ID : 7829

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Question. No #1 (A)

Answer :-

Velocity profile for laminar Flow:-

As we have

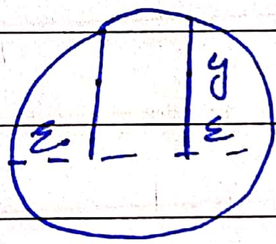
$$h_L = \frac{\tau . 2L}{\varepsilon \gamma}$$

From Viscosity $\Rightarrow$ $\tau = \mu \frac{du}{dy} \rightarrow ①$

Where "u" is velocity at distance "y" from the boundary.

Thus,

$$y = \varepsilon_o - \varepsilon$$



$$dy = d\varepsilon_o - d\varepsilon$$

$$dy = -d\varepsilon$$

Putting value in ① $\quad\quad$ $\because d\varepsilon_o = $ Constant value

$$\tau = \frac{-\mu du}{d\varepsilon}$$

Now,

$$h_L = \frac{2.2.L}{\varepsilon r} \cdot \varepsilon dr$$

Integrating on b/s.

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

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

Putting value.

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

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

$C = u_{max}$

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

(velocity at any point)

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

As for $r = r_0$, $u = 0$

$$0 = u_{max} - K r_0^2 \quad \text{or}$$

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

(It is also known as critical velocity)

Now

$$\underbrace{V_{av}}_{\text{(average velocity)}} = \frac{V_{cr} + 0}{2} = 0.5 V_{cr}$$

x x x

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Question-1 Part (B)
Answer-1 (Part (B))

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 to secure laminor flow, The head loss due to friction will be directly proportional to velocity, but increase in velocity change flow from Laminor to turbulant cause change in headloss. Thus it values are plotted, lines obtained with slope ranging about 1.75 to 2.

Thus for Laminor, drop of energy varies as V and for turbulant, friction varies as V^n where n is 1.75 to 2

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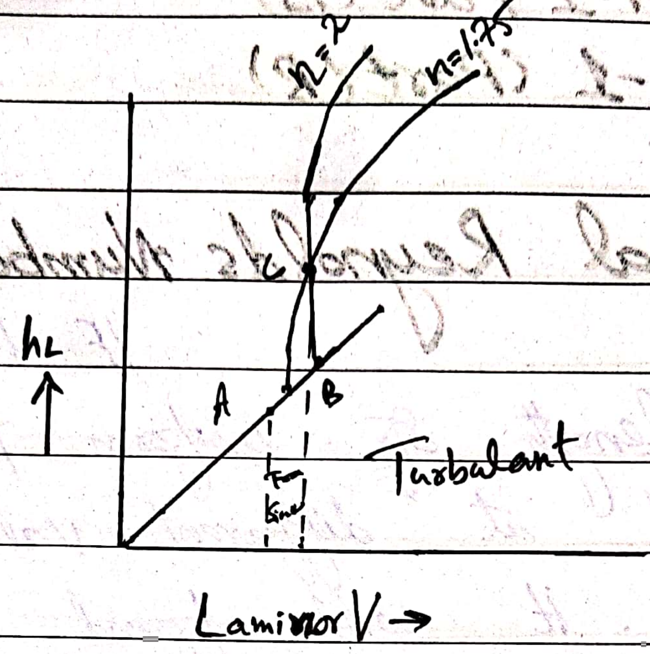

The upper Critical Reynold number corresponding to point B is indeterminate and depend upon care taken to pressure initial disturbance. It's value is 4000. But normally, its impossible for flow to be in straight line after R is at 2000. Thus lower value is much more definite than higher one and is dividing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

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Equation Reynold number

$$\boxed{Re = \frac{DVa}{\nu}}$$

x x x

Question. No. 2

Answer:

Given data:-

Specific Gravity $(S) = 0.7$

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

Dia of Pipe $(d) = 150mm = 0.15m$

Discharge $(Q) = 0.5\ L/sec$

$= \frac{0.5}{1000} = 5 \times 10^{-4}\ m^3/sec$

Required data:-

Centerline Velocity = ?

Velocity at 10mm from edge = ?

Velocity at edge of pipe = ?

Max Shear stress at wall = ?

Sol:-

$$Area = \frac{\pi}{4}(0.15)^2 = 0.0176\ m^2$$

$$\rightarrow \quad Q = AV \Rightarrow \quad V = \frac{Q}{A}$$

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

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$V = 0.028\ m/sec$

Reynold Number $(R) = DV/\nu$

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

$\downarrow$

So laminar Flow

Now Centerline Velocity,

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

$= 2(0.028) = 0.056\,m/sec$

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

for $r = r_0$

$$= \frac{0.15}{2} = 0.075\,m, \quad u = 0$$

Thus

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

$u_{max} = K r^2$

$K = u_{max}/r^2$

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

$K = 9.96$

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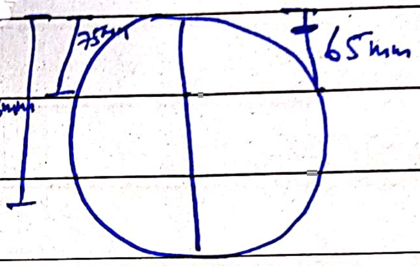
Now we get an equation;

$$u = 0.096 - 9.96(r^2) \rightarrow (A)$$

Velocity at 10mm from edge

$\hookrightarrow r = 0.065 m$



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

$V = 0.014 \, m/sec$

Similarly:- $f = 64/R = 64/233.33$

$\Rightarrow \boxed{f = 0.27}$

Velocity at edge;

$r = 0.075 m$

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

$V = -0.00002 \, m/sec$ or $V = 0$

Shear Stress at wall;

$$\tau = \frac{f}{4} \rho \frac{V^2}{2}$$

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

$$\boxed{\tau = 0.074 \, N/m^2}$$ Ans:-