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Section

B

Deptt

BE(C)

Subject

Fluid Mechanics

Submitted to

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Question No 01 (a):

Define Viscosity? Drive Newton equation of viscosity.

Viscosity:

The property of fluid by virtue of which it offer resistance to shear is known as viscosity.

OR

The viscosity of fluid is a measure of its resistance to shear or angular deformation.

OR

It is the property of fluid which is imparts resistance to fluid motion by offering resistance to movement of one layer over another.

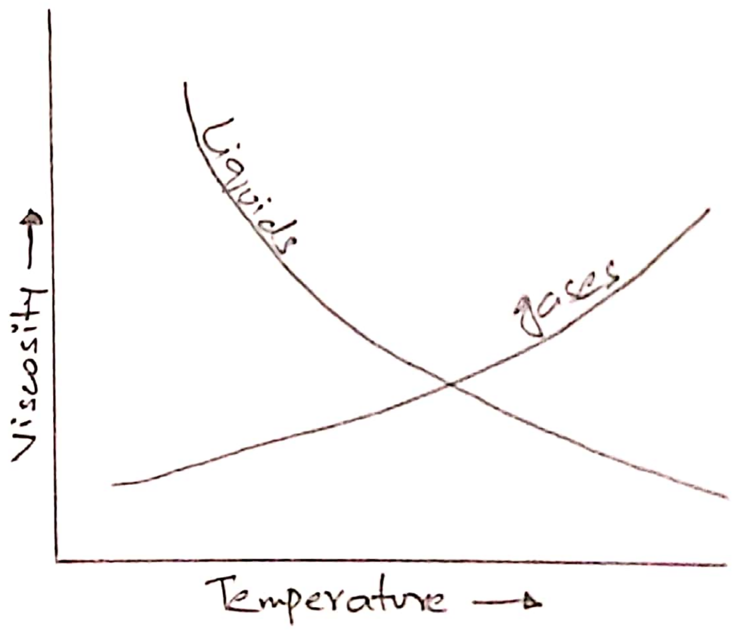
Example:

Motor oil has high viscosity and resistance to shear, is cohesive and feel "sticky" whereas gasoline has low viscosity.

Explaination:

The friction forces in flowing fluid result from the cohesion and momentum interchange between molecules. As Temperature increases, the velocities of liquids decrease while the velocities of all gases increase. This is because the force of cohesion, which diminishes with temperature, predominates with liquids while the gases the predominating with factor is the interchange of molecules between the layer of different Velocities.

Diagrametically:



Unit:

The Unit of Viscosity is kg/m.sec OR Pascal - Second.

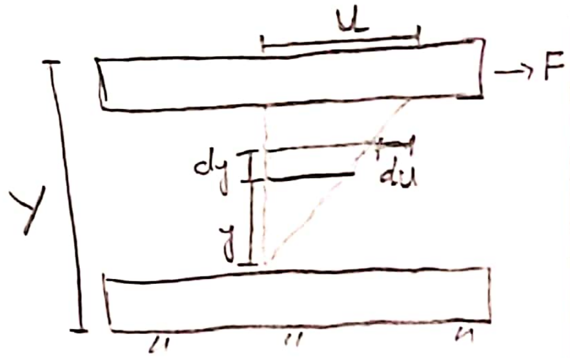
Newton Equation of Viscosity:

Now Consider two parallel plate placed at distance Y as Spaced in between with fluid. Lower surface is assumed to be Stationary while upper moved V Thus;

$F \propto \frac{AU}{Y}$ OR $F = \frac{\mu A U}{Y}$

OR $F/A = \frac{\mu U}{Y}$

$\tau = \frac{\mu U}{Y}$



stated that

" The Shear Stress in a flowing fluid is directly proportional to the rate of strain

Mathematically:

(For dy, the velocity will be du)

Thus $\tau \propto \frac{du}{dy}$

$\tau \rightarrow$ Shear stress

Thus

$$\tau = \mu \frac{du}{dy}$$

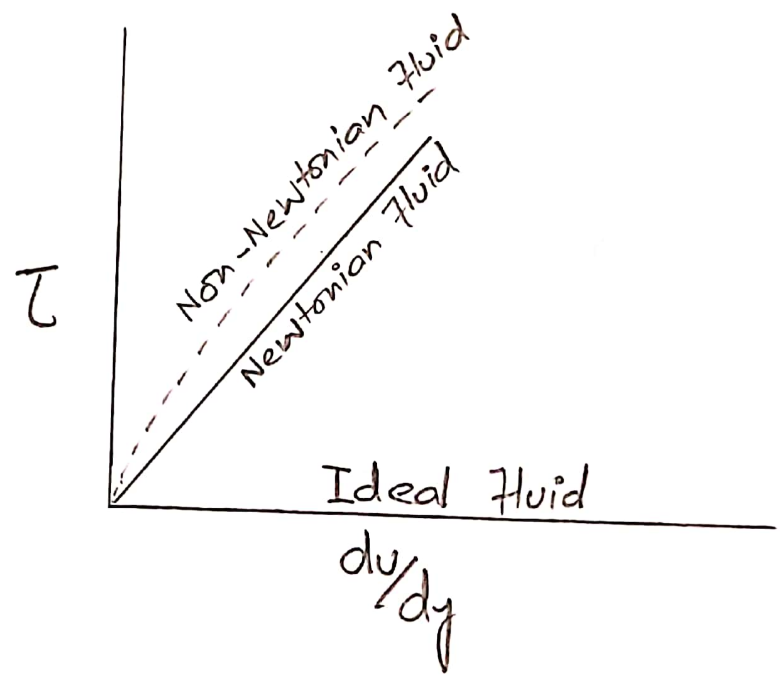
$\mu \rightarrow$ proportionality Constt

$\tau = \mu \frac{du}{dy} \rightarrow$ Newton equation of Viscosity

μ = Viscosity (Dynamic Viscosity)

$$\mu = \tau / \frac{du}{dy}$$

This is called dynamic Co-efficient of Viscosity OR Absolute Viscosity.



The fluid for which constant of proportionality does not change with rate of deformation is said to be Newtonian fluid

Ideal fluid with no viscosity is represented by horizantal axis.

Unit of absolute viscosity.

i.e $\frac{N \cdot S}{m^2}$

Question No 01 (b):

Define Density, specific weight and specific Volume. Show relation between density and specific weight.

Density: (Denoted by 'ρ')

Property of fluid

"Density can be defined as mass per unit volum of a fluid."

Mathematically:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \Rightarrow \rho = m/V$$

Unit: Kg/m^3

Specific Weight: (Denoted by "γ")

Property of Fluid

Specific Weight is the weight Possessed by Unit Volume of a Fluid.

Mathematically:

$$\text{Specific Weight} = \frac{\text{Weight}}{\text{Volume}}$$

$$\gamma = \frac{W}{V}$$

Unit:

N/m

Specific Volume: (Denoted by "υ")

Property of Fluid

Specific Volume is the volume of a Fluid which occupied per Unit mass of It is the reciprocal of density

Mathematically:

$$\text{Specific Volume} = V/m \Rightarrow \upsilon = V/m = 1/\rho$$

Unit: m^3/kg

Relation between Specific Weight and Density:

As $\gamma = \frac{W}{V}$

Thus $W = mg$

Then $\gamma = \frac{mg}{V}$

As we know that $m/V = \rho$

$$\boxed{\gamma = \rho g}$$

OR

$$\boxed{\rho = \gamma / g}$$

Question No 01 (C):

If Specific Volume of gas is $0.72 \, m^3/kg$. What is the specific Weight in N/m^3?

Given Data:

Specific Volume of gas $= 0.72 \, m^3/kg$

Required:

Specific Weight in $N/m^3 = ?$

Solution:

We Know that

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

$$\rho = 1/V$$

$$\rho = 1/0.72 = \boxed{1.389 \, kg/m^3}$$

Specific Weight "γ" $= \rho \times g$

$$\gamma = 1.389 \times 9.8$$

$$\boxed{\gamma = 13.62 \, N/m^3}$$

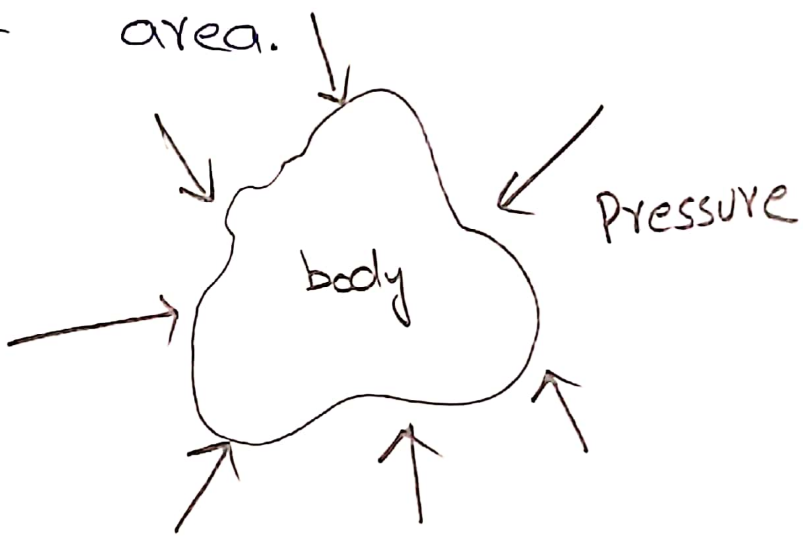
Question No. 02 (a):

Define Pressure? What is an absolute and guage pressure?

Pressure:

Pressure is a normal Stress, and has dimension of force per unit area.

Example:



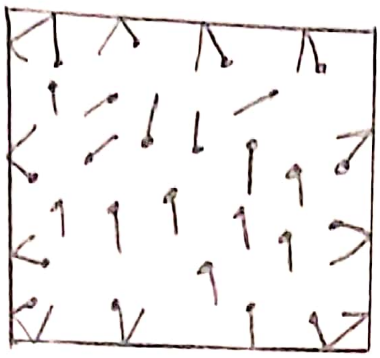
Pressure always act inward normal to any Surface (even Imagnary Surfaces as in a Control Volume).

OR Pressure is defined as the physical force exerted on an object. The force applied is perpendicular to the

Surface of objects per unit area. The basic formula for pressure is F/A (force per unit area).

Example:

Pressure on Wall of the Container



Formula:

$$\text{Pressure (P)} = \frac{\text{Thrust}}{\text{Area}} = \frac{\text{Force}}{\text{Area}}$$

$$P = F/A$$

Unit:

In English System of Unit, Pressure is expressed as "psi" or lbf/in^2.
In the matric system of unit, pressure is expressed as "pascals" or N/m^2.

Pressure Terminology:

Three different kinds of pressure reported in the literature.

Absolute pressure
Guage pressure
Vaccum pressure

Absolute Pressure:

If we measures pressure relative to absolute zero we call it absolute pressure

Guage Pressure:

If we measures relative to atmospheric pressure as a base we call it Guage pressure

Explaination of Absolute and Guage Pressure:

This is because practically all pressure guager register zero when open to the atmosphere, and So they measure the difference between the pressure of the fluid they are Connected to and that of the surrounding air.

If the pressure is below that of the atmosphere, we Call it a Vacuum and it guage value is the amount by which it is below that of atmospher. What we call a "high Vacuum" is really a low absolute pressure; a perfect Vacuum would correspond to absolute zero pressure.

All the value of absolute pressure are positive, Since a negative value would Tension, which are normally Consider in any fluid. Guage pressure are positive if they are above that of the atmosphere and negative if they are Vacuum.

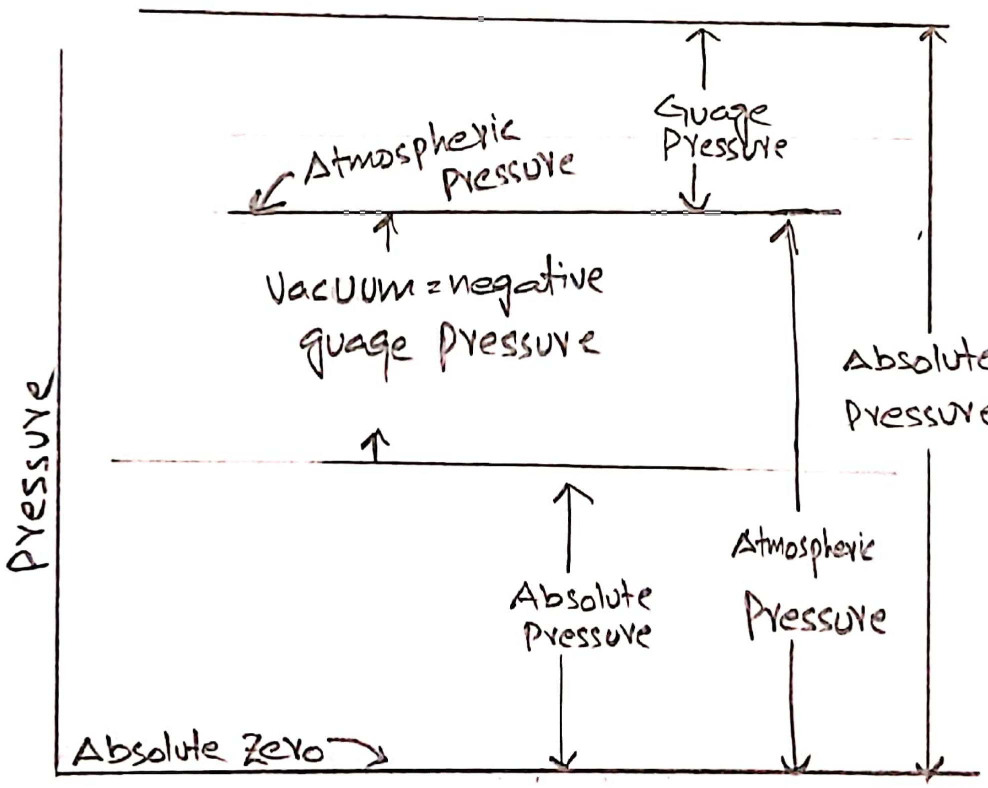
We Can Calculate/observe from the preceding discussion that the following relation hold Mathematically.

Mathematically:

$$P_{Abs} = P_{Atm} + P_{guage}$$

Where, P_{guage} may be positive or negative (vacuum)

Diagrametically:



Question No.02 (b)

A Water tank having dimensions of 1500mm x 1500mm Depth of the Water Tank is equal to your Student 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?

Given Data:

Length of Water Tank "l" = 1500mm = 1.5m
Width of Water Tank "W" = 1500mm = 1.5mm
Depth of Water Tank "h" = 7958mm = 7.958m
Unit weight of Water = 9.81 KN/m³

Required:

① Net Pressure = ?
② Location of pressure = ?

3) If water level drop half of depth What will be Net pressure and location of force application?

Solution:

Net Pressure:

As $p = \rho g h$

$\Rightarrow p = \rho g h$

$\Rightarrow p = 1000 \times 9.81 \times 7.958$

$\Rightarrow$ **$p = 78.067\ kPa$**

Pressur per Unit Width:

$P_1 = P/\text{width}$

$P_1 = \dfrac{78.067}{1.5}$

$\Rightarrow$ **$P_1 = 52.044\ kN/m$**

Location of Force:

$$\bar{y} = h/3$$

$$\Rightarrow \bar{y} = \frac{7.958}{3}$$

$$\Rightarrow \boxed{\bar{y} = 2.652 m}$$

Resultant Force:

Alway act at $\frac{1}{3}h$ from base

Resultan force $= \frac{1}{2}bh$

$$F = \frac{1}{2}(52.03)(7.958)$$

$$\boxed{F = 207.02 KN}$$

Water level half of Depth:

$$h = \frac{7.958}{2} = 3.979 m$$

Net Force + Pressure:

$$P = \rho g h$$

$$\Rightarrow P = 1000 \times 9.81 \times 3.979$$

$\Rightarrow$ $P = 39.033$ kpa

Pressure per Unit width:

$$P_2 = P/\text{width}$$

$$\Rightarrow P_2 = \frac{39.033}{1.5}$$

$$\Rightarrow P_2 = 26.022 \text{ kN/m}$$

Resultant force:

$$F = \tfrac{1}{2} bh$$

$$\Rightarrow F = \tfrac{1}{2}(39.210)(3.979)$$

$$\Rightarrow F = 78.008 \text{ kN}$$

Application of force:

$$\bar{y} = h/3$$

$$\bar{y} = \frac{3.979}{3}$$

$$\bar{y} = 1.326 \text{ m}$$