MID TERM PAPER.

NAME:: HAMAD-UR-RAHMAN.

ID:: 7669

Subject: Advance Fluid Mechanics.

Teacher:: Engr. Abdul Waheed.

Date:: 26/08/2020.

Advance Fluid Mechanics.

Q2) a). Velocity Profile For laminar Flow:

As,

$$h_L = \frac{\tau \cdot 2 \cdot L}{r\gamma}$$

Viscosity. $\tau = \mu \frac{du}{dy}$

where "u" is velocity at distance "y" from the boundary,

Thus,

$$y = r_0 - r$$

$$dy = d\cancel{r_0}^{\,0} - dr$$

$$\cancel{dy} = \cancel{-dr}$$

$\because dy = -dr.$ ($d r_0 \to$ Constant Value)

$$\therefore \tau = -\mu \frac{du}{dr}$$

Now,

$$h_L = -\frac{\mu\, du\, 2L}{r\gamma\, dr}$$

$$du = -\frac{h_L \gamma}{2\mu L} r\, dr$$

Integrating.

$$\int du = -\frac{h_L \gamma}{2\mu L} \cdot \frac{r^2}{2} + c$$

$$u = -\frac{h_L \gamma}{2\mu L} \cdot \frac{r^2}{2} + c$$

$r = 0$, $u = u_{max}$.

$\therefore$ $C = u_{max}$.

$$u = u_{max} - \frac{h_L \gamma}{2\mu L} \cdot \frac{r^2}{2}$$

$$u = u_{max} - k r^2$$

As we know. $u = 0$ where $r = r_0$.

$$u_{max} = k r_0^2 = \frac{h_L \gamma}{4\mu L} \cdot r_0^2$$

It is known as V_a.

$$\therefore \; V_a = \frac{h_L \gamma}{4\mu L} \cdot r_0^2 = \frac{h_L \gamma}{16\mu L} \cdot D^2$$

The Average velocity may be taken as,

$$\frac{V_u + 0}{2} = 0.5\, V_u.$$

$$= \frac{h_L \gamma \cdot D^2}{32 \mu L}$$

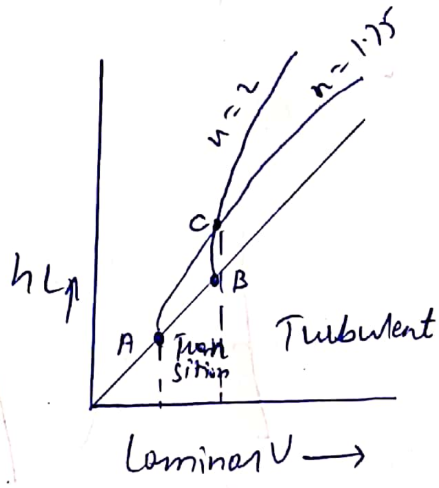
As, $\gamma = \rho g$, $\mu/\rho = \nu$

$$\frac{32 \mu L V}{D^2} = \frac{32 \mu L V}{\rho g \cdot D^2} = \frac{32 L}{g D^2} \nu.$$

Q2/b): Critical Reynold Number:-

If head loss in given length of uniform pipe is measured at different values of velocity, it will found that as long as velocity is low enough to secure laminar flow, the head loss due to friction will be directly proportional to velocity, but increase to turbulent cause change in head loss. thus if values are plotted, lines obtained with slope ranging about 1.75 to 2.

Thus for laminar, drop of energy varies as V & for turbulent, friction varies as V^n where n is 1.75 to 2.



The upper critical reynolds number corresponding to point B is indeterminate and depends upon care taken to prevent initial disturbance. It value is 4000. But normally, it's impossible for flow to be in straight line after R. is at 2000. Thus lower value is much more definite than higher ~~lighter~~ one. and is dividing point. Thus lower value is true critical Reynold Number.

$$R = \frac{DV\rho}{\mu} = \frac{DV}{\nu}.$$

Q No: 2. Given Data:-

Oil having (S.G = 0.7.

Kinematic Viscosity $(\nu) = 1.8 \times 10^{-5} m^2/sec$

Dia of Pipe $= 150mm = 0.15 m.$

Flow $(Q) = 0.5 L/sec = 0.0005 m^3/sec.$

Required:

Centerline Velocity =?

Velocity At 10mm?

Velocity At edge = ?

Maximum Shear Stress $(\tau_0) = ?$

Solution:

First Check for Laminar or Turbulent.

$$R = \frac{DV}{\nu} \qquad V = Q/A = \frac{Q}{\frac{\pi}{4}d^2} = \frac{0.0005}{\frac{\pi}{4}(0.15)^2}.$$

$$\boxed{V = 0.028 m/sec}$$

Now,

$$R = \frac{(0.15)(0.028)}{1.8 \times 10^{-5}}$$

$R = 233.33 < 2000$ (laminar)

$V_u = 2v$.

$V_u = 2 \times 0.028$.

$$\boxed{V_u = 0.056 \text{ m/sec}}$$

$u = u_{max} - k r^2$.

At $r = r_0 = 0.075\text{m}$, $u = 0$.

Thus,

$$\cancel{u}^{\,0} = u_{max} - k r^2$$

$$u_{max} = k r^2$$

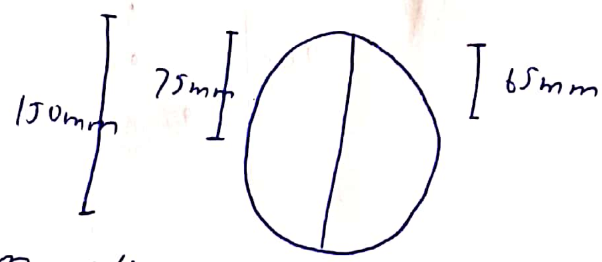
$$k = \frac{u_{max}}{r^2}$$

$$k = \frac{0.056}{(0.075)^2}$$

$$\boxed{k = 9.96}$$

Now, we get a equation.

$$u = 0.056 - 9.96(r^2)$$



Velocity At 10mm from edge,

$r = 0.065m.$

$$V = 0.056 - 9.96(0.065)^2$$

$$\boxed{V = 0.014 m/sec}$$

Velocity At Edge,

$r = 0.075m.$

$$V = 0.056 - 9.96(0.075)$$

$$V = -0.00002 m/sec$$

Say $V = 0$

Similarly :. $f = \frac{64}{R} = \frac{64}{233.33}$

$$\boxed{f = 0.27}$$

Shear Stress At wall,

$$\tau_0 = \frac{f}{4} \rho \frac{v^2}{2}$$

$$\tau = \frac{0.27}{4} \times (0.7 \times 1000) \times \frac{(0.056)^2}{2}$$

$$\boxed{\tau = 0.074 N/m^2}$$