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QUESTION NO # 01

(A) Expressions for velocity profile in laminar flow inside the pipe :~

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

from viscocity :: $\mu \, du/dy$

where u is value of velocity at distance y from boundry.

$$\because y = r_0 - r$$

$$dy = d r_0 - d r$$

$$d r_0 = \text{Constant} = 0$$

$$dy = -dr$$

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

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

Integrating

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

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

$U = U_{max}$

$\because \; C = U_{max}$

$\Rightarrow$

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

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

Now as we know that $U = 0$ when $r = r_0$

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

It is also known as V_{cr}

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

The average velocity maybe taken as

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

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

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

$$h_L \frac{32 \mu L V}{\gamma D^2} \Rightarrow \frac{32 \mu L V}{\rho g \cdot D^2} \Rightarrow 32 \frac{\nu L}{g D^2} V$$

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(B)

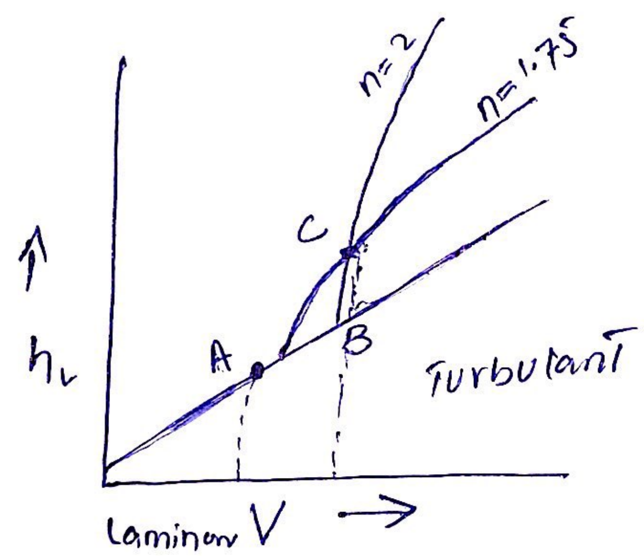
Critical Reynold Number :n

A Reynold number at which the flow of a fluid Changes from laminar to turbulent.

if head loss in given length of uniform pipe is measured at different values of velocity is low enough to secure laminar flow, the head loss due to fraction will be directly proportional to velocity, but Increase in velocity, Change flow from laminar to turbulent Cause change in head loss. Thus if value are plotted, lines obtained with

Slope ranging about 1.75 to 2.

Thus for laminar drop of energy varies as V and 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 depend upon case taken to prevent initial disturbance.

It is value is 4000. But normally, but normally, its possible for flow to be in straight one after R is at 2000. Thus lower value is much more definite than higher one and is dividing point. Thus lower value is true Critical Reynold number.

$$\because \quad R = \frac{DV\rho}{\mu} = \frac{DV}{\nu}$$

$\Rightarrow$ equation for determine Critical Reynold number

$$\therefore \quad N_{REC} = 3470 - 1370n$$

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QUESTION NO # 02

Given data :~

Oil of $S = 0.7$

Kinematic viscosity $= 1.8 \times 10^{-5}\ m^2/s$

Dia of pipe $= 250\ mm = 0.25\ m$

$Q = 0.5\ m^3/s$

Required Data :~

Centerline velocity , $U_{max} = ?$

velocity at 10 mm from edges $= ?$

velocity at the edge of pipe $= ?$

max shear stress at wall of pipe $= ?$

Solution:-

Check the flow of ~~Pipe~~ oil

$$V = \frac{Q}{A} = \frac{0.5}{\pi/4\,(0.15)^2}$$

$$\boxed{V = 28.29\ m/s}$$

$$\Rightarrow \quad R = \frac{DV}{\nu}$$

$$R = \frac{(0.15)(28.29)}{1.8 \times 10^{-5}}$$

$$\boxed{\begin{array}{l} R = 235750 > 2000 \\ \text{Flow is turbulent} \end{array}}$$

$$f = \frac{0.316}{R^{0.25}}$$

$$f = \frac{0.316}{(235750)^{0.25}}$$

$$\boxed{f = 0.0143}$$

⇒ Centerline velocity

$$U_{max} = V\left(1 + 1.33\sqrt{f}\right)$$

$$= 28.29\left(1 + 1.33\sqrt{0.0143}\right)$$

$$\boxed{U_{max} = 32.74 \text{ m/s}}$$

⇒ velocity at 10mm from edges

$$U = U_{max} - 2.5\sqrt{\frac{\tau_0}{\rho}}\ \ln \frac{r_0}{r_0 - r}$$

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first Calculate Shear

$$\tau_0 = \frac{f \rho V^2}{8}$$

$$= (0.0143)(0.7 \times 1000)(28.29)^2$$

$$\boxed{\tau_0 = 1001.40 \ N/m^2}$$ Shear Stress at wall

$$U_{10mm} = U_{max} - 2.5 \sqrt{\frac{\tau_0}{\rho}} \ln \frac{r_0}{r_0 - r}$$

$$= 32.74 - 2.5 \sqrt{\frac{1001.40}{0.7 \times 1000}} \ln \frac{0.075}{0.075 - 0.01}$$

$$\boxed{U_{10mm} = 32.31 \ m/s}$$

velocity at edge

$$U_{max} = V\left(1 + 1.33\sqrt{f}\right)$$

$$V = \frac{U_{max}}{1+1.33\sqrt{f}}$$

$$V = \frac{32.74}{1+1.33\sqrt{0.0143}}$$

$$\boxed{V = 28.24 \text{ m/s}}$$