SYED JAWWAD

7386

ADVANCE FLUID MECHANICS

Q No # 1 (Part-A)

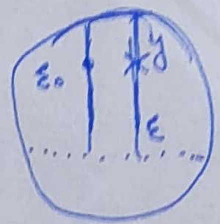
VELOCITY PROFILE FOR LAMINAR FLOW

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

From viscosity $\rightarrow \tau = \mu \frac{du}{dy}$

where "u" is velocity at distance "y" from the boundary

Thus



$y = \xi_0 - \xi$

$dy = \cancel{d\xi_0}^{\,0} - d\xi$

$dy = -d\xi$

($\because d\xi_0 \rightarrow$ Constant) level

Putting Values in (x)

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

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

or $du = \frac{-h_L \gamma}{2\mu L} \cdot \xi \, d\xi$

Integrating b/s

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

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

⇒ Now for $\xi = 0$, $u = u_{max}$

Putting Values

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

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

Thus $u = u_{max} - \frac{h_L \gamma}{2\mu L} \cdot \frac{\xi^2}{2}$ → Velocity at any point.

→ Assume $k = \frac{h_L \cdot \gamma}{4 \cdot \mu L}$ $\because u = u_{max} - k\xi^2$

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

$0 = u_{max} - k\xi_0^2$ or $u_{max} = k\xi_0^2 = \frac{h_L \gamma}{4\mu L} \cdot \xi_0^2$

Its also known as Critical Velocity

Now $\underbrace{V_{av}}_{\text{Average Velocity}} = \frac{V_{cr} + 0}{2} = 0.5\, V_{cr}$

(Q No. 1 Part. b)

CRITICAL REYNOLDS NUMBER:-

If head loss in 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 headloss due to friction will be directly Proportional to Velocity but increase in velocity, change flow from laminar to turbulent change in head loss. Thus ~~cause change in~~ 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.

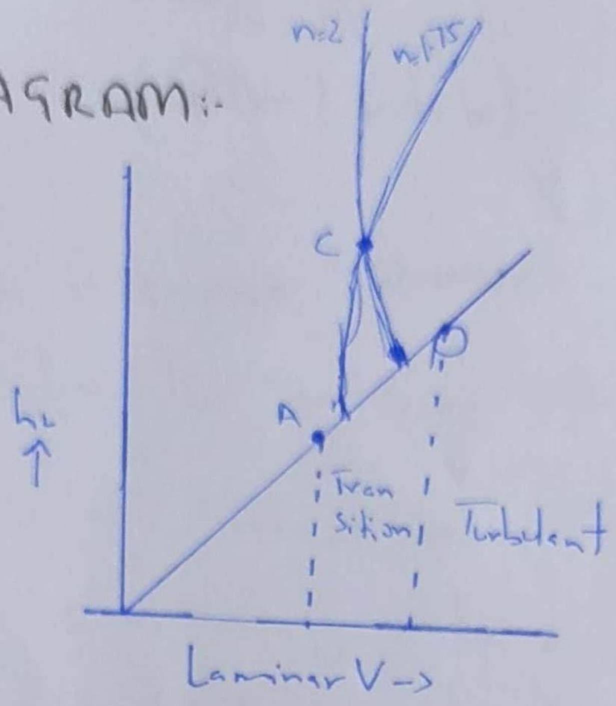
The upper Critical Reynolds number Corresponding to Point B is Indeterminate and depend upon care taken to Prevent initial Disturbance. It's value is 4000. But normally It's Impossible for flow to be in straight line after R is at 2000. Thus lower Value is much more definite than higher one and it's dividing Point. Thus lower Value is True Critical Reynold number.

Equation for determine Critical Reynold number

$N_{REC} = 3470 - 1370n$

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

DIAGRAM:-



Q#2

Given Data:-

Specific Gravity $(S) = 0.7$

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

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

Discharge $(Q) = 0.5\ L/Sec$

$$= \frac{0.5}{1000} = 5 \times 10^{-4}\ m^3/Sec$$

Solution:-

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

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

$$= \frac{5 \times 10^{-4}}{0.0176}$$

$$V = 0.028\ m/Sec$$

Reynold Number $(R) = \frac{DV}{\nu}$

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

$$= 233 < 2000$$

$\downarrow$

So laminar flow.

Now Centerline Velocity,

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

$= 2(0.28) = 0.056 m/Sec$

$u = U_{max} - k\varepsilon_0^2$

for $\varepsilon = \varepsilon_0 = \frac{0.15}{2}$

$= 0.075m$, $u = 0$

As $u = U_{max} - K\varepsilon^2$

$\gamma = \gamma_0 = 0.075$, $u = 0$

Thus

$\cancel{u}^{0} = U_{max} = K\varepsilon^2$

$K = \frac{U_{max}}{\gamma^2}$

$= \frac{0.056}{(0.0756)^2}$

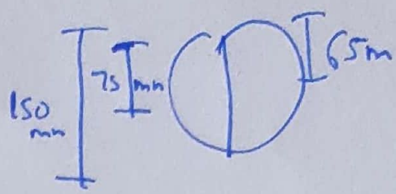
$k = 9.96$

we get a Equation

$u = 0.056 - 9.96(\gamma^2) \rightarrow$ 1

velocity from Edge

$\gamma = 0.065m$



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

$V = 0.014\ m/sec$

Velocity at Edge

$r = 0.075m$

$V = 0.056 - 9.96(0.075)$

$V = 0.0002\ m/sec$. Say $V = 0$

Similarly

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

$$f = 0.27$$

Shear Stress at wall

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

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

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

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