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Subject = Advance Fluid 2

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Ans # 01:
part (B):

Critical Reynolds number:-

If head loss in given length of uniform pipe is measured at different values of velocity. if with found that has long as velocity is low enough to secure laminar flow, The head loss to secure laminar flow, The head loss due to friction will be directly proportional to velocity, but increase in velocity, change from laminar to turbulant change in head loss. Thus if values are plotted, lines obtained with slope about 1.75 to 2. Thus for laminar, drop of energy varies as V and for turbulent, fraction varies

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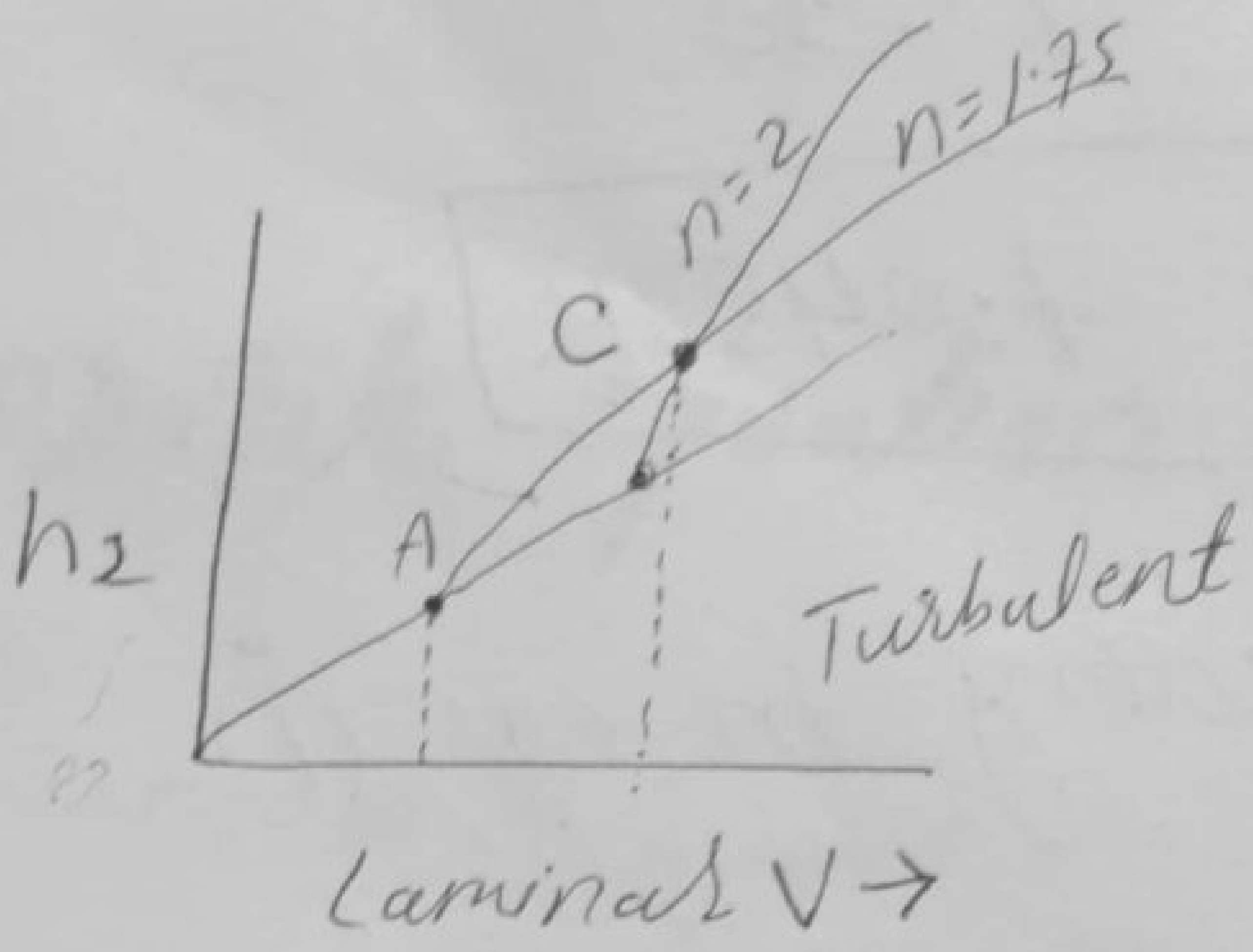
as V^n where n is 1.75 to 2.



The upper critical reynolds number corrosponding to point B is indertamirate and depend upon care taken to prevent initial disturbance. its value is 4000. But normally it is impossible for flow to be in straight one then 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 Reynolds Number.

matimaticall form $\Rightarrow \boxed{R_{cr} = \frac{D V_{cr}}{\nu}}$

Ans # 01

part (A)

Velocity profile equation:.

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

from viscosity : $\tau = \mu \, du/dy$

where u is a value of velocity at distance y from boundary.

$$y = r_0 - r$$

$$dy = dr_0 - dr$$

$$dr_0 = \text{const} = 0$$

$$\therefore dy = -dr$$

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

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

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

P.T.O

integrating:-

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

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

As; $u = U_{max}$

$\therefore \quad C = U_{max}$

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

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

Now:, As we know that $u = 0$

where $r = r_0$

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

It is also known as V_{cr}

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

P.T.O.

The averge velocity may be taken as;

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

$$= \frac{h_L \gamma D^2}{32 \mu L} \quad \text{As } \gamma = \rho g, \ \mu/\rho = \nu$$

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

$$\rho\, du$$

$$\boxed{= \quad u = 1/2}$$ Ans.

Ans: 02; "Given Data"

Oil;

$S = 0.7$

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

Flow;

Pipe dia $= 150mm = 0.15m$

$Q = 0.5\ m^3/s$

"Required Data";

Centerline velocity, $V_{max} = ?$

Velocity at 10mm from edges $= ?$

Velocity at edge of pipe $= ?$

Max shear stress at wall pipe $= ?$

"Solution";

Check the flow of oil;

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

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

※ $R = \frac{DV}{\nu} = \frac{(0.15)(28.29)}{1.8\times10^{-5}}$

$$\boxed{R = 235750 > 2000}$$

"Flow is turbulent"

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

$$\boxed{f = 0.0143}$$

※ Centerline velocity;

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

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

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

※ Velocity at 10mm from edges;

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

First calculate shear;

$$\tau_0 = \frac{f \cdot \rho \cdot V^2}{8} = \frac{(0.0413)(0.7\times1000)(28.29)^2}{8}$$

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

* "i" ⇒

$$V_{10mm} = V_{max} - 2.5\sqrt{\frac{1001.4}{0.7 \times 1000}} \cdot \ln \frac{0.075}{0.075 - 0.01}$$

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

* Velocity at edge;

$$U_{max} = V(1 + 1.32\sqrt{f})$$

$$V = \frac{V_{max}}{1 + 1.32\sqrt{f}}$$

$$V = \frac{32.74}{1 + 1.32\sqrt{0.0143}}$$

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