\frac{1}{n}+1}\right)\right)\right\}\right] \end{array} \quad (18)$$

By inserting equation (17) and (18) in to series equation (4) we get

$$\begin{aligned}
w(r) = & -\frac{\beta\rho g}{2R}\left((R+\delta)^2-R^2\right)+\left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left(r^{2k-\frac{1}{n}+1}-R^{2k-\frac{1}{n}+1}\right)+ \\
& \frac{\beta\eta\varepsilon}{2}\left(-\frac{\beta\rho g}{2R}\left((R+\delta)^2-R^2\right)\right)\left((R+\delta)^2-R^2\right)-\beta\eta\varepsilon\left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\Bigg\{\frac{1}{2k-\frac{1}{n}+3} \\
& \left(R^{2k-\frac{1}{n}+3}-(R+\delta)^{2k-\frac{1}{n}+3}\right)-\frac{R^{2k-\frac{1}{n}+1}}{2}\left(R^2-(R+\delta)^2\right)\Bigg\}-\frac{\varepsilon}{n}\left(\frac{\rho g}{2\eta}\right)^{\frac{1-n}{n}}\Bigg[\Bigg[\left(-\frac{\beta\rho g}{4R}\left(R^2-(R+\delta)^2\right)\right) \\
& \sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left(r^{2k-\frac{1}{n}+1}-R^{2k-\frac{1}{n}+1}\right)+\left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\sum_{l=0}^{\infty}\binom{\frac{1}{n}}{k}\binom{\frac{1-n}{n}}{l}\frac{(-1)^{(k+l)}(R+\delta)^{\frac{4}{n}-2k-2l-2}}{2k-\frac{1}{n}+1}\Bigg\{\frac{1}{2k-\frac{1}{n}+3} \\
& \left(\left(\frac{r^{2k+2l-\frac{2}{n}+4}-(R)^{2k+2l-\frac{2}{n}+4}}{2k+2l-\frac{2}{n}+4}-\frac{(R+\delta)^{2k-\frac{1}{n}-3}}{2l-\frac{1}{n}+1}\left(r^{2l-\frac{1}{n}+1}-R^{2l-\frac{1}{n}+1}\right)\right)-\frac{R^{2k-\frac{1}{n}+1}}{2}\left(\frac{r^{2l-\frac{1}{n}+3}-R^{2l-\frac{1}{n}+3}}{2l-\frac{1}{n}+3}-\frac{(R+\delta)^2}{\left(2l-\frac{1}{n}+1\right)^2}\left(r^{2l-\frac{1}{n}+1}-R^{2l-\frac{1}{n}+1}\right)\right)\right)\Bigg\}\Bigg]\Bigg]
\end{aligned} \tag{19}$$

here setting the $\varepsilon = 0$, we regain the solution of with power law fluid without MHD and if we set $\beta = 0$ we get the result with no slip condition with MHD and if $\varepsilon = \beta = 0$ then results will become without MHD with no slip condition (Memon, *et al.*, 2014).

2.2.2 "Volume flow Rate" :

By working equation (19) in to (14)

$$\begin{aligned}
Q = \pi \Bigg[& -\frac{\beta\rho g}{2R}\left((R+\delta)^2-R^2\right)^2+\left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left(\left(\frac{1}{2k-\frac{1}{n}+3}\right)\left((R+\delta)^{2k-\frac{1}{n}+3}-R^{2k-\frac{1}{n}+3}\right)-\right. \\
& \left.\frac{R^{2k-\frac{1}{n}+2}}{2}\left((R+\delta)^2-R^2\right)\right)+\varepsilon\left\{\beta\eta\left(U_o\left((R+\delta)^2-R^2\right)-\frac{\beta\rho g}{2R}\left((R+\delta)^2-R^2\right)^3\right)\right\}-\beta\eta\varepsilon \\
& \left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left\{\frac{1}{2k-\frac{1}{n}+3}\left(\left((R+\delta)^2-R^2\right)-(R+\delta)^{2k-\frac{1}{n}+3}\right)-\frac{R^{2k-\frac{1}{n}+1}}{2}\left((R+\delta)^2-R^2\right)^2\right\} \\
& +\frac{\varepsilon}{n}\left(\frac{\rho g}{2\eta}\right)^{\frac{1-n}{n}}\Bigg[\Bigg(\frac{\beta\rho g}{2R}\left(R^2-(R+\delta)^2\right)\Bigg(\sum_{k=0}^{\infty}\binom{\frac{1}{n}}{k}\frac{(-1)^{(k)}(R+\delta)^{\frac{2}{n}-2k}}{2k-\frac{1}{n}+1}\left(\frac{1}{2k-\frac{1}{n}+3}\left((R+\delta)^{2k-\frac{1}{n}+3}-R^{2k-\frac{1}{n}+3}\right)-\frac{R^{2k-\frac{1}{n}+3}\left((R+\delta)^2-R^2\right)}{2}\right) \\
& +\left(\frac{\rho g}{2\eta}\right)^{\frac{1}{n}}\sum_{k=0}^{\infty}\sum_{l=0}^{\infty}\binom{\frac{1}{n}}{k}\binom{\frac{1-n}{n}}{l}\frac{(-1)^{(k+l)}(R+\delta)^{\frac{4}{n}-2k-2l-2}}{2k-\frac{1}{n}+3}\Bigg\{\frac{1}{\left(2k-\frac{1}{n}+3\right)\left(k+l-\frac{1}{n}+2\right)}\Bigg(\frac{(R+\delta)^{2k+2l-\frac{2}{n}+6}-(R)^{2k+2l-\frac{2}{n}+6}}{2k+2l-\frac{2}{n}+6}-- \\
& \frac{(R)^{2k+2l-\frac{2}{n}+4}\left((R+\delta)^2-R^2\right)}{2}\Bigg)-\frac{(R+\delta)^{2k-\frac{1}{n}+3}}{2l-\frac{1}{n}+1}\left(\frac{2}{2k-\frac{1}{n}+3}\left(\frac{(R+\delta)^{2l-\frac{1}{n}+3}-(R)^{2l-\frac{1}{n}+3}}{2l-\frac{1}{n}+3}-\frac{(R)^{2l-\frac{1}{n}+3}\left((R+\delta)^2-R^2\right)}{2}\right)\right)\Bigg\} \\
& -\frac{(R)^{2k-\frac{1}{n}+1}}{2l-\frac{1}{n}+3}\left\{\frac{(R+\delta)^{2l-\frac{1}{n}+3}-R^{2l-\frac{1}{n}+3}}{2l-\frac{1}{n}+3}-\frac{R^{2l-\frac{1}{n}+3}\left((R+\delta)^2-R^2\right)}{2}-\frac{(R+\delta)^2}{2l-\frac{1}{n}+1}\frac{(R+\delta)^{2l-\frac{1}{n}+3}-R^{2l-\frac{1}{n}+3}}{2l-\frac{1}{n}+3}-\frac{R^{2l-\frac{1}{n}+3}\left((R+\delta)^2-R^2\right)}{2}\right\}\Bigg)\Bigg]\Bigg]
\end{aligned} \tag{20}$$

2.2.3 Average velocity:

By working equation (20) in to (16) the we can get the average as the formula of Newtonian case.

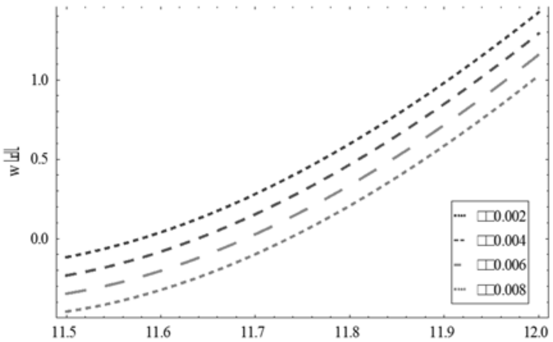

Fig. 1. Difference concerning ϵ at velocity profilefor Newtonianfluid, when , $\delta = 0.5$cm, $R = 12$cm, $\rho = 0.88$g/cm^3, $\beta = 0.002$, $\eta = 10$

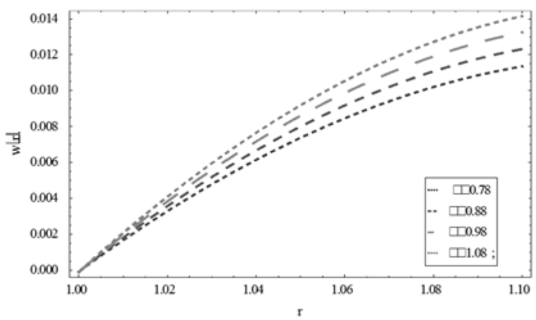

Fig. 2. Difference concerning η at velocity profilefor Newtonian fluid, when, $\delta = 0.5$cm, $R = 12$cm, $\rho = 088g/cm^3$, $\beta = 0.0002$, $\epsilon = .8$

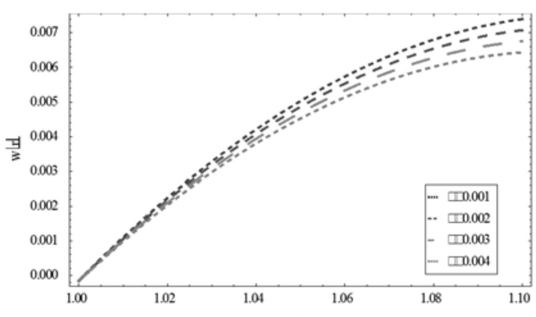

Fig. 3. Difference concerning β at velocity profile for Newtonian fluid, when, $\delta = 0.5$cm, $R = 11.5cm$, $\eta = 9$poise, $\epsilon = 0.8$, $\rho = 0.78gcm^3$

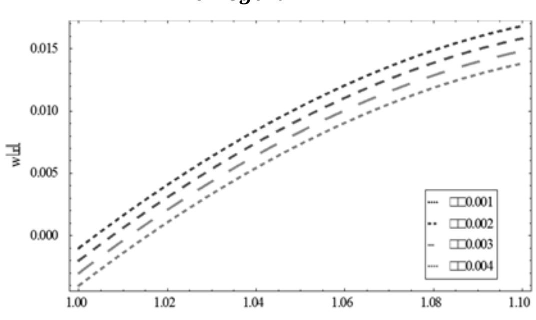

Fig. 4. Difference concerning ρ at velocity profile for Newtonian fluid for Drainage, when, $\delta = 0.5$cm, $R = 11.5cm$, $\beta = 0.0002$; $\eta = 10$poise, $\epsilon = 0.8$

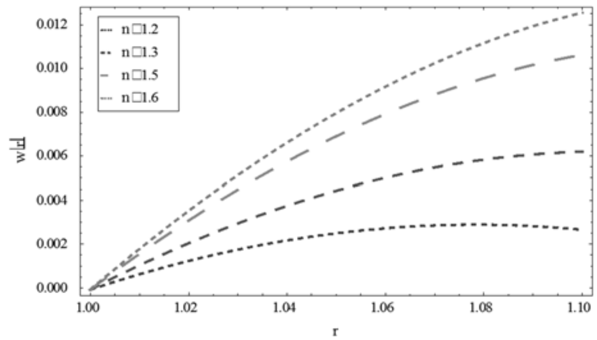

Fig. 5. Differenceconcerning ρ at velocity profile for Power-law fluid, When$\delta = .1$cm, $R = 1$cm, $\beta = 0.0001$; , $\eta = 10$poise, $\epsilon = 0.005$, $n = 1.5$

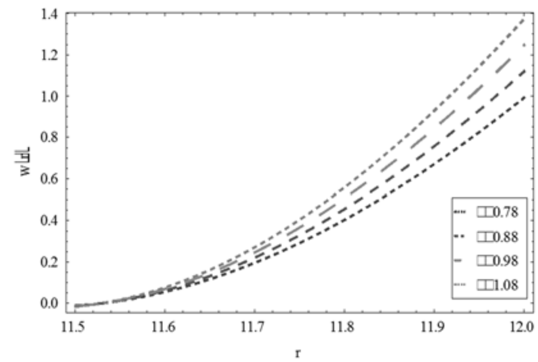

Fig. 6. Difference concerningβat velocity profile for power law fluid, When$\delta = .1$cm, $R = 1cm$, $\rho = 0.98g/cm^3$, $\eta = 8\,poise$, $\epsilon = 0.005$, $n = 1.6$

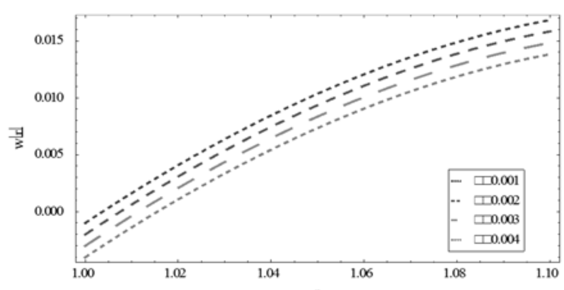

Fig. 7. Difference concerningϵat velocity profile for power law fluid, when$\delta = .1$cm, $R = 1\,cm$, $\rho = \frac{0.78g}{cm^3}$, $\beta = 0.0002$, $\eta = 11poise$, $n = 1.3$

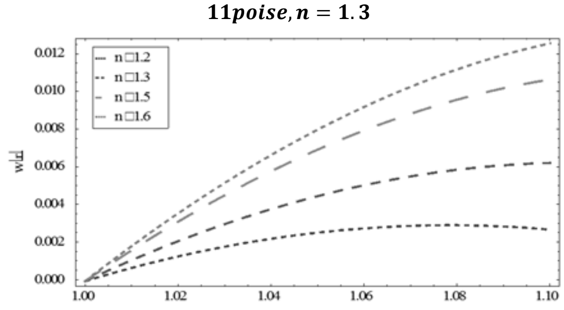

Fig. 8. Difference concerning n at velocity profile for power law fluid, when$\delta = 0.1$cm, $R = 1cm$, $\rho = 0.78gcm^3$, $\beta = 0.0001$, $\eta = 11$poise, $\epsilon = 0.005$

3 RESULTS AND DISCUSSION

Effective dependency like flow measures in the assessment about power-law index n, slip parameter β, co-efficient of viscosity η, density ρ and magnetic parameter ε are observed physically over and done with figures (3) - (10). The deviation concerning axial velocity on behalf of ε, n, η, ρ as well as β used for together Power lawand Newtonian MHDfluid is displayed, we perceived that, with an rise in η, β and ε velocity profile decrease for Newtonian as well as power law MHD fluidand increase for the growth of n and ρ.

4 CONCLUSION

We have delivered outcomes in the thin film flow field of a fluid named as Power law MHD fluid with slip condition, upon a upward cylinder on behalfof drainageproblem. The consequential "non-linear differential equation" has been resolved throughthe technique of Perturbation that is in force also unswerving technique for the purported problem.

The velocity distribution, volume flow rate and average velocity have been followed on analytically. The analogy of the power law MHD and Newtonian MHD fluids for the velocity profile discloses that the magnitude of velocity of power law fluid is greater than that of the Newtonian.

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