Fluid Mechanics 1 :-

Q1: Define Viscosity? Derive newton equation of viscosity.

Ans:- **Viscosity :**

"Viscosity is a measure of fluid's resistance to flow."

In other words it can be describes the Internal friction of a moving fluid.

More viscosity of a fluid refers to resists to motion.

"The viscosity of a fluid is a measure of its resistance to deformation at a given. For liquids, it corresponds to the informal concepts of "thickness"

Newton Equation of Viscosity:

Let us consider a number of fluid layers between two parallel plates as shown in fig (a)

Let the bottom plate be fixed mean the velocity is zero $v_1 = 0$. And the top plate is having certain velocity v_2. Both are seperated by distance Y.

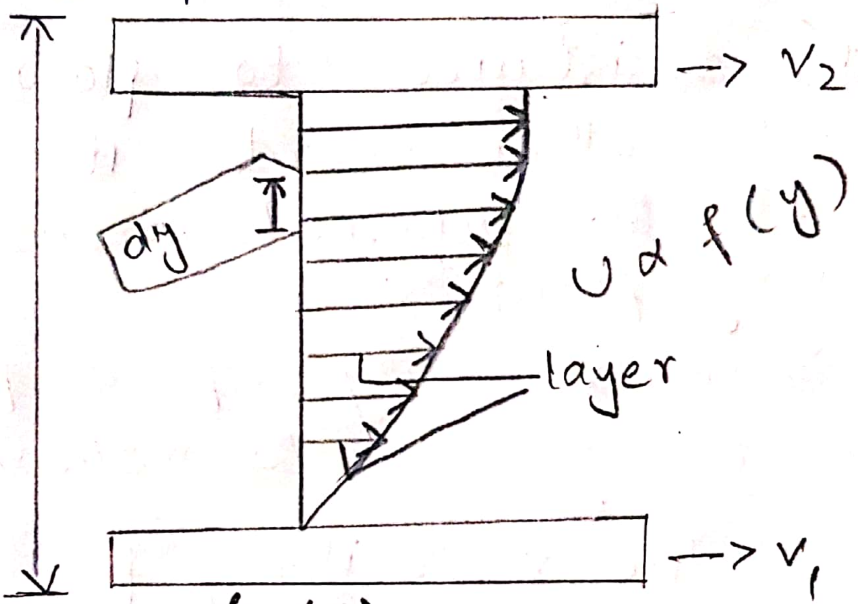
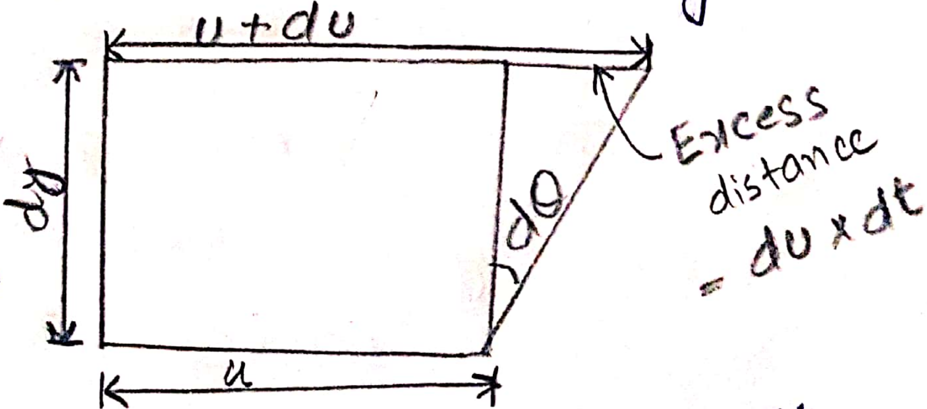


fig (a)

- The space is filled by fluid.
- The number of fluid layers are parallel to plates

$\Rightarrow$ Now take Two layer.



From traingle $\tan d\theta = \frac{du \times dt}{dy}$

As "$d\theta$" is very small

$$d\theta = \frac{du\,dt}{dy} \Rightarrow \frac{d\theta}{dt} = \frac{du}{dy}$$

* From newton law of vescosity shear stress is directly propotional to angular deformation or rate of shear stress.

$$\tau \propto \left(\frac{d\theta}{dt}\right) \times \left(\frac{du}{dy}\right)$$

$$\tau = \mu \frac{du}{dy}$$ This is newton law of viscosity

where μ = dynamic viscosity

$$\mu = \tau \left[\frac{dy}{du}\right]$$

Units are :

$$\tau = \frac{N}{m^2}$$

$$\frac{dy}{du} = sec$$

So, $\frac{N}{m^2}[sec]$ = pascal seconds.

Dimensional units = $ML^{-2}T^{-1}$

(b) Define Density, specific weight and specific volume. Show relation between Density and specific weight.

Ans:-

DENSITY, SPECIFIC WEIGHT / VOLUME :

: Density :

"The density of a substance is its mass per unily volume."

Symbol : ρ , latin letter D also can be used.

SI Unit : Kilogram per cubic metre.

Formula $\rho = \frac{m}{V}$

ρ = density
m = mass
V = volume.

Specific weight :

"Specific weight also known as the unit weight, is the weight per unit volume of a material"

Unlike density, specific weight is not a fixed property of a material.

Units : kN/m^3

Specific weight of water at 0°C is 9.805 kN/m^3

at 100°C is 9.399 kN/m^3.

Specific Volume :

Definition :

"Specific volume of a fluid is defined as the ratio of the volume of a fluid to the mass of the fluid"

"It may be defined as volume per unit mass of a fluid".

Formula:

$$\text{Specific volume} = \frac{(\text{volume of fluid})}{\text{mass of fluid}}$$

$$\text{Specific volume} = V/m = 1/\rho$$

Relation b/w Density & Specific weight.

As $\gamma = \frac{w}{V}$ $\because w = mg$

Thus $\gamma = \frac{mg}{V}$ $\because \rho = \frac{m}{V}$

Thus $\gamma = \rho \times g$

(c) If Specif volume of gas is 0.72 m³/kg What is specific weight in N/m³?

Sol:- Given that.

⇒ specific volume = $0.72\ m^3 kg^{-1}$

⇒ specific weight = ?

As $v = 1/\rho$

$\rho = 1/v$

$\rho = \frac{1}{0.72}$

$\rho = 1.38\ kg/m^3$

As $\gamma = \rho g$

$\gamma = 1.38 \times 9.81$

$\boxed{\gamma = 13.54\ N/m^3}$ Ans

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QUESTION # 02

a. Define Pressure? What is an absolute and gauge pressure?

Ans:- **Pressure :-**

"Force per unit Area"

It is more usually more convenient to pressure rather than force to describe the influence upon fluid behavior.

Formula: $Pressure = \frac{Force}{Area} = \frac{F}{A}$

Unit : N/m^{-2}, "Psi", "lbf/in^2"

→ Pressure is a normal stress

→ Dimensions are $[ML^{-1}T^{-2}]$

Absolute Pressure:

It is a pressure that is relative to the zero pressure in the empty, air free space of the universe.

This refrenec pressure is the ideal vacume

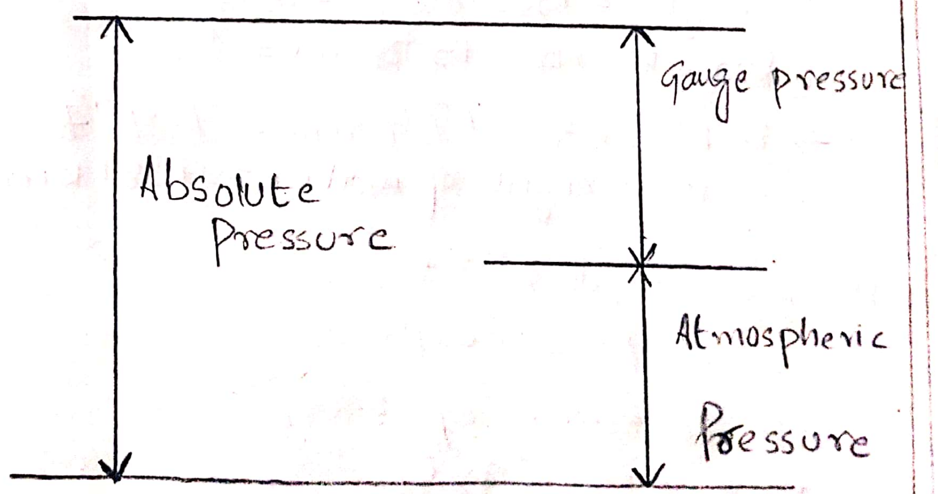
Gauge Pressure:

Gauge Pressure is relative to atmospheric pressure. Gauge Pressure is positive for pressure above atmospheric pressure. and negative for pressures below it.

Formula: calculating gauge Pressure at height

$$P = hdg + P_0$$

=> P_0 is atmospheric pressure.



b. A water tank having dimensions of 1500 mm x 1500 mm. Depth of the water tank is equal to your ID number in mm. What is the net pressure force on wall of water tank? Find the location of force application? If the water level drops to the half of the depth, what will be the force and point of application of force?

Solution :-

Given Data :

→ length = 1500 mm = 1.5 m
→ Breath, b = 1500 mm = 1.5 m
→ Depth, h = 7974 mm = 7.974 m
→ Unit weight of water = $9.81 \, kN m^{-3}$

Required Data:

→ Net pressure, P = ?
→ Location of force
→ If half level drops of water depth, find P and Location force.

(a) **Net Pressure**

$P = \gamma h$

$P = 9.81 \times 7.974$

$P = 78.22 \ KN/m^2$

(b) **Force application centriod:-**

$\bar{y} = h/3$

$\bar{y} = \frac{7.974}{3}$

$\bar{y} = 2.658 \ KN/m^2$

Half Depth:-

Pressure at half depth

$P' = \gamma h/2$

$P' = 9.81 \times \frac{7.974}{2}$

$P' = 39.11 \ KN/m^2$

Centroid,

$\bar{y} = \frac{h}{2} \times \frac{1}{3}$ $\Rightarrow$ $\bar{y} = 1.329m$