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Q#01

a) Write down .... the pipe.

Ans:-

Velocity Profile for Laminar Flow.

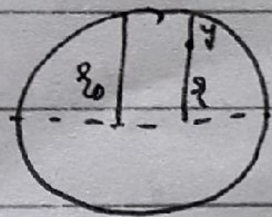
As $h_L = \dfrac{\tau \cdot 2L}{\gamma r}$

from viscosity $\tau = \mu \dfrac{du}{dy} \rightarrow (x)$

where "u" is velocity at ~~diameter~~ distance "y" from the boundary.

Thus

$y = r_0 - r$



$\Rightarrow dy = dr_0 - dr$

or.

$\Rightarrow dy = -dr \qquad \because dr_0 = 0$

put it in Equation (x)

$\Rightarrow \tau = -\mu \dfrac{du}{dr}$

Now $h_L = \frac{\tau . 2L}{r} . r dr$

Integrating on b/s
we, get

$\Rightarrow \int du = \int -\frac{h_L r}{2\mu L} . r . dr$

$\Rightarrow u = -\frac{h_L r}{2\mu L} . \frac{r^2}{2} + C$

Now for $r = 0$, $u = max$, putting value,

$\Rightarrow u = -\frac{h_L r}{2\mu L} . \frac{r^2}{2} + C$

$u = U_{max}$, $U_{max} = 0 + C$

$\Rightarrow C = U_{max}$

Thus $u = U_{max} - \frac{h_L r}{2\mu L} . \frac{r^2}{2}$

→ velocity at Any point.

Assume $K = \frac{h_L . r}{4\mu L}$ $\therefore U = U_{max} - K r^2$

As for $r = r_0$, $U = 0 \Rightarrow 0 = U_{max} - K r_0^2$ or,
$U_{max} = K r_0^2 = \frac{h_L r}{4\mu L} . r_0^2$ (critical velocity)

Now,

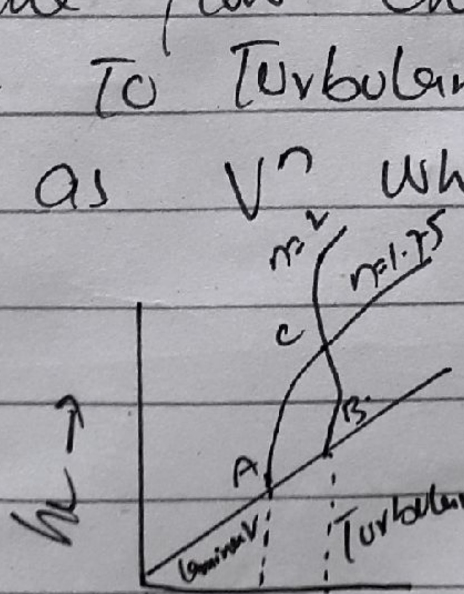
$V_{av} = \frac{V_{cr} + 0}{2} = 0.5 V_{cr}$

b)

Define Critical .... equation.

Ans: Critical Reynolds 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 that to secure laminar flow, the headloss due to friction will be directly proportional to velocity but as the flow changes from laminar to Turbulent, the headloss varies as V^n where n is 1.75 to 2



Transition.

The upper critical Reynold Number corresponding to point B is indeterminate & depends upon case taken to prevent initial disturbance. Its value to 4000. But normally, its impossible for flow to be instraight one after R is at 2000. Thus lower value is much more definite the higher one and is dividing point. Thus lower value is true critical Reynold Number.

Equation of Reynold Number.

$$R = \frac{D V_{cr}}{\nu}$$

Q#02

Given data:

→ Kinamatic Viscosity (ν) = 1.8×10^{-5} m²/sec
→ Specific Gravity (S) = 0.7
→ Dia of pipe (d) = 150mm = 0.15m
→ Discharge (Q) = 0.5 L/sec
Or, = 5×10^{-4} m³/sec.

Solution:

→ Area = $\pi/4 (0.15)^2 = 0.0176 m^2$

→ $Q = AV \Rightarrow V = Q/A = \frac{5 \times 10^{-4}}{0.0176}$

$\Rightarrow V = 0.028 m/sec.$

→ Reynold Number, (R) = DV/ν

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

$= 233 < 2000$

→ So flow is laminar

Now

Centerline velocity.

$\Rightarrow V_{cr} = 2 V_{av} = 2(0.028)$
$= 0.056 \, m/sec$

$\Rightarrow u = u_{max} - K r_0^2$

for $r = r_0 = 0.15/2 = 0.075 m$, $u = 0$

$u = u_{max} = kr^2$

$\Rightarrow u_{max} = kr^2 \quad \because u = 0$

$\Rightarrow k = \frac{u_{max}}{r^2} = \frac{0.056}{(0.075)^2} = 9.96$

we get

$\Rightarrow u = 0.056 - 9.96(r^2) \rightarrow (x)$

velocity at Edge of the pipe.

$U = U_{max} - K r^2$

At wall of pipe, we have $r_0 = 0.15m$

$\Rightarrow U = 0.056 - 9.95(0.075)^2$

$= 3.125 \times 10^{-5}$ m/s. (negligible)

$\Rightarrow U = 0$

velocity at 10mm from edge

$\Rightarrow r = 0.065m$

$\Rightarrow U = 0.056 - 9.96(0.065)^2$

$\Rightarrow U = 0.014 m/sec.$

(10)

→ Shear Stress at wall.

$$\tau = \frac{f}{8} \rho V^2 / g$$

$$= \frac{0.27}{8} \times (0.7 \times 1000) \times \frac{(0.056)^2}{g}$$

$$\tau = 0.074 \ N/m^2$$