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Q No 1
Part (A)

⇒ velocity profile in laminar Flow inside the pipe.

For a circular pipe:-
The liminar flow is defined to have the flow Reynolds number < 2000.

Reynold number

$$Re = \frac{\rho V D}{\mu} = \frac{VD}{\nu} < 2000$$

For laminar flow.

Laminar pipe Flows:-
The shear stress laminar flow is linearly related. The fluid viscosity as.

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

Aidedu by the above relation.

$$\mu \frac{du}{dr} = -\frac{r}{2}\frac{dp}{dx}.$$

To Integrate the above above yeilds.

$$u = \frac{1}{\mu} \frac{dP}{dx} \frac{r^2}{2} + C$$

the Integration Constt C Can be determined by $u=$ at $r = D/2$

(on Solid boundry)

$$0 = \frac{1}{\mu} \cdot \frac{dP}{dx} \frac{R^2}{2} + C$$

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

putting values.

$$u = \frac{-hLV}{2\mu L} \cdot \frac{\varepsilon^2}{2} + C$$

$\therefore u_{max} = 0 + C$

$C = u_{max}$.

Thus

$$u = u_{max} - \frac{hLV}{2uL} \cdot \frac{\varepsilon^2}{2}$$ $\therefore$ velocity at any point

$(u = u_{max} - Kr^2)$

Assume $K = \dfrac{hLV}{4uL}$

As for $\varepsilon = \varepsilon_0$, $u = 0$.

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$$0 = \mu_{max} - K\varepsilon_0^2$$

or

$$U_{max} = K q^2_0 = \frac{hL\gamma}{4\mu L} = \varepsilon_0^2$$

it is also known as critical velocity.

Now.

$$V_{av} = \frac{V_{eq} + 0}{2} = 0.5\, V_{eq}$$ (Average velocity)

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(b) Critical Rynold number:- The critical reynolds numbers is which decides whether flow is liminar or turbulent.

⇒ if head loss in given length of uniform pipe is measured at different values of velocity is low ~~enogh~~ enough to secure laminar flow, the head loss due to friction will be directly proportional to velocity, but increase in velocity, change flow from laminar to turbulent cause change in head loss. Thus if values 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 Rynold number corresponding to point B is indeterminate and depend upon care taken to prevent initial disturbance. its 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 is true critical Reynold number.

$$\boxed{R = \frac{DV\rho}{\mu} = \frac{DV}{\nu}}$$

Equation.

OR

$$R_n = \text{Inertial} / \text{Viscos Force.}$$

$$R_N = \frac{F_i}{F_V} = \frac{ma}{\mu \frac{du}{dy} \times A}$$

$$= \frac{\rho L^{3} \times L \times t \times L}{T^{2} \cdot \mu \cdot L \times L^{2}}$$

$$= \frac{\rho L L}{\mu T}$$

$$R_N = \frac{\rho V L}{\mu}$$

$$R_N = \frac{VL}{\nu}$$

$$\because \nu = \frac{\mu}{\rho}$$

$$\mu = \frac{\rho V}{\mu}$$

Q2 Given Data.

OiL having $S = 0.7$
Kinametic viscosity = $1.8 \times 10^{-5}\ m^2/sec$
Dia of Pipe = 150 mm = 0.15 m
Flow = 0.5 L/sec = $0.0005\ m^3/sec$.

Required data:

Centerline velocity = ?
velocity at 10mm from edge = ?
velocity at edge of Pipe = ?
Max shear stream at well = ?

Solution:

First we check the flow is Liminar or turbulent;

$$R = \frac{DV}{\nu} \rightarrow (1)$$

$$V = \frac{Q}{A} = \frac{Q}{\pi/4\, d^2} = \frac{0.0005}{\pi/4\,(0.15)^2}$$

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$$\boxed{V = 0.028 \ m/sec}$$

$$R = \frac{(0.15)(0.028)}{1.8 \times 10^{-5}}$$

$R = 233.33 < 2000$ (LAMINAR FLOW)

$V_{cr} = 2V = 2 \times 0.028$

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

As:

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

at

$r = r_0 = 0.075m, \quad u = 0.$

Thus

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

$U_{max} = kr^2$

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

$$\boxed{K = 9.96}$$

3.

we get a equation;

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

=> velocity at 10 mm from edge

$r = 0.065\,m$

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

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

velocity at edge;

$r = 0.075\,m$

$V = 0.056 - 9.96(0.075)$

$V = -0.00002\ m/sec$ Say $V = 0$

Similarly:

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

$$\boxed{f = 0.27}$$

(4)

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