Fluid Mechanics

Mechanics

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Study of motion

Kinematics –
study of motion without the consideration of basic causes of motion i.e - force.

$\vec{v} = \frac{ds}{dt}$ not including

$\vec{a} = \frac{d\vec{v}}{dt}$ mass (directly or indirectly)

unit – M, M/S

M/S^2, M/S^3

Dynamics –
study of motion with the consideration of basic causes of motion. i.e - Force

$\vec{Fex} = \frac{d}{dt}(M\vec{v})$

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including mass.

Dynamic viscosity (μ) = $\frac{N\text{-}S}{M^2}$

Kinematic viscosity (ν) = $\frac{\mu}{\rho}$ (M^2/S)

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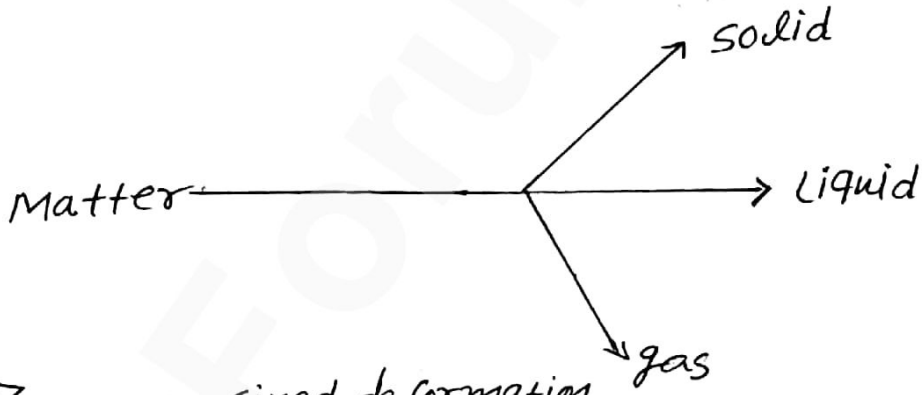
Fluid Mechanics :-

Fluid :-

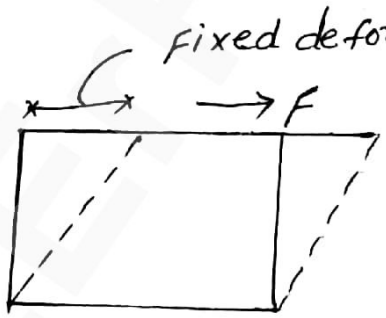
"Liquid & Gases both are having the Property of contineons deformation under the action of shear or tangential force. This Property of contineonsly deformation is also Knowr as flow Property & hence Liquid & gases are Kept in diffrent catagory which is for away from the solids & this catagory is known as fluid."

A fluid is a substance which is having & ability to flow. under the action of shear & tangential forces.

Fluid –

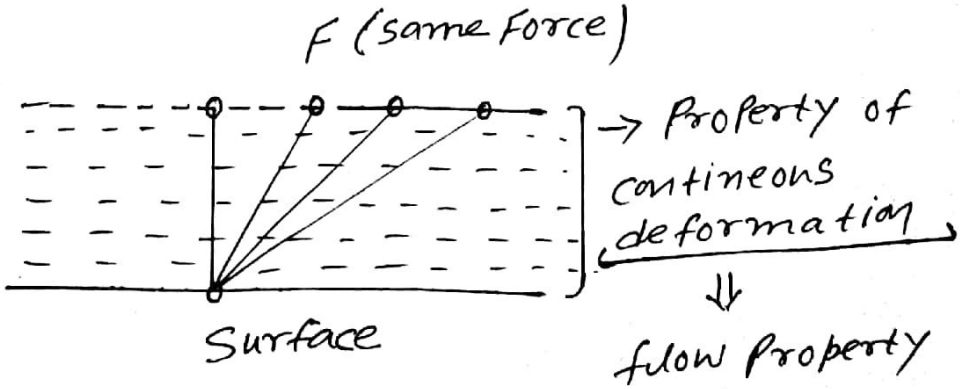


In solid →



deformatian change when forces are changes at different -2 time.

In liquid :-



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Fluid as a continuum :-

" In macroscopic system, the inter atomic space b/w the molecules of fluid can be treated as negligible as compared to the dimension of the system therefor we can assume adjacent to one molecule there is a another molecule & their is no interspace b/w them. Hence the entire fluid molecule system can be treated as contineons distribution of mass system & it is known as continuum."

BASIC FLUID PROPERTY :-

(1) Density (ρ) :- It is defined as mass per unit body of the substance.

$$\rho = \frac{m}{\forall}$$

unit :- kg/m^3

In C.G.S unit -

$$1\ gm/cc = 1\ gm/cm^3$$

$$= \frac{10^{-3} kg}{10^{-6} m^3} = \frac{1000\ kg}{m^3}$$

(2) Specific weight :-

It is the weight of the substance per unit volume.

$$Sp.wt = \frac{m\,g}{\forall} = \rho \cdot g$$

$$\boxed{Sp.wt = \rho g} \quad N/m^3$$

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(3) Specific Gravity (S.g) :-

A sp. gravity of the fluid is defined as a Ratio of density of fluid to the denisity of stendard fluid.

$$(S.g)\ \text{fluid} = \frac{\text{Density of fluid}}{\text{Density of standared fluid}}$$

for lg ⇒ standard fluid ⇒ water (1000 Kg/m³)

for gas ⇒ standard fluid ⇒ Atm Air (1-2 kg/m³)

(4) Relative density (R.D) :-

$$(R.D)\ 1/2 = \frac{P_1}{P_2}$$

(5) Compressibility (B) :-

$$\beta = \frac{\frac{-d\forall}{\forall}}{dP} \quad \text{——— (1)}$$

$$m = P \times \forall = \text{constant}$$

$$\rho \cdot d\forall + \forall \cdot d\rho = 0$$

$$\frac{-d\forall}{\forall} = \frac{d\rho}{\rho}$$

Put these valne in eqn (1)

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$$\boxed{\beta = \frac{1}{\rho} \cdot \frac{d\rho}{dP}}$$

If ρ is not changing w.r.t Pressure

$$\frac{d\rho}{dP} \to 0 \Rightarrow \boxed{\beta = 0}$$

Incompressive

If ρ is changing w.r.t Pressure

$$\frac{d\rho}{dP} = 0 \Rightarrow \boxed{\beta = 0}$$

Compressive

Liquid

$\Downarrow$

Compressive

For water :-

at 1 atm $\longrightarrow \rho_{water} = 998\ Kg/m^3$

at 100 atm $\longrightarrow \rho_{water} = 1003\ Kg/m^3$

$$\therefore \Delta\rho = 5\ Kg/m^3$$

$$\% \text{ change} = \frac{5}{998} \times 100$$

$$= \frac{\Delta\rho}{\rho} \times 100$$

$$= 0.5\%$$

$$\boxed{\beta_{liq} = 0}$$

Liquid area treated as Incompressible

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Gases

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Highly compressible

$P = \rho RT$

$\boxed{P \propto \rho}$

NOTE :- The Reciprocal of compressibility is known as Bulk modulus of elasticity.

(6) Isothermal compressibility of gas :-

$$\boxed{\beta = \frac{1}{\rho} \cdot \frac{d\rho}{dP}}$$

Ideal gas eqn :-

$P = \rho RT$ [Isothermal, T = Constant]

$P = \frac{\rho}{RT}$

$$\boxed{\frac{d\rho}{dP} = \frac{1}{RT}}$$

$$\boxed{\beta iso = \frac{1}{\rho} \cdot \frac{1}{RT}}$$

$$\boxed{Biso = \frac{1}{\rho RT}}$$

$$\boxed{Biso = \frac{1}{P}}$$

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