

- * Fluids : - Substances which are capable of flowing.
- Conform 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.

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

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

* Difference between liquids + gases:

- ① Incompressible
(48×10^{-6} times the original volume for every added atm. pressure).
- ② Changes in temp. do not affect the volume
- ③ Have free space
- ④ Have definite volume

Compressible



Affects the volume

No free space

Expand and occupy the entire container.

FLUID MECHANICS

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

and compressibility.

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

(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 FLUIDS:

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

Otherwise known as Mass density (or) Specific mass

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

(ii) Specific weight : $\frac{\text{Weight}}{\text{Volume}} = \gamma = \frac{N}{\text{m}^3} = \frac{Mg}{V} = \frac{\text{kg} \cdot g}{\text{m}^3}$

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

$\gamma = \frac{W}{V} = \frac{Mg}{V} = \rho g$

$\bar{w} = \rho g$

(iii) Relative density : $\frac{\text{Mass density of liquid/gas at } 4^\circ\text{C (s)}}{\text{Mass density of water/air}} = \frac{\text{Weight density of liquid/gas}}{\text{Weight density of water/air}}$

Otherwise known as Specific gravity.

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

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

Problems:

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

Given data:

Volume (v) = 5.60 m^3

Weight (W) = $46,800 \text{ N}$

Density = ?

Relative density = ?

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

$$(W) = M \times g$$

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

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

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

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

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② If the density of liquid is 837 kg/m^3 , find its specific weight and relative density.

Given data:

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

(i) Specific weight = ?

(ii) Relative density = ?

Solution

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

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

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

③ If a liquid weighs 100 kN and occupies 4 m^3 , find its specific mass weight, mass density and relative density.

Given data:

$$\text{Weight } (W) = 100 \text{ kN}$$

$$\text{Volume } (V) = 4 \text{ m}^3$$

(i) Specific weight (γ) = ?

(ii) Mass density (ρ) = ?

(iii) Relative density (s) = ?

Solution

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

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

$$s = \frac{\rho_l}{\rho_w} = \frac{2.54 \times 10^3}{1000} = 2.54$$

Techm2

It is the property of fluid to resist the movement of one layer of fluid over another adjacent layer of the fluid.

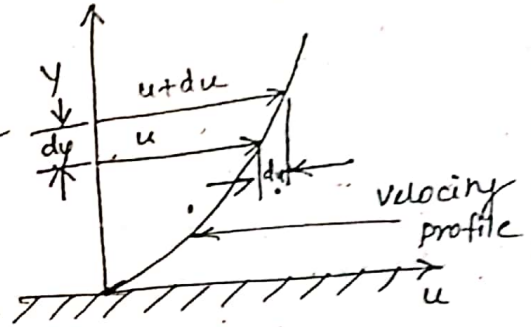
Also defined as the shear stress required to produce unit rate of shear strain.

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

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

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

τ - shear stress
 $\frac{du}{dy}$ - rate of shear strain
 μ - viscosity.



$$= \frac{F}{A} = \frac{N}{m^2} = \frac{kg \cdot m}{s^2} \cdot \frac{1}{m^2} = \frac{kg}{s^2 \cdot m}$$

$$\mu = \frac{Ns}{m^2} = Pa \cdot s$$

$$\text{One poise} = \frac{1}{10} \frac{Ns}{m^2}$$

CGS

$$= \frac{kg \cdot m}{s^2 \cdot m^2} = \frac{kg}{s^2 \cdot m}$$

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

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

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

(vi) Kinematic viscosity: (ν) - nu

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

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

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

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

$$\frac{Ns}{m^2} \cdot \frac{m^3}{kg} = \frac{Ns}{m^2} \times \frac{m^3}{kg} = \frac{kg \cdot m}{s^2} \cdot \frac{m^3}{kg} = \frac{m^2}{s}$$

Team 1