Q no 1A    ID 764    SeA Senior

• **Velocity Profile for Laminar Flow**

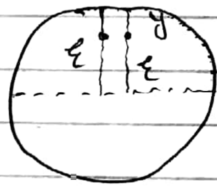
As $h_L = \frac{\tau \cdot 2 \cdot L}{\xi r}$

From Viscocity → $\tau = \mu \frac{du}{dy}$

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

Thus

$$y = \xi_0 - \xi$$
$$dy = d\xi_0 - d\xi$$
$$dy = -d\xi$$




∴ $d\xi_0$ → Constant value

Put value in (*)

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

Now $du = \frac{-h_L r}{2\mu L} \cdot \xi d\xi$

Integration b/c

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

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

⇒ Now for $\xi = 0$  $u = u_{max}$

Putting value

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

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

Thus $u = u_{max} - \frac{h_L \gamma}{2\mu L} \cdot \frac{r^2}{2}$ velocity at any point

Assume $K = \frac{h_L \gamma}{4 \cdot \mu L}$ $\quad u = u_{max} - K r^2$

As for $r = r_0$ $\quad u = 0$

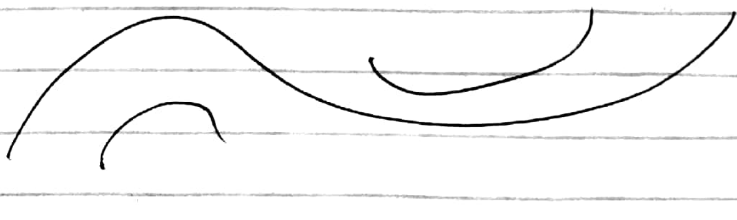
$0 = u_{max} - K r_0^2$ or $u_{max} = K r_0^2 = \frac{h_L \gamma}{4\mu L} r_0^2$

It is also known as critical velocity

Now $u_a = \frac{U_{cl} + 0}{2} = 0.5\, U_{cl}$

$\downarrow$

Average velocity



# Q no 2

## Given data:-

Oil of $S = 0.7$

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

Dia of pipe $= 150mm = 0.15m$

$Q = 0.5\ m^3/s$

Required data

Centerline velocity $U_{max} = ?$

Velocity at 10mm from edge $= ?$

Velocity at edge of pipe $= ?$

max shear stress at wall of pipe $= ?$

Sol:-

Check the flow of oil

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

$$V = 28.29\ m/s$$

$$\rightarrow R = \frac{DV}{\nu}$$

$$= \frac{(0.15)(28.29)}{1.8 \times 10^{-5}}$$

$$R = 235750 > 2000$$

Flow is turbulent

$$f = \frac{0.316}{Re^{0.25}}$$

$$f = \frac{0.316}{(2357\,50)^{0.25}}$$

$$f = 0.0143$$

⇒ Centaline velocity

$$u_{max} = V(1 + 1.33\sqrt{f})$$

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

$$u_{max} = 32.74\ m/s$$

⇒ Velocity at 6 mm from edge

$$u = u_{max} - 2.5\sqrt{\frac{\tau_0}{\rho}}\ \ln\frac{r_0}{r_0 - y}$$

First calculate shear

$$\tau_0 = \frac{f\rho V^2}{8}$$

$$= \frac{(0.0143)\,(0.7 \times 1000)\,(28.29)^2}{8}$$

$$\tau_0 = 1001.40\ N/m^2$$

Shear stress at wall

$u_{comm} = 32.31$ m/s

Velocity at edge

$u_{max} = V(1 + 1.33\sqrt{f})$

$V = \frac{u_{max}}{1+1.33\sqrt{f}}$

$V = \frac{32.74}{1+1.33\sqrt{0.0143}}$

$V = 28.24$ m/s

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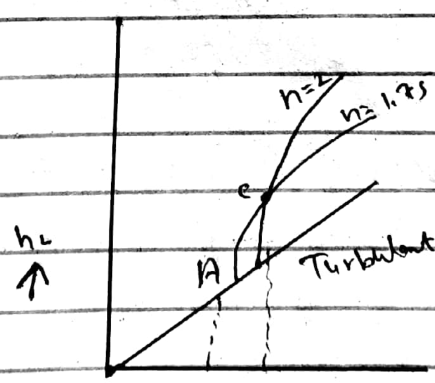
# Q no 1 B

## CRITICAL Reynold Number

if head loss in given length of uniform pipe is measured at different value of velocity. it was found that as long as velocity is low enough to seaser 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 if value are plotted, lines obtained with slop langing 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




Laminar V→

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