MID - EXAM

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Sec : "A"

Subject : Fluid Mechanics-II

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QNo: 1 :-

Part: a As we have

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

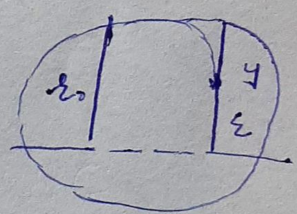
From viscosity :

$$\tau = \mu \frac{du}{dy} \quad — \quad 1$$

where "u" is the velocity at distance "y" from the boundary

So,

$$y = r_0 - r$$



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

$$dy = -dr$$

$\because dr_0$ Constant value

putting value in eq 1

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

Now, $h_L = \frac{\tau \cdot 2 \cdot L}{r \gamma} \cdot r\,dr$

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integrating on b/s

$$\int du = \int -\frac{hL\gamma}{2\mu L} \cdot \xi \cdot d\xi$$

$$u = \frac{-hL\gamma}{2\mu L} \frac{\xi^2}{2} + C$$

So for,

$\xi = 0 \quad u = u_{max}$

putting values

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

$u = u_{max}, \quad u_{max} = 0 + C$

$C = u_{max}$

Thus $$u = u_{max} - \frac{hL\gamma}{2\mu c} \cdot \frac{\xi^2}{2}$$

(velocity at any point)

we have assume that

$$K = \frac{hL \cdot \gamma}{4\mu c} \quad \therefore \quad u = u_{max} - K\xi^2$$

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As for,

$$\xi = \xi_0 \quad , \quad u = 0$$

$$0 = u_{max} - K\xi_0^2 \quad \text{or}$$

$$u_{max} = K\xi_0^2 = \frac{hLr}{4\mu l} \cdot \xi_0^2$$

(It is also known as Critical velocity)

Therefore

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

: (V_{av} = Average Velocity)

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Part: b :- Critical Reynold number:

Def: A Reynolds number at which the flow of a fluid change from Laminar to turbulent in which Laminar flow is Less Than "2000" (are unstable) and turbulent flow is greater Than "2000" (are Stable)

Equation:

$$R_e = \frac{\rho u L}{\mu}$$

where

→ ρ = The density of fluid (SI Units : kg/m^3)

→ u = The velocity of fluid (m/s)

→ L = Characteristic Linear dimension (meter)

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→ μ = Dynamic viscosity of the fluid ($N.s/m^2$ or $kg/m.s$)

→ ν = Kinematic viscosity of the fluid (m^2/s)

⇒ Also equation is

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

where

D = Diameter

V_{cr} = Critical velocity

ν = Kinematic viscosity

x ——————————— x

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QNO: 02 :-

Given data:

Specific Gravity (S) = 0.7

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

Dia of pipe (D) = 150mm = 0.0005m

Discharge (Q) = 0.5 L/s = $0.0005 m^3/sec$

Solution:

$$V = \frac{Q}{A}$$

$$\because A = \frac{\pi}{4}(D^2)$$

$$= \frac{0.0005}{\frac{22}{28} \times (0.15)^2} = \frac{0.0005 \times 28}{22 \times (0.15)^2}$$

$= 0.028 m/s$

$$R = \frac{DV}{\nu} = \frac{0.15 \times 0.028}{1.8 \times 10^{-05}}$$

$R = 233.33$

$R < 2000$ (So its Laminar Flow)

(7)

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$$V_{cr} = 2V$$

$$= 2 \times 0.028$$

$$V_{cr} = 0.056 \, m/sec$$

As,

$$u = U_{max} - Kr^2$$

at

$$r = r_0 = \frac{0.15}{2} = 0.075m \quad , \quad u = 0$$

Thus

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

$$U_{max} = Kr^2$$

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

$$K = 9.96 \, Pas$$

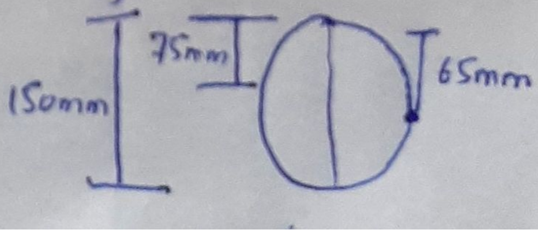
we get a equation.

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

velocity at 10mm from edge

(1000mm = 1m)

$$r = 0.065m$$



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

$$V = 0.014 \text{ m/sec}$$

Velocity at edge ;

$$r = 0.075 \text{m}$$

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

$$V = -0.0002 \text{ m/se}$$

$\therefore$ Say $V = 0$

Similarly.

$$f = \frac{64}{R} = \frac{64}{233.33}$$

$$f = 0.27$$

→ Shear Stress at wall

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

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

$$\boxed{\tau = 0.074 \text{ N/m}^2}$$