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Section	A
Subject	Advanced fluid mechanics

Q1a

velocity profile in laminar folw :

As we have

$$hL = \frac{\tau \cdot 2L}{\varrho r}$$

from viscosity => $\tau = \frac{\mu du}{dy}$ — (*)

Where u is velocity at distance y from the boundary.

They y = from the boundary.

They $y = \varrho_0 - \varrho$

$dy = \underbrace{d\varrho_0}_{0,\ \text{bcx it is constan}} - d\varrho$

$dy = -d\varrho$

putting value in (*)

~~$\tau = \mu du$~~

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

Now $hL = \frac{\tau \cdot 2 \cdot L}{\varrho r}$

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$$hL = \frac{-\mu \, du - 2L}{\xi r \, d\xi}$$

or $$du = \frac{-hLr}{2\mu L} \cdot \xi \cdot dr$$

intergrating both Sides.

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

$$u = \frac{-hLr}{2\mu L} \cdot \frac{\xi}{2} + c$$

Now for $\xi = 0$ $u = u_{max}$

putting values.

$$U = \frac{-hLr}{2\mu L} \cdot \frac{\xi}{2} + c$$

Now for $\xi = 0$, $u = u_{max}$

putting value

$$u = \frac{-hLr}{2\mu L} \cdot \frac{\xi^2}{2} + c$$

$U_{max} = 0 + C \Rightarrow C = U_{max}$

Thus $U = U_{max} - \frac{hL\gamma}{2\mu} \cdot \frac{\xi^2}{2}$

Assume $k = \frac{hL\gamma}{4 \cdot \mu L}$

$\Rightarrow u = u_{max} - k\xi^2$

As for $\xi = \xi_0$, $u = 0$

$0 = u_{max} - k\xi_0^2$

$\cancel{U_{max} = \frac{k\xi^2}{2}}$.

$U_{max} = k\xi^2 = \frac{hL\gamma}{4\mu} \cdot \xi_0^2$

It is also known as critical velocity.

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

Q1b Q1b page 1

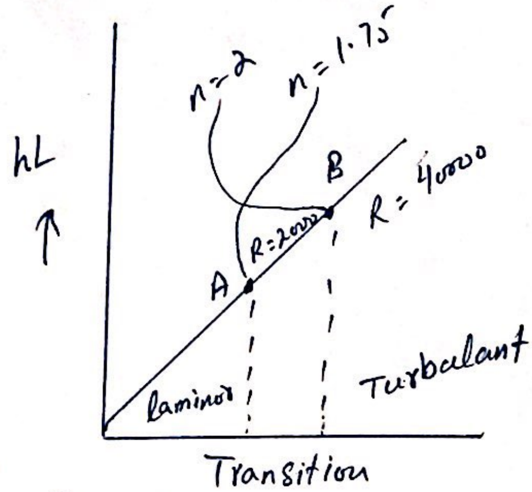
Define critical Reynold number write down its equation.

Critical Reynold number:-

it headloss in given length of uniform pipe is measured at different value 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 propotional to velocity but as the flow changes from laminar to turbolant the headloss varies as V^n where n is 1.75 to 2.

$hL \propto V$

$hL \propto V^n$



The upper critical reynold number corresponding to point B is indeterminate and depends on care taken to prevent initial distarbance it value is 4000 but normally.

it is not possible for flow to be in Straight line after R is 2000 The lower value point A is much definite than highers one lower value is true critical Raynold number and is equal to 2000.

equation

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

where

R = Reynold number

D = Diameter of pipe

V_{cr} = critical velocity.

ν = Kinematic Viscosity.

Q2 page 1

Q2 An oil of ($S=0.7$) and kinematic viscosity of $1.8\times10^{-5} m^2/s$ flows in 150mm Pipe at 0.5L/sec Find the centreline velocity velocity at 10mm for edges and velocity at edge of the pipe also find max Shear Stress at wall of the pipe?

Given Data.

Specific Gravity $(S) = 0.7$

Kinematic viscosity$(\nu) = 1.8\times10^{-5} m^2/sec$

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

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

$$= \frac{0.5}{1000} = 5\times10^{-4} m^3/sec.$$

Sol:.

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

$$Q = AV \Rightarrow V = Q/A$$

$$= \frac{5\times10^{-4}}{0.0176}$$

$$V = 0.028 m/sec$$

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

$$= \frac{0.15\times0.028}{1.8\times10^{-5}} = 233 < 2000$$

Laminar flow

Now centerline velocity

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

$$= 2(0.028) = 0.056 m/sec.$$

Q2 page 2

$U = U_{max} - k \xi_0^2$

for $\xi = \xi_0 = 0.15/2 = 0.075m$, $u = 0$

Thus

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

$U_{max} = kr^2$

$k = U_{max}/r^2 = \dfrac{0.056}{(0.075)^2}$

$k = 9.96$

we get a equation

$u = 0.056 - 9.96(r^2) \longrightarrow$ ✱

velocity at 10mm form edge

$r = 0.065m$

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

$V = 0.014$ m/sec

velocity at edge

$r = 0.075m$

$V = 0.056 - 9.96(0.075)$

$V = -0.00002$ m/sec say $V = 0$

Similarly

$f = \dfrac{64}{R} = \dfrac{64}{233.33}$ $\quad f = 0.27$

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Shear Stress at wall

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

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

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