Introduction

1

1. Ideal Fluid and Real Fluid

- **Ideal fluid**

  A fluid is said to be ideal if it is assumed to be both incompressible and non-viscous. Its bulk modulus is infinite.

- **Real fluid**

  Real fluid have viscosity, finite compressibility and surface tension.

Remember:

☑ Ideal fluid has no surface tension.

☑ Ideal fluid are imaginary and do not exist in nature.

2. Specific Weight, Specific Volume, Specific Gravity

- **Specific weight (w) or weight density**

$$w = \frac{\text{Weight}}{\text{Volume}} = \frac{mg}{V} = \rho g$$

where, ρ = Density, g = Acceleration due to gravity

S.I. unit of specific weight is N/m^3

Specific weight of water = 9810 N/m^3

- **Specific Volume**

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

Specific volume of the water: $v = \frac{1}{\rho} = \frac{1}{1000} = 0.001\ m^3/kg$

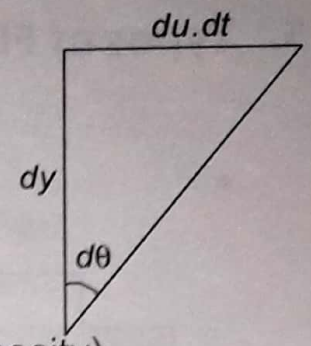
- **Specific gravity (S) or Relative density**

$$\text{Specific gravity} = \frac{\text{Density of fluid}}{\text{Density of standard fluid}}$$

$$= \frac{\text{Specific weight of fluid}}{\text{Specific weight of standard fluid}}$$

Scanned by CamScanner

3. Newton's Law of Viscosity



$$\tau = \mu \frac{du}{dy} = \mu \frac{d\theta}{dt}$$

τ = Shear stress

μ = Coefficient of viscosity or absolute viscosity (or dynamic viscosity)

Here, $\frac{du}{dy}$ = Velocity gradient

$\frac{d\theta}{dt}$ = Rate of angular deformation or Rate of shear strain

- For Newtonian fluid, coefficient of viscosity remain constant.

4. Dynamic Viscosity and Kinematic Viscosity

Due to viscosity a fluid offer resistance to flow

(i) Dynamic Viscosity (μ):

- Its SI unit is pascal-second or **Ns/m² or kg/ms**
- Its CGS unit is poise = Dyne-s/cm²
- 1 poise = **0.1** Ns/m²

(ii) Kinematic Viscosity,

$$\nu = \frac{\text{Dynamic viscosity } (\mu)}{\text{Mass density } (\rho)}$$

- Its SI unit is m²/s
- Its CGS unit is cm²/s or stoke
- 1 stoke = cm²/s = 10^{-4} m²/s

Remember:

☑ Viscosity of **liquids** decreases with temperature whereas viscosity of **gases** increases with increase in temperature.

☑ Liquids with increasing order of viscosity are gasoline, water, crude oil, castor oil.

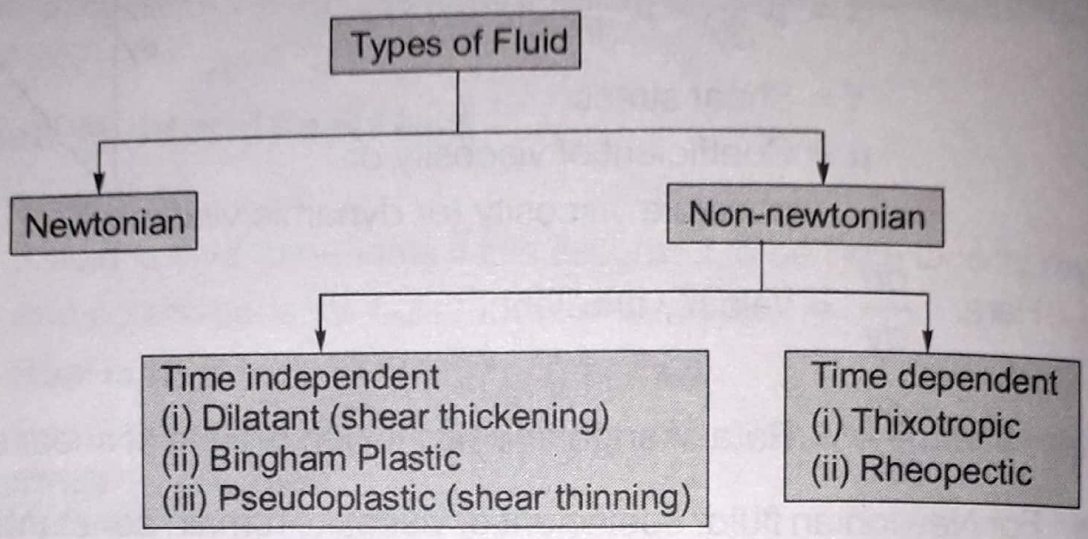
☑ Viscosity of **water** at 20°C is 1 centipoise.

☑ Viscosity is due to

- Intermolecular forces of cohesion [dominant in liquids]
- Transfer of molecular momentum between fluid layers [dominant in gases].

Scanned by CamScanner

5. Types of Fluid

- 

- **Non-Newtonian Fluids**

These do not follow Newton's law of viscosity. The relation between shear stress and velocity gradient is

$$\tau = A\left(\frac{du}{dy}\right)^n + B$$

where A and B are constants depending upon type of fluid and condition of flow.

(i) For Dilatant Fluids: $n > 1$ and $B = 0$,
Example: Butter, Quick sand.

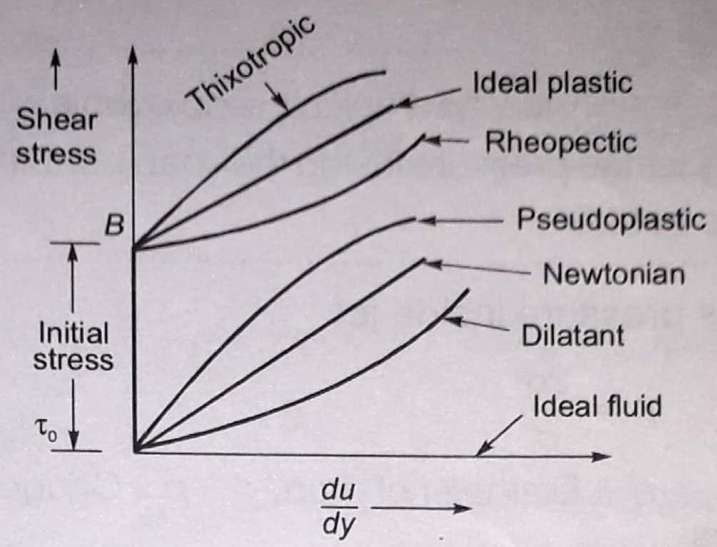
(ii) For Bingham Plastic Fluids: $n = 1$ and $B \neq 0$
Example: Sewage sludge, Drilling mud, tooth paste and gel. These fluids always have certain minimum shear stress before they yield.

(iii) For Pseudoplastic Fluids: $n < 1$ and $B = 0$
Example: Paper pulp, Rubber solution, Lipsticks, Paints, Blood, Polymetric solutions etc.

(iv) For Thixotropic Fluids: $n < 1$ and $B \neq 0$
Viscosity increases with time.
Example: Printer ink and Enamels.

(v) For Rheopectic Fluids: $n > 1$ and $B \neq 0$
Viscosity decreases with time.
Example: Gypsum solution in water and Bentonite solution.

Scanned by CamScanner



6. Compressibility (β), Isothermal Bulk Modulus (k_T) and Adiabatic Bulk Modulus

- Compressibility (β)

  It is inverse of bulk modulus of elasticity.

$$\beta = \frac{1}{k} = \frac{-dv}{vdp} = \frac{d\rho}{\rho dp}$$

where, k = Bulk modulus of elasticity

ρ = Density; v = Specific volume

- Isothermal bulk modulus (k_T)

$$k_T = p_{final} = \rho RT$$

- Adiabatic bulk modulus

$$k_a = \gamma\, p_{final}$$

Here, $\gamma = \frac{c_p}{c_v}$

c_p = Specific heat at constant pressure

c_v = Specific heat at constant volume

7. Surface Tension/Pressure Inside Drop, Bubble and Jet

Surface tension occurs at the interface of liquid and a gas or at the interface of two liquid. Surface tension is inversely proportional to temperature and it also acts when fluid is at rest.

- Liquid tends to minimize its surface area and hence surface energy.
- Excess pressure inside drop (Solid like sphere)

$$p = \frac{4\sigma}{d}$$

- Excess pressure inside bubble

$$p = \frac{8\sigma}{d}$$

Scanned by CamScanner

Remember:

- ☑ The pressure inside the droplet of soap bubble will be higher than p_{atm}.
- ☑ The higher the pressure inside the soap bubble the smaller the size of soap bubble.

- **Excess pressure inside jet**

$$p = \frac{2\sigma}{d}$$

Here d = Diameter of drop, p = Gauge pressure

Remember:

- ☑ It is a **surface** phenomenon
- ☑ It is force per unit length (N/m)
- ☑ For **water-air** interface at 20°C its value is 0.0736 N/m and Air-mercury Interface σ = 0.480 N/m
- ☑ At critical point, liquid-vapuor state are same thus surface tension = 0
- ☑ It is due to **cohesion** only

8. Capillary Action

- **Height of water in capillary tube**

$$h = \frac{4\sigma\cos\theta}{\rho g d}$$

where, h = rise in capillary, σ = surface tension of water
d = diameter of tube
θ = angle of contact between the liquid and the material.
θ = 0° for water and glass (clean)
θ = 128° for mercury and glass (clean)

	$F_{cohesion} < F_{adhesion}$	$F_{cohesion} > F_{adhesion}$
Level	Rises	Falls
θ	< 90°	> 90°
Ex.:	H_2O-glass	Hg-glass

- **When a liquid surface supports another liquid of density ρ_b, then rise in capillary is given as**

$$h = \frac{4\sigma\cos\theta}{(\rho - \rho_b)gd}$$

- Capillary action is due to **both** adhesion and cohesion.
- For capillary action diameter of tube should be **less** than 3 cm.

■■■■

Scanned by CamScanner

* Properties of fluid -

(1) Density or Mass density $\rho = \frac{m}{V}$, $\rho_{water} = 1000\ kg/m^3$, $\rho_{Hg} = 13600\ Kg/m^3$

(2) Sp. weight or Weight density $w = \frac{mg}{V} = \rho g$, $\left(w_{H_2O} = 9.81 \times 1000\ N/m^3 \right)$

(3) Sp. volume $= \frac{V}{m} = \frac{1}{\rho}$ commonly applied to gas, m^3/kg

(4) Sp. gravity $= S_{Liq.} = \frac{w_{Liq}}{w_{H_2O}} \Rightarrow w_{Liq.} = S \times w_{H_2O} = S \times 9810\ N/m^3$

or

Relative Density $S_{gas} = \frac{w_{gas}}{w_{air}}$

$S_{Hg} = 13.6$ $\quad \because$ density of Hg $= 13.6 \times 1000 = 13600\ kg/m^3$

$S_{H_2O} = 1$

$\therefore S = \frac{w_1}{w_2} = \frac{\rho_1 g}{\rho_2 g} = \frac{\rho_1}{\rho_2}$

$\Rightarrow$

Problem - Calculate the sp. wt., density and sp. gravity of one litre of a liq. which weighs 7N.

Sol^n $V = 1\ lit. = \frac{1}{1000}\ m^3$

$W = 7N$

$\therefore$ (i) Sp. wt. $w = \frac{W}{V} = \frac{7}{1/1000} = 7000\ N/m^3$

(ii) density $= \frac{w}{g} \Rightarrow \rho = \frac{7000}{9.81}\ kg/m^3 = 713.5\ kg/m^3$

(iii) Sp. gravity $= S = \frac{\rho_{Liq.}}{\rho_{water}} = \frac{713.5}{1000} = 0.7135$

Intro

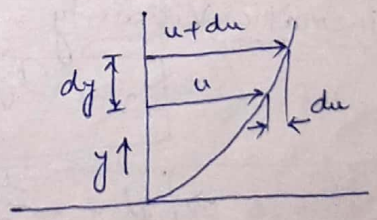
Fluid Mechanics $\rightarrow$ Statics, Kinematics, Dynamics

fluid - Liquid and gas flow

(5) **Viscosity** - $\tau \propto \frac{du}{dy}$

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

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



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

Scanned by CamScanner

Units of Dynamic Viscosity $\mu = \dfrac{\text{Shear stress}}{\dfrac{\text{Change of velocity}}{\text{Change of distance}}}$

$\left\{ \dfrac{F/A}{\frac{L}{T} \times \frac{1}{L}} = \dfrac{F \times T}{L^2} \right.$

MKS unit of $\mu = \dfrac{\text{kgf-sec}}{m^2}$

CGS " " " $= \dfrac{\text{dyne-sec}}{m^2}$ or poise

SI " " " $= \dfrac{N\text{-}s}{m^2}$

$1 \dfrac{\text{kgf-sec}}{m^2} = 9.81 \dfrac{Ns}{m}$ $(\because 1\,kgf = 9.81\,N)$

$1\,\text{Newton} = 1\,kg \times \dfrac{1\,m}{sec^2}$

$= \dfrac{1000\,gm \times 100\,cm}{sec^2}$

$= 100{,}000 \dfrac{gm\text{-}cm}{sec^2}$

$= 1000 \times 100$ dyne

$\therefore 1 \dfrac{\text{kgf-sec}}{m^2} = 9.81 \times 100000 \dfrac{\text{dyne-sec}}{m^2}$

$= 9.81 \times 100000 \dfrac{\text{dyne-sec}}{100 \times 100\,cm^2}$

$= 98.1 \dfrac{\text{dyne-sec}}{cm^2}$

$\Rightarrow 1 \dfrac{\text{kgf-sec}}{m^2} = 98.1$ poise

So, $1 \dfrac{\text{kgf-sec}}{m^2} = 9.81 \dfrac{Ns}{m^2} = 98.1$ poise

$\Rightarrow 1 \dfrac{Ns}{m^2} = \dfrac{98.1}{9.81} = 10$ poise

$\Rightarrow 1\,\text{poise} = \dfrac{1}{10} \dfrac{Ns}{m^2}$

$\Rightarrow 1\,cp = \dfrac{1}{100}$ poise , cp = centi-poise

e.g. Viscosity of H_2O at 20°c is 0.01 poise ~~or 1 cp~~ or 1 cp

(6) Kinematic Viscosity -

$$\boxed{\nu = \frac{\text{Dynamic viscosity}}{\text{Density}}}$$

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

MKS unit of ν is m^2/sec

CGS " " " " $cm^2/sec = \left(\frac{1}{100}\right)^2 m^2/s$

$= 10^{-4}\,m^2/s$

Scanned by CamScanner

⇒ 1 stokes = 10^{-4} m^2/s

Centistokes means = $\frac{1}{100}$ stoke

→ Newtons law of Viscosity -

It states that, the shear stress (τ) on a fluid element layer is directly proportional to the rate of shear strain. The constant of proportionality is called the coeff. of viscosity.

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

{ Newtonian fluids And Non-Newtonian fluids

→ Variation of viscosity with temp. -

(i) The viscosity of liquids decreases with the increase of temp. For liquids, $\boxed{\mu = \mu_0 \left[\frac{1}{1+\alpha t+\beta t^2}\right]}$

e.g. for water $\mu_0 = 1.79 \times 10^{-3}$ poise

$\alpha = 0.03368$

$\beta = 0.000221$

(ii) Viscosity of gases increases with the increase in temp. For gases, $\boxed{\mu = \mu_0 + \alpha t - \beta t^2}$

e.g. for air $\mu_0 = 0.000017$ poise

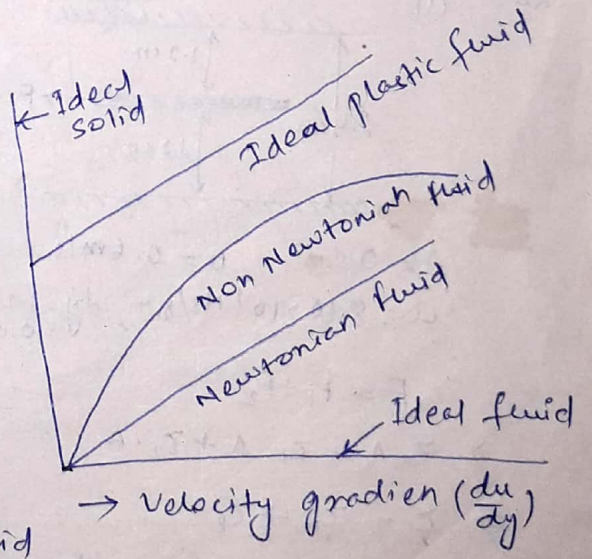
$\alpha = 0.000000056$

$\beta = 0.1189 \times 10^{-9}$

→ Types of fluid

1. Ideal fluid - Incompressible and having no viscosity. It is an imaginary fluid

2. Real fluid - Which possesses viscosity, all fluids in actual practice, are real fluids



3. Newtonian fluid - A real fluid which obeys ~~neto~~ Newton's law of viscosity. $\tau \propto \frac{du}{dy}$

4. Non-Newtonian fluid - A real fluid that doesnt obey Newton's law of viscosity.

Scanned by CamScanner

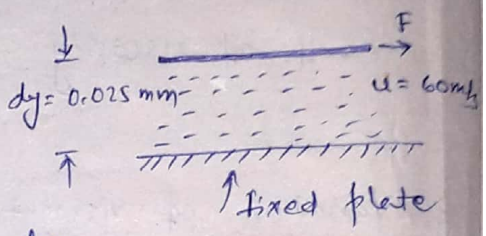
5. Ideal plastic fluid - A fluid in which shear stress is more than yield value and shear stress is proportional to the rate of shear strain (or velocity gradient)

Problem (Q) A plate 0.025 mm distant from a fixed plate, moves at 60 cm/s and requires a force of 2 N/m² to maintain its speed. Determine the fluid viscosity between the plates.

Sol^n: $dy = 0.025\,mm = 0.025 \times 10^{-3}\,m$

$u = 60\,cm/s = 0.6\,m/s$

$F = 2\,N/m^2 = \tau$



$\therefore \tau = \mu \frac{du}{dy} \Rightarrow \mu = \frac{\tau}{du} \times dy$

$= \frac{2 \times 0.025 \times 10^{-3}}{0.6}$

$\Rightarrow \mu = 8.33 \times 10^{-5}\,Ns/m^2$

$= 8.33 \times 10^{-5} \times 10$ poise

$= 8.33 \times 10^{-4}$ poise

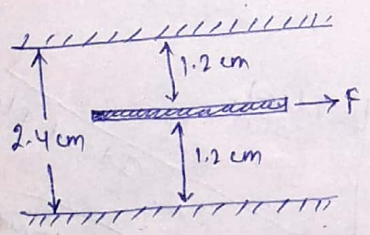
(Q) Problem - Two large plane surfaces 2.4 cm apart. Space between the surfaces is filled with glycerine. What force is required to drag a very thin plate of surface area 0.5 m² between the two large plane surfaces at a speed of 0.6 m/s if

(i) the thin plate is in the middle of two plane surfaces

(ii) the thin plate is at 0.8 cm from one of the plane surfaces

Take dynamic viscosity of glycerine $= 8.10 \times 10^{-1}\,Ns/m^2$

Sol^n: (i)



$A = 0.5\,m^2$, $u = 0.6\,m/s$

$\mu = 8.10 \times 10^{-1}\,Ns/m^2$, $dy = 1.2\,cm = 0.012\,m$

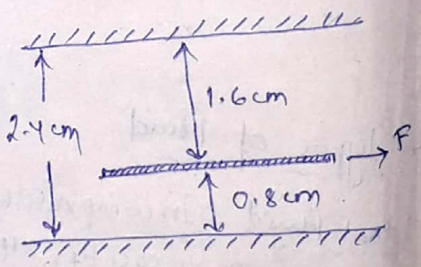
$F = F_1 + F_2$

$\Rightarrow \tau \cdot A = \tau_1 \cdot A + \tau_2 \cdot A$

$\Rightarrow \tau = \tau_1 + \tau_2$

$= \mu \left(\frac{du}{dy}\right)_1 + \mu \left(\frac{du}{dy}\right)_2$

$= 8.10 \times 10^{-1} \times \left(\frac{0.6}{0.012}\right) + 8.10 \times 10^{-1} \left(\frac{0.6}{0.012}\right)$



$F = F_1 + F_2$

$\Rightarrow \tau = \tau_1 + \tau_2$

$\Rightarrow \tau = \mu \left(\frac{du}{dy}\right)_1 + \mu \left(\frac{du}{dy}\right)_2$

$= 8.10 \times 10^{-1} \left[\left(\frac{0.6}{0.016}\right) + \left(\frac{0.6}{0.008}\right)\right]$

$\Rightarrow F = \tau \cdot A$

$= \tau_1 \cdot A + \tau_2 \cdot A$

Scanned by CamScanner

$\Rightarrow \tau = 2 \times 8.10 \times 10^{-1} \left(\frac{0.6}{0.012}\right)$

$= 2 \times 40.5 \ N/m^2$

$\therefore F = \tau \cdot A$

$= 2 \times 40.5 \times 0.5 \ N$

$= 40.5 \ N$ (Ans)

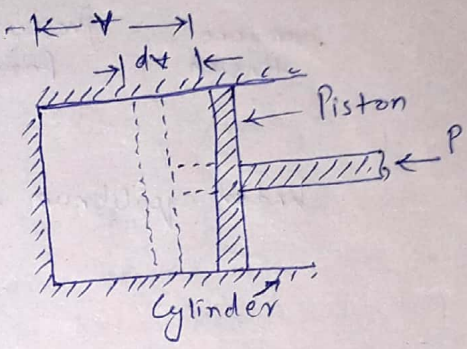
$\Rightarrow F = (\tau_1 + \tau_2) \cdot A$

$= 8.10 \times 10^{-1} \times \left(\frac{0.6}{0.016}\right) + \left(\frac{0.6}{0.008}\right) \times 0.5$

$= 15.18 + 30.36$

$\Rightarrow F = F_1 + F_2 = 45.54 \ N.$

* Compressibility and Bulk Modulus



Increase in pressure $= dp \ kgf/m^2$

Decrease in volume $= d\forall$

volumetric strain $= -\frac{d\forall}{\forall}$

(-ve sign means vol. decreases with increase in pressure)

$\therefore$ Bulk Modulus $\Rightarrow K = \frac{dp}{-\frac{d\forall}{\forall}} = -\frac{dp}{d\forall} \times \forall$

Compressibility $= \frac{1}{K}$.

→ Relationship between Bulk Modulus 'K' and Pressure 'p' for a gas:-

(i) for isothermal process:- $\frac{p}{\rho} = \text{constant}$

$p\forall = \text{constant}$

Differentiating $p\,d\forall + \forall\,dp = 0 \Rightarrow p\,d\forall = -\forall\,dp$

$\Rightarrow p = -\frac{\forall\,dp}{d\forall}$

$\Rightarrow \boxed{p = K}$

(ii) for Adiabatic process:- $\frac{p}{\rho^n} = \text{constant}$

$\Rightarrow p\forall^n = \text{constant}$

Differentiating $p\,d(\forall^n) + \forall^n dp = 0$

$\Rightarrow p \cdot n \cdot \forall^{n-1} d\forall + \forall^n dp = 0$

$\Rightarrow p\,n\,d\forall + \forall\,dp = 0$

$\Rightarrow p\,n\,d\forall = -\forall\,dp$

$\Rightarrow p\,n = -\frac{\forall\,dp}{d\forall}$

$\Rightarrow \boxed{p \cdot n = K}$

$\left(\frac{C_p}{C_v} = n\right.$ = Specific heat ratio

Scanned by CamScanner

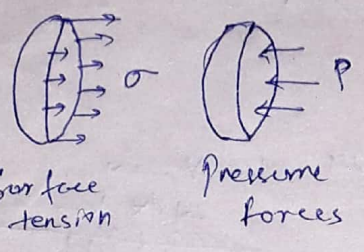
* Surface Tension (σ) :-

(a) Surface tension on liquid droplet

(b) Surface tension on Hollow bubble

(c) Surface tension on liquid jet

(a)



Tensile force due to surface tension acting on circumference

$= \sigma \times$ circumference

$= \sigma \times \pi d$

Pressure force on the area

$= p \times \frac{\pi}{4} d^2$

Under equilibrium $\Rightarrow \sigma \times \pi d = p \times \frac{\pi}{4} d^2$

$\Rightarrow \boxed{p = \frac{4\sigma}{d}}$ Pressure intensity inside the droplet increases if dia. decreases.

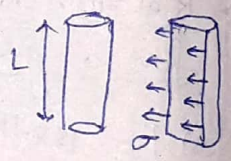
(b) For Hollow bubble $\Rightarrow p \times \frac{\pi}{4} d^2 = 2 \times (\sigma \times \pi d)$

$\Rightarrow \boxed{p = \frac{8\sigma}{d}}$

(c) For Liquid jet $\Rightarrow p \times L \times d = \sigma \times 2L$

$\Rightarrow p = \frac{\sigma 2L}{L \times d}$

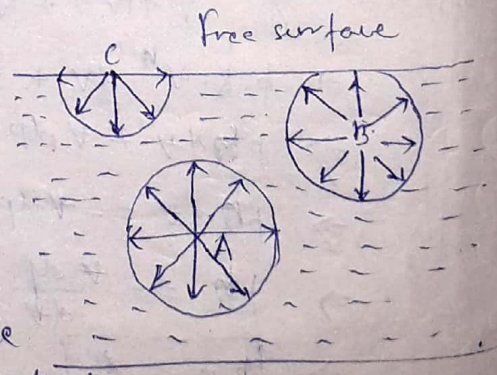
$\Rightarrow \boxed{p = \frac{2\sigma}{d}}$



→ Surface tension is defined as "the tensile force acting on the surface of the liquid in contact with a gas or on the surface between two immiscible liquids such that the contact surface behaves like a membrane under tension.

Units – MKS kgf/m

SI N/m



In this fig. Molecule C expreience a resultant downward force. All such such molecules at the free surface experience a downward force, thus acts as elastic membrane under tension.

(Q) The pressure outside the droplet of water of dia. 0.04 mm is 10.32 N/cm² (atmospheric). Calculate the pressure within the droplet if surface tension is 0.0725 N/m of water.

Sol: $p = \frac{4\sigma}{d} = \frac{4 \times 0.0725}{0.04 \times 10^{-3}} = 7250 \text{ N/m}^2$

$= \frac{7250}{10^4} \text{ N/cm}^2$

$= 0.725 \text{ N/cm}^2$

∴ pressure inside the droplet $= p + p_{atm}$

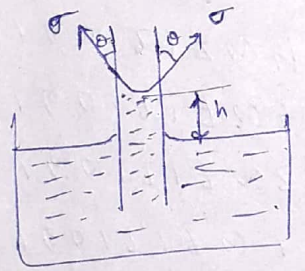
$= 0.725 + 10.32$

$= 11.045 \text{ N/cm}^2$

* Capillarity - Phenomenon of rise or fall of a liquid surface in a small tube relative to the adjacent level of liquid when the tube is held vertically in the liquid.

It is expressed as cm of liq. or mm of liq. and its depends upon sp-wt. of liq, dia. of tube and surface tension of liq.

(I) Capillary Rise for water



θ = angle of contact

h = rise or fall

Weight of liq. of height h in tube = vertical component of surface tensile force

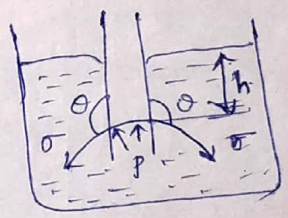
$\Rightarrow \frac{\pi}{4} \times d^2 \times h \times \rho \times g = \sigma \times \pi d \times \cos\theta$

$\Rightarrow h = \frac{\sigma \times \pi d \times \cos\theta}{\frac{\pi}{4} d^2 \rho g}$

$\Rightarrow h = \frac{4\sigma \cos\theta}{\rho g d}$

$\Rightarrow \boxed{h = \frac{4\sigma}{\rho g d}}$ ($\cos 0° = 1$, $\theta = 0°$ for water and glass.)

(II) Capillary depression for Mercury



$\frac{\pi}{4} d^2 h \rho g = \sigma \pi d \cos\theta$

$\Rightarrow \boxed{h = \frac{4\sigma \cos\theta}{\rho g d}}$

$\theta = 128°$ for Mercury and glass

Scanned by CamScanner

[3rd sem B.tech]

* Topics - Pressure and its Measurement

1Q) A Hydraulic press has a ram of 20cm diameter and a plunger of 3cm diameter, It is used for lifting a weight of 30KN. find the force required at the plunger.

Sol:

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\Rightarrow \frac{F}{\frac{\pi}{4}d_1^2} = \frac{W}{\frac{\pi}{4}d_2^2}$$

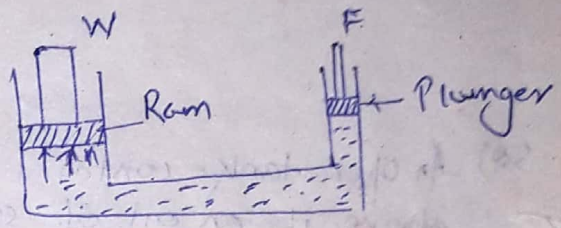
$$\Rightarrow F = \frac{\pi/4\, d_1^2}{\pi/4\, d_2^2} \times W$$

$d_2 = 20\ cm = 0.2\ m$

$d_1 = 3\ cm = 0.03\ m$

$W = 30\ KN = 30 \times 10^3\ N$

$F = ?$



$$\Rightarrow F = \frac{(0.03)^2}{(0.20)^2} \times 30 \times 10^3 \Rightarrow F = 675.2\ N \text{ (Ans)}$$

$\approx 675\ N$

2Q) The pressure intensity at a point in a fluid is given 3.94 N/cm find the corresponding height of fluid when the fluid is (a) water (b) Oil of sp. gr. 0.9

Sol: (a) Pressure intensity $p = 3.94\ N/cm^2 = 3.94 \times 10^4\ N/m^2$

Corresponding height for water $z = \frac{p}{\rho g}$

$\rho = 1000\ kg/m^3$

$g = 9.81\ m/s^2$

$$\Rightarrow z = \frac{3.94 \times 10^4}{1000 \times 9.81}$$

$\Rightarrow z = 4\ m$ of water

(b) Corresponding ht. for Oil of sp. gr. 0.9

$$z = \frac{3.94 \times 10^4}{900 \times 9.81}$$

$= 4.44\ m$ of Oil

(or $\rho_1 h_1 = \rho_2 h_2$ $\rho_1 = 1, \rho_2 = 0.9$

$\Rightarrow h_2 = \frac{\rho_1 h_1}{\rho_2} = \frac{4}{0.9} = 4.44\ m$ of oil)

$S_o = \frac{\rho_o}{\rho_{H_2O}}$

$\Rightarrow \rho_o = S_o \times \rho_{H_2O}$

$= 0.9 \times 1000$

$= 900\ kg/m^3$

2013 (2 marks)

3Q) Differentiate between intensity of pressure and pressure head.

Ans:- Intensity of pressure at a point in static fluid is equal in all direction. It's unit is N/m^2, bar, Pa.

Pressure head $\Rightarrow z = P/w$ is expressed in m of liq. or fluid column.

Scanned by CamScanner

49) The pressure at a particular location of a centrifugal pump measured by Bourdon tube pressure gauge is 3.23 kgf/cm². Determine the equivalent water head ?

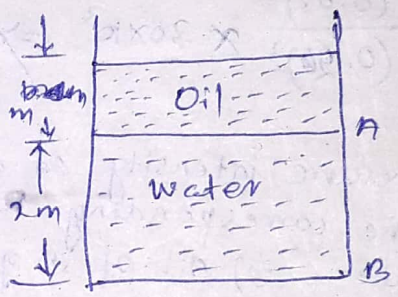
Sol^n: $z = \frac{P}{\rho g} = \frac{9.81 \times 3.23 \times 10^4}{9.81 \times 1000}$

$\Rightarrow z = 32.3$ m of water.

$P = 3.23$ kgf/cm²
$= 9.81 \times 3.23$ kgf/cm²
$= 9.81 \times 3.23 \times 10^4$ N/m²
Since 1 kgf = 9.81 N
or Sp. wt. of water
$w = 1000$ kgf/m³
$= 9.81 \times 1000$ N/m³

50) An open tank contains water upto a depth of 2m and above it an oil of sp. gr. 0.9 for a depth of 1m. Find the pressure intensity :-
(i) at the interface of the two liquids and
(ii) at the bottom of the tank.

Sol^n: $Z_1 = 2$m = Height of water
$Z_2 = 1$m = Height of Oil
Sp. gr. of oil $= S_0 = 0.9$
density of $H_2O = \rho_1 = 1000$ kg/m³



$\therefore$ density of oil $= \rho_2 = S_0 \times \rho_1$
$= 0.9 \times 1000 = 900$ kg/m³

$\because \frac{p}{w} = z \Rightarrow p = z \times w = z \times \rho \times g$

(i) At interface i.e at A $p = \rho_2 \times g \times 1.0$
$= 900 \times 9.81 \times 1$
$= 8829$ N/m²
$= 0.8829$ N/cm² (Ans)

(ii) At bottom i.e at B
$p = \rho_2 \times g z_2 + \rho_1 g z_1$
$= 900 \times 9.81 \times 0.1 + 1000 \times 9.81 \times 2.0$
$= 8829 + 19620$
$= 28449$ N/m²
$= 2.8449$ N/cm² (Ans)

Scanned by CamScanner

69) What are the gauge pressure and absolute pressure at a point 3m below the free surface of a liquid having a density of $1.53 \times 10^3 \, kg/m^3$ if the atm. pressure is equivalent to 750 mm of Hg ? Sp. gr. of Hg is 13.6 and density of water is $1000 \, kg/m^3$

Soln: Depth of liq. $Z_1 = 3m$, Density of liq. $\rho_1 = 1.53 \times 1000$
$= 1.53 \times 10^3 \, kg/m^3$

Atm. pr. head $Z_0 = 750mm$ of Hg $= 0.75m$ of Hg.

$\therefore$ Atm. pr. $p_{atm} = Z_0 \times \rho_0 \times g$

$= 0.75 \times (S_0 \times \rho_{H_2O}) \times g$

$= 0.75 \times 13.6 \times 1000 \times 9.81$

$= 100062 \, N/m^2$

Pressure at a point which is at a depth of 3m from free surface of liq.

$p = \rho_1 \times g \times Z_1$

$= (1.53 \times 1000) \times 9.81 \times 3$

$= 45028 \, N/m^2$ = Gauge pressure

$\therefore$ Absolute pressure $= p_{gauge} + p_{atm}$

$= 45028 + 100062$

$= 145090 \, N/m^2$ (Ans)

Scanned by CamScanner