# FLUID MECHANICS & MACHINARY   3   (1)

* Fluids :- Substances which are capable of flowing.
  - Confirm to the shape of the container.
  - Change its shape even under the action of very small forces. (Shear force
  - Some degree of compressibility
  - Cannot sustain tangential and shear forces.

E.g. liquids + gases.

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* Liquids : — No defnite shape.
  - Take the shape of container.
  - Have defnite volume.
  - Highly incompressible.
  - Variation in temp. do not affect their volu to large extent.

* Gases : — No definite shape + volume
  - Take the shape of container
  - Higntly compressible
  - change in temp. affects the volume.

* Difference between liquids + gases:

| | |
|---|---|
| (1) Incompressible (4.8 x 10-6 times the original volume for every added atm. pressure). | compressible |
| (2) changes in temp. do not affect the volume | Affects the volume |
| (3) Have free space | No free space |
| (4) Have definite volume | Expand and occupy the entire container. |

## FLUID MECHANICS

A branch of applied science which deals with ~~liquids~~ the behaviour of fluids at rest and

35V

and compressibility.

(ii) Real fluids (Practical fluids) : They possess the above.

(iii) Newtonian fluids : Viscosity does not change with the rate of deformation of shear strain.

(iv) Non-newtonian fluids : Viscosity changes with rate of shear strain

## PHYSICAL PROPERTIES OF ~~LIQUIDS~~ Fluids:

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(i) Density : $\frac{\text{Mass}}{\text{Volume}} = \frac{Kg}{m^3} = \boxed{\rho = \frac{M}{V}}$

Otherwise known as Mass density (or) Specific mass

$\boxed{\text{Density of pure water} = 1000 \frac{kg}{m^3}}$

(ii) Specific weight : $\frac{\text{Weight}}{\text{Volume}} = \boxed{\gamma (\omega) = \frac{N}{m^3}} = \frac{Mg}{M}$ = ~~$\frac{Kg \times g}{m^3} = \frac{Kg\, m}{s^2\, m^3}$~~

Otherwise known as Weight density (water $9.81 \times 10^3 \frac{N}{m^3}$)

$\boxed{\gamma (\omega) = \frac{W}{V} = \frac{Mg}{V} = \rho g}$ $\boxed{\omega = \rho g}$

(iii) Relative density at 4°c (S) : $\frac{\text{Mass density of liquid/gas}}{\text{Mass density of water/air}} = \frac{\text{Weight density of liquid}}{\text{Weight density of water}}$

Otherwise known as specific gravity.

$\boxed{(S) = \frac{\rho_l}{\rho_w} = \frac{\gamma_l}{\gamma_w}}$

(iv) Specific volume = $\frac{\text{Volume of fluid}}{\text{Mass of fluid}}$

Problems:

1) If $5.60 m^3$ of oil weighs 46,800 N, calculate its density and relative density.

Given data:

Volume (v) = $5.60 m^3$

Weight (W) = 46,800 N

Density = ?

Relative Density = ?

(i) Density $= \frac{M}{V}$

$(W) = M \times g$

$M = \frac{W}{g} = \frac{46,800}{9.81} = 4770.64 \text{ kg}$

$\therefore \rho = \frac{4770.64}{5.60} = 851.90 \frac{\text{kg}}{m^3}$

(ii) Relative Density (s) $= \frac{\rho_l}{\rho_w}$



$= \frac{851.90}{1000} = 0.85$

(2) If the density of liquid is 837 kg/m³, find its specific weight and relative density.

$\rho = M/V$

Given data:

Density $(\rho) = 837 \text{ kg/m}^3$

(i) Specific weight = ?

(ii) Relative density = ?

$W = M \times g$

Solution

(i) Specific weight $= \frac{W}{V} = \frac{Mg}{V} = \rho g = 837 \times 9.81$

$\gamma = 8210.97 \frac{N}{m^3}$

(ii) Relative density $= (S) = \frac{\rho_l}{\rho_w} = \frac{837}{1000} = 0.837$

(3) If a liquid weighs 100 kN and occupies 4 m³, find its specific ~~mass~~ weight, mass density and relative density.

Given data:

Weight (W) = 100 kN

Volume (V) = 4 m³

(i) Specific weight $(\gamma)$ = ?

(ii) Mass density $(\rho)$ = ?

(iii) Relative density (s) = ?

Solution

$\gamma = \frac{W}{V} = \frac{100 \times 10^3}{4} = 25 \times 10^3 \text{ N/m}^3$

$\gamma = \rho g \therefore \rho = \frac{\gamma}{g} = \frac{25 \times 10^3}{9.81} = 2.54 \times 10^3 \frac{\text{kg}}{m^3}$

$S = \frac{\rho_l}{\rho_w} = \frac{2.54 \times 10^3}{10^3} = 2.54$

Tdom2

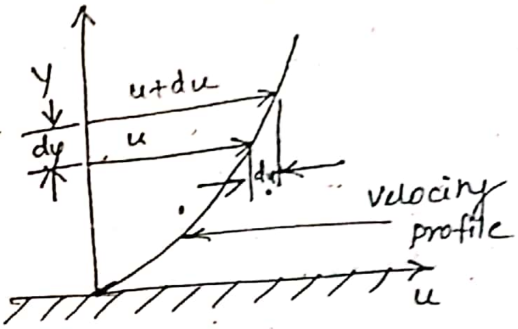
It is the property of [illegible] to the movement of one layer of fluid over another adjacent layer of the fluid.

Also defined as the shear stress required to produce unit rate of shear strain.

$\tau \propto \frac{du}{dy}$ $\quad$ $\tau$ - shear stress

$\frac{du}{dy}$ - rate of shear strain

$\tau = \mu \frac{du}{dy}$ $\quad$ $\mu$ - viscosity.




$$\therefore \boxed{\mu = \frac{\tau}{\left(\frac{du}{dy}\right)}}$$

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$$= \frac{\frac{F}{A}}{\frac{m/s}{m}} = \frac{\frac{N}{m^2}}{\frac{m}{s} \times \frac{1}{m}} = \frac{\frac{kg\,\frac{m}{s^2}}{m^2}}{s} = \frac{kg\,\frac{m}{s^2} \times \frac{1}{m^2}}{s}$$

$$\boxed{\mu = \frac{NS}{m^2} = Pa.s}$$

$$= \frac{\text{Mass} \times \text{Acceleration} \times \text{Time}}{\text{Area}}$$

$$= \frac{M \times \frac{L}{T^2} \times T}{L^2} = MLT^{-1}L^{-2}$$

$$\boxed{= ML^{-1}T^{-1}}$$

$$\boxed{\text{One poise (CGS)} = \frac{1}{10}\frac{NS}{m^2}}$$

(vi) **Kinematic Viscosity : ($\nu$) - nu**

It is ratio between the dynamic viscosity and density of fluid.

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

$$\frac{\frac{NS}{m^2}}{\frac{m}{m^3}} = \frac{NS}{m^2} \times \frac{m^3}{kg} \qquad \frac{kg \times \frac{m}{s^2} \times S \times \dots}{} = \frac{m^2}{s}$$

$$\boxed{\text{One stoke} = \frac{1}{10^4}\frac{m^2}{s}}$$

$$\boxed{L^2T^{-1}}$$

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