Chapter 2

Fundamentals of Fluid Mechanics

Mechanics

It is a physical science that deals with the state of rest or motion of bodies under the influence of forces (compressive, tensile and shear).

Fluid Mechanics

It is that branch of science which deals with the behaviour of fluids at rest and in motion.

Fluid

Is a substance which deforms continuously when subjected to a shear stress.

A Fluid may be a Liquid or Gas.

Liquid

A liquid occupies a fixed volume and forms a horizontal free surface.

Gas

A gas fills the container which holds it, and it does not form free surface.

The main differences between liquids & gases are

- Liquids are practically incompressible whereas gases are compressible.
- Liquids occupy a definite volume and have a free surface whereas a given mass of gas expands until it occupies all portion of any containing vessel.

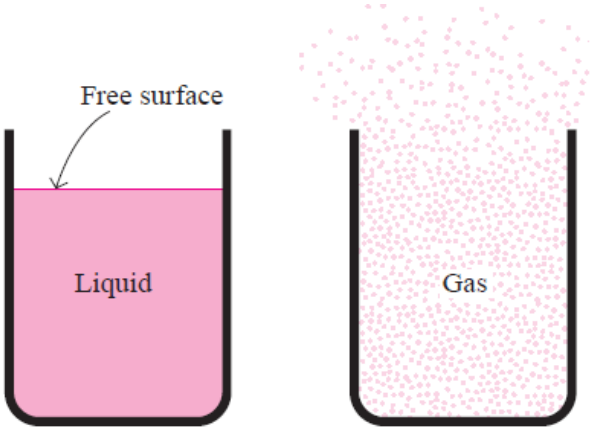

Fig.2.1 Behaviour of a fluid (liquid and gas) in a container.

Units of Measurements

There are two fundamental systems of units.

Metric system

Quantity	Symbol	Main unit	Fractions
Mass	M	kg	gr
Length	L	m	cm
Time	T	sec	msec
Force	F	N	dyne

English system

Quantity	Symbol	Main unit	Fractions
Mass	M	lb	slug
Length	L	ft	in
Time	T	sec	msec
Force	F	lb_f	

The International System of Units [SI Units]

The Basic Units

Quantity	Symbol	Name of Unit	Symbol
Length	L	Metre	m
Mass	M	Kilogram	kg
Time	t	Second	sec
Temperature	T	Kelvin or Celsius	K= °C+273

The Derived Units

Quantity	Symbol	Name_of_Unit	Symbol
Frequency	f	Hertz	Hz = 1/sec
Force	F	Newton	N = kg. m/s^2
Energy	E	Joule	J = N. m
Work	W	Joule	J = N. m
Heat	Q	Joule	J = N. m
Power	$\mathcal{P}$	Watt	Watt = J/s
Pressure	P	Pascal	Pa = N/m^2
Stress	τ	Pascal	Pa = N/m^2

Fluid Properties

Mass (m**)**

It is the amount of matter contained in the substance.

The principle of mass conservation is [the mass cannot be created nor destroyed] Unit of mass [kg].

Volume (V**)**

It is the amount of space occupied by the substance. Unit of volume [m^3].

1 m^3 = 1000 Liter

Density (ρ)

It is the mass per unit volume. It changes with pressure & temperature. Unit of density [kg/m^3].

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

Density of water = 1000 kg/m^3 at standard conditions.

Density of air = 1.2 kg/m^3 at standard conditions.

Weight Density or Specific Weight (γ)

It is the weight of fluid contained in a unit volume. Unit of weight density [N/m^3].

$$\gamma = \frac{w}{V}$$

$w = mg$ [Newton's 2nd law]

$$\gamma = \frac{mg}{V}$$

$$\gamma = \rho g$$

Relative Density (r.d) or Specific Gravity (s.g)

It is the density of a substance relative to that of water at a specified temperature & pressure.

$$r.d = \frac{density\ of\ fluid}{density\ of\ water}$$

$$r.d = \frac{\rho_{sub}}{\rho_{water}}$$

$$r.d = \frac{\gamma_{sub}}{\gamma_{water}}$$

Specific Volume (v)

It is reciprocal of density. Unit of v [m^3 /kg].

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