

NAME:

FARAN-AU KOBAN

ID: 7395

SUB: ADVANCED FLUID MECHANICS

INSTRUCTOR:

ENGR. ABDUL WAHEED

Question No 1:

Part (A):

In Velocity Profile:

$$\text{As } h_c = \frac{\tau L}{\rho g y}$$

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

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

$$\therefore y = h_0 - h$$

$$dy = dh_0 - dh$$

$$dh_0 = \text{const} = 0$$

$$\therefore dy = -dh$$

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

$$\text{Now } h_c = \frac{-\mu du \tau L}{\rho g dh}$$

$$du = \frac{-h_c \rho g dh}{2\mu L}$$

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

Integrating

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

$$\mu = \frac{h \gamma}{2\mu} \cdot \frac{r^2}{2} + C$$

$$\tau = \mu \quad , \quad \mu = \mu_{\max}$$

$$\therefore C = \mu_{\max}$$

$$\Rightarrow \mu = \mu_{\max} - \frac{h \gamma}{2\mu} \cdot \frac{r^2}{2}$$

$$\mu = \mu_{\max} - k r^2$$

Now as we know that $\mu = 0$ where

$$r = r_0$$

$$\therefore \mu_{\max} = k r_0^2 = \frac{h \gamma}{4\mu} \cdot r_0^2$$

It is also known as V_{cr}

$$\therefore V_c = \frac{h_2 \gamma \cdot h_0^2}{4\mu} = \frac{h_2 \gamma \cdot D^2}{16\mu}$$

The average velocity may be taken as

$$V_L = \frac{V_{c, \text{top}} + 0}{2} = 0.5 V_{c, \text{top}}$$

$$= \frac{h_2 \gamma \cdot D^2}{32\mu} \quad \text{As } \gamma = \rho g, \mu/\rho = \nu$$

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

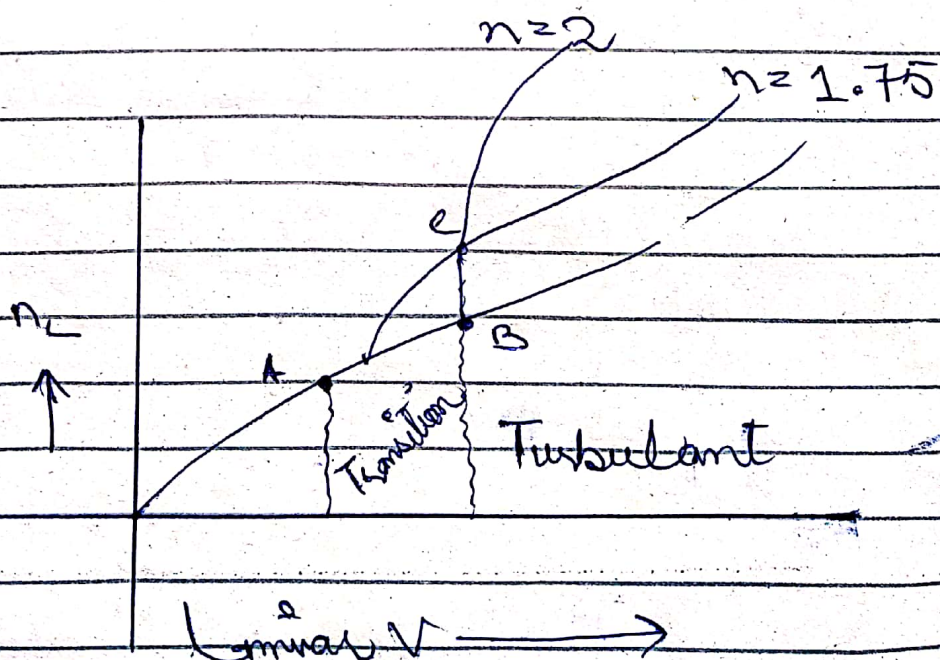
$$= \frac{32\nu L V}{g D^2}$$

PART (B):

On 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 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 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. This lower value is true Reynold number.
critical

$$R = \frac{D \rho V}{\mu} = \frac{D V}{\nu}$$

Question No 2^e

Given Data:

Oil of $S = 0.7$

$$\text{Kinematic viscosity} = 1.8 \times 10^{-5} \frac{\text{m}^2}{\text{s}}$$

$$\text{Dia of pipe} = 150 \text{ mm} = 0.15 \text{ m}$$

$$Q = 0.5 \frac{\text{m}^3}{\text{s}}$$

Required Data:

Centerline Velocity, $U_{\text{max}} = ?$

Velocity at 10 mm from edges = ?

Velocity at edge of pipe = ?

max shear stress at wall pipe = ?

Sol.

Check the ~~pipe~~ flow of oil.

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

$$= V = 28.29 \frac{\text{m}}{\text{s}}$$

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

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

$$R = ~~237~~ 235750 > 2000$$

Flow is Turbulent

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

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

$$f = 0.0143$$

\rightarrow Centreline Velocity

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

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

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

\rightarrow Velocity at 10 mm from edges

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

First calculate shear

$$\tau_0 = \frac{f \int v^2}{8}$$

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

$$\tau_0 = 1001.40 \text{ N/m}^2$$

$$u_{20\text{mm}} = u_{\text{max}} - 2.5 \sqrt{\frac{\tau_0}{\rho}} \ln \frac{y_0}{y_0 - y}$$

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

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

→ Velocity at edge:

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

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

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

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