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SECTION	"A"
SUBJECT:	FLUID MECHANICS
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QUESTION: 01

PART: (a)

Velocity Profile for laminar flow:

As we know

$$h_L = \frac{\tau \times 2L}{\rho g r}$$

Now From Viscosity $\Rightarrow \tau = \mu \frac{du}{dy}$

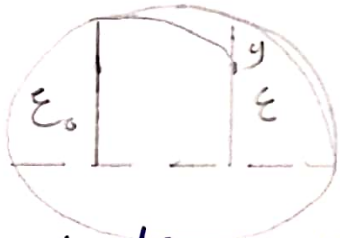
where 'u' is velocity at distance 'y' from boundary

Thus we have

$$y = r_0 - r$$

$$\Rightarrow dy = \cancel{dr_0}^{0} - dr$$

$$\Rightarrow dy = dr$$



$\therefore dr_0$ constant value

putting value in n

$$\tau = -\mu \left(\frac{du}{dr}\right)$$

Now we have

$$h_L = \frac{\tau . 2 . L}{\rho g r} . \quad r . dr$$

Now, Integrating on b/s.

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

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

Now for $r = 0$ $u = u_{max}$

putting these values we get

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

$u = u_{max}$, $u_{max} = 0 + c$

$c = u_{max}$

Thus we get

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

velocity at any point

Assume $K = \frac{h_L r}{4\mu L}$ $\therefore u = u_{max} - K\varepsilon^2$

As for $\varepsilon = \varepsilon_0$ $u = 0$

So $0 = u_{max} - K\varepsilon_0^2$ (or)

$$u_{max} = K\varepsilon_0^2 = \frac{h_L r}{4\mu L} \cdot \varepsilon_0^2$$

It is also known as critical velocity.

Now average velocity calculation

$$V_{av} = \frac{V_c \varepsilon + 0}{2} = 0.5 V_c \varepsilon.$$

QUESTION: 01

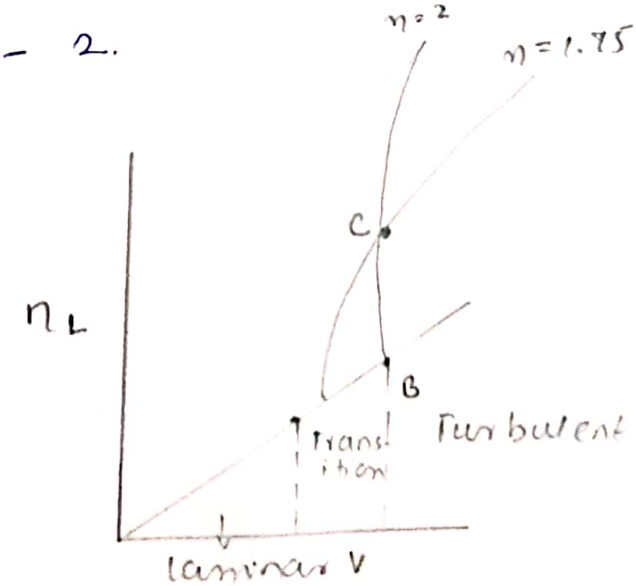
PART: (b)

CRITICAL REYNOLDS NUMBER:

If headloss in given length of uniform pipe is measured at different values of velocity, it will be found that as long as velocity is low enough to secure laminar flow, the headloss due to friction will be directly proportional to velocity, but increase in velocity will change flow from laminar to turbulent and change in head loss.

Thus if values are plotted lines obtained with slope range from 1.75 - 2

Thus, for laminar flow, drop of energy varies as "V" and for turbulent flow, friction varies as "V^n" where n is 1.75 - 2.



The upper critical Reynolds number corresponding to point "B" is indeterminate depending upon care taken to prevent initial disturbance. It's value considered as 4000.

But normally it becomes impossible for the flow to be in straight line after R is at 2000. The lower value is relatively more definite than upper value (higher one).

The lower value is true critical Reynold Number.

$$R = \frac{DV_{cr}}{\nu}$$

QUESTION: 02

Given Data:

Specific Gravity = (S) = 0.7

Kinematic velocity (ν) = 1.8×10^{-5} m^2/s

Diameter of pipe (d) = 150mm = 0.15 m

Discharge (Q) = 0.5 L / sec = $\frac{0.5}{1000}$ = $5 \times 10^{-4} m^3/sec$

Solution:.

We Know

Area = $\frac{\pi}{4}(d)^2$ putting values

$= \frac{3.14}{4}(0.15)^2 = 0.176 m^2$

Now $Q = AV$

$\Rightarrow V = Q/A$ (putting values)

$= \frac{5 \times 10^{-4}}{0.0176}$

$V = 0.028 m/sec$

Reynolds Number (R) = Dv/ν (putting values)

$= \frac{0.15 \times 0.028}{1.8 \times 10^{-5}} = 233 < 2000$

↓

so for laminar flow.

→ Now finding centre line velocity

$V_{cr} = 2 V_{av}$

$= 2(0.028) = 0.056 m/s$

$U = (U_{max} - K r_o^2)$

For $r = r_o$ = $0.15/2 = 0.075$, $u = 0$

Thus

$u^{\to 0} = U_{max} - Kr^2$

$U_{max} = Kr^2$

$K = U_{max}/r^2 = \frac{0.056}{(0.075)^2}$

$K = 9.96$

We get an equation

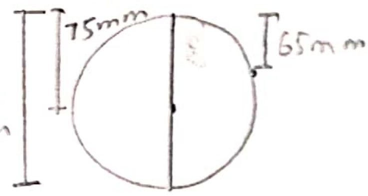
$U = 0.056 - 9.96(r^2)$ —

Now velocity at 10mm from edge

$r = 0.065\ m$

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

$V = 0.014\ m/sec$



Now velocity at edge

$r = 0.075\ m$

$V = 0.056 - 9.96\ (0.075)$

$V = 0.00002\ m/sec$ $\therefore$ say $V = 0$

Similarly

$f = 64/R$ putting values

$f = 64/233.33 = 0.27$

Now finding sheer stress at wall

$\tau = f/8\ \rho . V^2$

$= 0.27/4 \times (0.7 \times 1000) \times (0.056)^2$

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

$f = 64/R$
$= 64/233$
$= 0.27$

$S = \frac{\rho_{fluid}}{\rho_{water}}$

$0.7 = \frac{\rho_{soil}}{1000}$

$\rho_{oil} = 700 kg/m^3$