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Subject Fluid Mechanics

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Section A

Semister 4th

Student Signature 

Question No 1

a) Define viscosity? Derive Newton equation of viscosity.

Viscosity:

Definition:

It is the Property of a fluid which resist relative motion of its adjacent layer. It is due to cohesion and molecular momentum exchange between two layers.

Unit:

The unit of viscosity is Poise

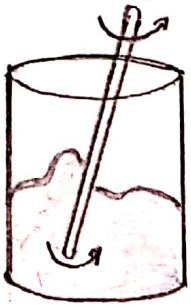
Example:

Syrup has a greater viscosity that water.

Lower viscosity:

Water

Greater viscosity



Syrup

NEWTON'S EQUATION OF VISCOSITY

Statment:

It stated that

"The shear stress in a flowing fluid is directly proportional to the rate of shear strain"

Mathematicaly Representation:

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

τ → shear stress

Change the sign of proportionality

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

where:

μ = viscosity (dynamic viscosity)

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

$\frac{du}{dy}$ = Rate of shear deformation

Newtonian Fluids:

The Fluid which follows "Newton's Law of viscosity are called Newton Fluids

b) Define density, specific weight and specific volume show relation between density and specific weight

Answer:

Density:

Definition: Density of a Fluid is derived as:

"The ratio of mass of a fluid to the volume of the Fluid."

OR

Mass Per unit volume

Mathamatical Form:

$$P = m/v = kg/m^3$$

Where:

P = Rho = density
m = mass
v = volume

Specific weight:

Definition: Specific weight of a Fluid is defined as;

"The ratio of the weight of a fluid to the volume of the Fluid."

OR

"Weight of a Fluid Per unit volume"

Mathamaticaly Form:

$$W = mg/V = Pg = N/m^3$$

Where:

W = Specific weight
mg = weight of the fluid
V = Volume.

Specific Volume:

Specific volume is defined as;

"The ratio of the volume of a fluid to the mass of the fluid"

OR

"volume per unit mass of a fluid".

Mathamatical Form:

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

Relation Between Density And Specific Weight:

As we know that,

$$w = w/v$$

and that

$$w = mg$$

So, $w = mg/v \Rightarrow \boxed{w = \rho g}$ $\quad \therefore \rho = m/v \Rightarrow \rho =$ density

c) If Specific volume of a gas is $0.72 m^3/kg$ what is specific weight in N/m^3?

Given Data:

Specific volume, $v = 0.72 m^3/kg$

Required Data:

Specific weight, $w = ?$

Solution:

As,

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

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

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

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

As,

$$w = \rho g$$

$$g = 9.81 m/s^2$$

$$w = 1.38 kg/m^3 \times 9.81 m/s^2$$

Answer Result:

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

Question No 2

a) Define Pressure? what is absolute and gauge Pressure?

Pressure:

Definition:

Pressure is defined as

> The force applied perpendicular to the surface of an object per unit area over which that force is distributed.

Unit:

The unit of Pressure is Pascal

GAUGE PRESSURE:

Definition:

> Gauge Pressure is the pressure relative to atmospheric pressure. Gauge Pressure is positive for Pressures above atmospheric pressure and negative for Pressure below it.

Mathematically:

Total Pressure or obsolute Pressure is thus the sum of Gauge Pressure and atmospheric Pressure.

$$P_{abs} = P_g + P_{atm}$$

Where:

Pabs = Absolute Pressure

Pg = Gauge Pressure

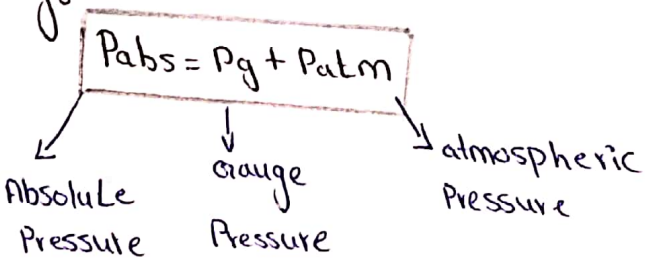
Patm = Atmospheric Pressure

Absolute Pressure:

Definition:

It is a total pressure at a point in a fluid equatling the sum of gauge Pressure and the atmospheric pressure.

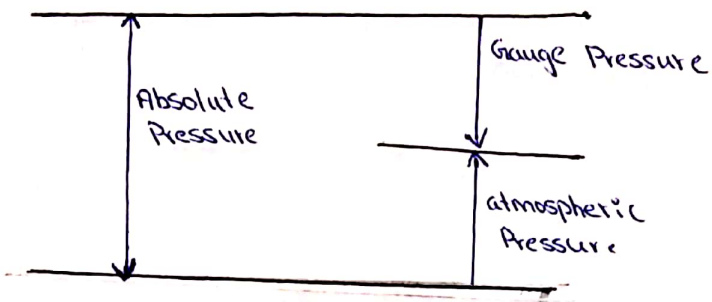
Mathematically:



Example:

If your tire gauge reads 39psi (Pound per square inch) then the absolute Pressure is 39pi plus 14.7 psi (Patm in Psi) or 53.7 psi (equivalent to 337 Kpa)

DIAGRAM



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

Given Data:

length, l = 1500mm = 1.5m
Breath, b = 1500mm = 1.5m
Depth, h = 7940 = 7.940
unit weight of water = 9.81 kN/m^3

Required Data:

-> a. net pressure, P = ?
-> b. Location of force
-> c. If water level drops half of depth find P and location of force.

Solutions:

a) Net Pressure

$P = \gamma h$
$P = 9.81 \times 7.940$
$\boxed{P = 77.8914 \text{ N/m}^2}$

b) Force application (centriod)

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

$$\bar{y} = \frac{7.940}{3}$$

$$\boxed{\bar{y} = 2.646\,m}$$

c) Half Depth:

Pressure at half depth, $p' \gamma d/2$

$$p' \gamma \, d/2$$

$$p' = 9.81 \times \frac{7.940}{2}$$

$$\boxed{p' = 38.94\,kN/m^2}$$

Centriod

$$\bar{y} = h/2 \times 1/3$$

$$\boxed{\bar{y} = 1.323m}$$

Result: