IQRA NATIONAL UNIVERSITY

NAME : NOUMAN TAHIR SHAH

ID : 7735

SECTION : A

MODULE : 8TH SEMESTER

Question No. 1:

Part (A): Velocity Profile:

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

from viscosity $\therefore \tau = \mu \frac{du}{dy}$

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

$\therefore y = r_o - r$

$dy = dr_o - dr$

$dr_o = \text{const} = 0$

$\therefore dy = -dr$

$\tau = -\mu \, du/dr$

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

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

2

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

Integrating

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

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

$r = u, \; u = u_{max}$

$\therefore C = u_{max}$

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

$u = u_{max} - k r^2$

Now as we know that $u = 0$ where $r = r_0$

$u_{max} = k r_0^2 = \frac{h_L r}{4\mu L} \cdot r^2$

It is also known as Veq

3

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

⇒ The average velocity maybe taken as

$$V_L = \frac{V_{cr} + 0}{2} = 0.5\, V_{eq}$$

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

$$\Rightarrow \frac{32\mu L v}{\sqrt{g \cdot D^2}} \Rightarrow \frac{32\mu L v}{\rho g \cdot D^2}$$

$$= \frac{32 v L}{g D^2} V$$

Part (B):

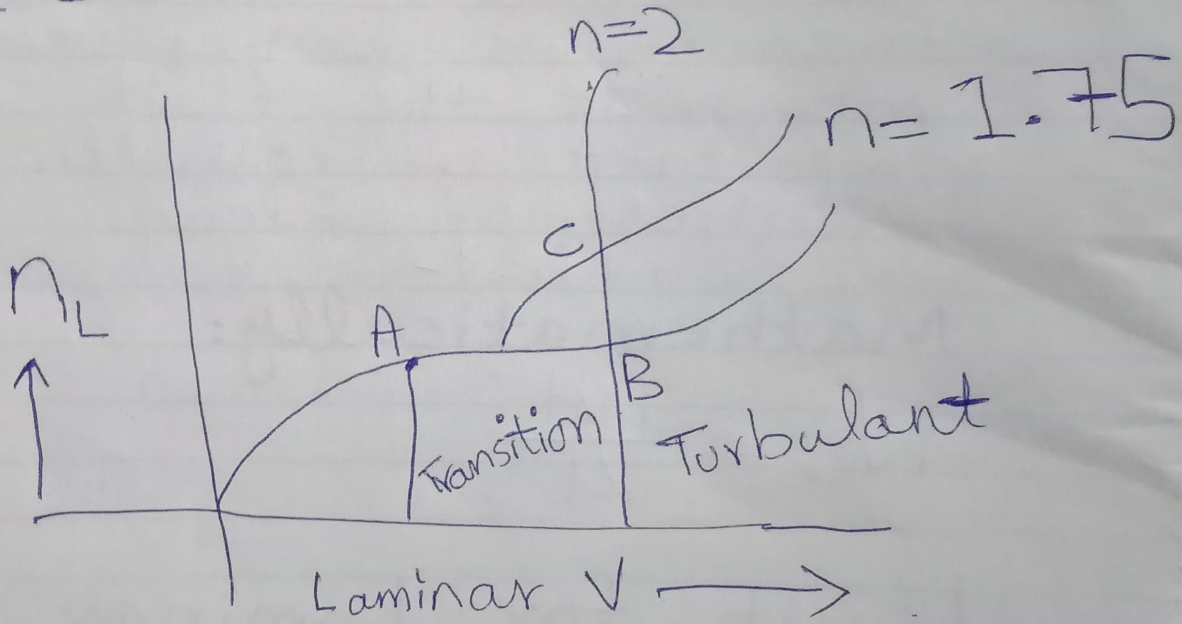
Critical Reynold's Number:

⇒ If head loss is given length of uniform pipe is measured at different values of velocity, it will found that as long as velocity is low 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 turbulant cause change in head loss.
Thus if values are plotted, lines obtained with slope

ranging about 1.75 to 2.

5

Thus for laminar, drop of energy varies as V and for turbulant, friction varies as V where n is 1.75 to 2.



The upper critical reynold's number corresponding to Point B is indeterminate and depends 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 our critical Reynold number.

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

(Q_2)

Given Data:

Oil of $S = 0.7$

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

Dia of pipe $= 150mm = 0.15m$

$Q = 0.5\ m^3/D$

Required Data:

Centreline velocity, $u_{max} = ?$

velocity at 10mm from edges $= ?$

velocity at edge of pipe $= ?$

8

Max shear stress at wall pipe = ?

Sol: Check the flow of oil.

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

$$= V = 28.29 \, m/s$$

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

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

$$R = 235750 > 2000$$

Flow is turbulant

$$f = 0.316 / R^{0.25}$$

$$f = 0.316 / (235750)^{0.25}$$

$$f = 0.0143$$

(9)

→ Centreline Velocity

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

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

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

→ velocity at 10mm from edges

$u = u_{max} - 2.5\sqrt{\frac{\tau_o}{\rho}} \ln \frac{r_o}{r_o - r}$

⇒ First calculate shear

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

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

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

$$u_{10mm} = u_{max} - 2.5\sqrt{\frac{\tau_0}{\rho}} \ln \frac{r_0}{r_0 - r}$$

$$= 32.74 - 2.5\sqrt{\frac{1001.40}{0.7 \times 1000}} \ln \frac{0.075}{0.075 - 0.01}$$

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

→ Velocity at edge:

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

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

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

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