| | |
|---|---|
| Name | Shahkar |
| ID | 7808 |
| Section | A |
| Program | BSC Civil Engineering. |
| Submitted to | Engr. Abdul Waheed. |
| Date | 26/08/2020 |
| Subject | Fluid Mechanics II |

Mid Term Exam (Summer 2020)

ID=7808



## Question No1 (part a)

Q1(a) write down expression for velocity profile in laminar flow inside the pipe?

### Velocity profile for laminar flow

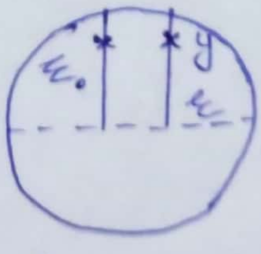
As we know that

$$h_L = \frac{\tau \cdot 2 \cdot L}{\varepsilon \gamma}$$

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

where "$\mu$" is velocity at a distance 'y' from the both thus,

$$y = \varepsilon_0 - \varepsilon$$




$$dy = d\cancel{\varepsilon_0} - d\varepsilon$$

$$dy = -d\varepsilon$$

$(\therefore d\varepsilon_0 \rightarrow$ constant value$)$

putting values in (1)

Now we have

$$h_L = \frac{\tau \cdot 2 \cdot L}{\varepsilon \cdot \gamma} \cdot - \frac{\mu d\mu \cdot 2L}{\varepsilon \cdot \gamma \cdot d\varepsilon}$$

ID=7808



or

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

Now Integreting both side.

$$\int du = \int \frac{-hLr}{2\mu L} r . dr$$

so

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

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

Putting the values

$$u = \frac{-hLr}{2uL} \cdot \frac{r^2}{2} + c$$

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

thus $u = u_{max} - \frac{hLr}{2uL} \cdot \frac{r^2}{2}$ here velocity available is at any point.

$\Rightarrow$ Assume $K = \frac{hLr}{4.\mu L}$ $\therefore u = u_{max} - Kr^2$

As for $r = r_0$, $u = 0$

$0 = u_{max} - Kr_0^2$ or $u_{max} = Kr_0^2 = \frac{hLr}{4\mu L} \cdot r_0^2$

Scanned with CamScanner

ID= 7808 

The upper equation is also known as critical velocity.

So

Now $V_{av} = \frac{V_{cr}+0}{2} = 0.5 V_{cr}$

$V_{av}$ → average velocity

$$\boxed{V_{av} = \frac{V_{cr}+0}{2} = 0.5 V_{cr}}$$

---

Q No 1 (part B)

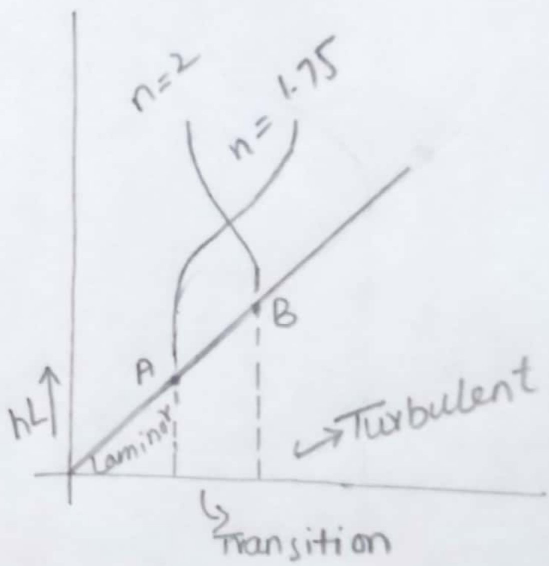
(B) Define critical Reynold number and write down its equation?

Critical reynold number:= if head loss in given length of uniform pipe to be measured at different values of velocity it will be found that as long as velocity is low enough to secure laminor flow then the headloss due to friction will be directly proportionally to velocity but as the flow changes from Laminor to turbulent the head losses varries as '$V^n$' wher n is range 1.75 to 2

so

$hL \propto V$

$hL \propto V^n$




The upper critical reynold number corresponding to point B is in determine and depends on care taken to prevent initial disturbance it value is 4000 but normally it is not possible for flow to be in straight line after

R is 2000. The lower value point A is much definite than highers one lower value is true critical reynold number and is eqlual to zero.

Reynold number equation:-

we know that

$$R = \frac{D V_{cr}}{r}$$

where,

R = Reynold number.
D = Diameter of pipe.
$V_{cr}$ = critical velocity.
r = kinematic viscosity.

ID =7808 (6)

## Question NO 2

An oil of ( $S=0.7$) and kinematic viscosity of $1.8 \times 10^{-5}$ $m^2/s$ flows in 150mm pipe at 0.5 L/sec. Find the centereline velocity. velocity at 10mm from edges and velocity at edge of the pipe. Also find max shear stress at wall of the pipe?

Solution:

Given data

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

Diameter of pipe (d) = 150mm = 0.15m

Specific gravity of oil (s) = 0.7

Flow rate (Q) = 0.5 L/sec

$$= \frac{0.5}{1000} \; m^3/sec \Rightarrow \boxed{0.0005 \, m^3/sec}$$

Solution:

First we have to find the reynold number

So $R = \frac{DV}{\nu}$ wher 'V' is unknown.

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

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

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

Now the Reynold number will be

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

$= \frac{0.15 \times 0.028}{1.8 \times 10^{-5}} = 233$

AS $233 < 2000$

So we know that the flow is Laminar.

Now for centerline velocity:-

First we have to find critical velocity

i.e

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

$$= 2(0.028) = 0.056 \text{ m/sec.}$$

By the help of formula-

$$u = u_{max} - K\xi_0^2$$

Finding value of K:-

For $\xi = \xi_0$, $u = 0$

$$\Rightarrow 0.15/2 = 0.075 \text{ m}$$

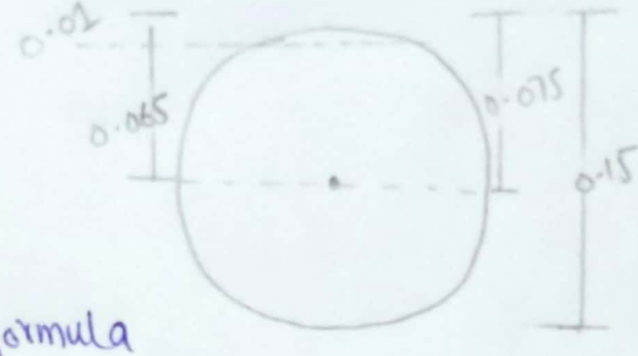
so

$$0 = u_{max} - K\xi_0^2$$

$$K = \frac{u_{max}}{\xi_0^2} = \frac{0.056}{(0.0752)^2} = 9.95$$

$$K = 9.95$$

⇒ **velocity at 10mm from Edge of pipe:**




By the help of formula

$$u = U_{max} - K r^2$$

$$u = 0.056 - (9.95)(0.065)^2$$

$$= 0.0139 \text{ m/sec}$$

⇒ **velocity at Edge of the pipe:**

Taking $r_0 \rightarrow$ max radius (i.e $r_0 = 0.075m$)

$$u = 0.056 - (9.95)(0.075)$$

$$= 0.0000312 \text{ m/sec}$$

so less value so we can also say that $u = 0$

⇒ **Max. Shear stress at wall of Pipe:-**

By formula

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

$$= \frac{0.27}{8} \times 700 \times (0.056)^2$$

$$\bar{\tau}_0 = 0.074\ N/m^2$$

For Laminar flow

we have

$$f = 64/R$$

$$= \frac{64}{233}$$

$$\boxed{f = 0.027}$$

$$S = \frac{\rho_{Fluid}}{\rho_{water}}$$

$$0.7 = \frac{\rho_{oil}}{1000} \Rightarrow \rho_{oil} = 700\ kg/m^3$$