FLUID MECHANICS AND MACHINERY

UNIT – I

(1)

UNITS AND DIMENSIONS

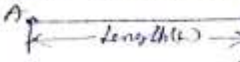
bEFBmy

Dimension is a name which describes the measurable qualities or characteristics of an object such as mass, length, time and temperature etc.

A unit is an accepted standard for measuring the dimension or quality.

Example:

Consider distance between two points



in that

Dimension-Length indicates – Qualitative Concept of physical quantity

Unit – Indicates magnitude of the distance – Quantitative Concept

Finally Length in meter or miles

Four Fundamental Dimensions are:

1. Mass (M) – Kilogram – Kg
2. Length (L) – Length – m
3. Time (T) – Time – s
4. Temperature (θ) – Kelvin (or) Celsius K, °C.

Based on Fundamental units, numbers of derived units are developed

Example:

1. Density = mass per unit volume
   = kg/m^3.
   = ML^{-3} ⇒ in fundamental unit

Newton:

Force = mass x acceleration
= $kg \times m/s^2$
= N.

Pressure:

Pressure = force per unit area

SI units → $= \frac{N}{m^2}$
= pascal (or) Pa.

Since, it is very small, the unit in General practice world wide is bar.

$1 \text{ bar} = 10^5 \text{ Pa}$ ∵ $1 \text{ Pa} = 1 \text{ N/m}^2$, $1 \text{ bar} = 10^5 \text{ N/m}^2$
= 100 KPa
1 bar = 0.1 MPa

in standard atmosphere
1 atm = 101.325 KPa = 1.01325 bar

- Joule

$$Work = Force \times distance$$
$$= newton \times metre$$
$$= Nm$$
$$= J \text{ or Joule}$$

- watt

$$power = \frac{J}{S}$$
$$= W$$

Derived term	Dimensions	SI units
1. Area	L^2	m^2
2. Volume	L^3	m^3
3. velocity	LT^{-1}	m/s
4. Acceleration	LT^{-2}	m/s^2
5. Force	MLT^{-2}	N
6. Pressure	$ML^{-1}T^{-2}$	N/m^2 (or) Pascal.

Specific Weight (w) of a fluid is its weight per unit volume $w = \frac{W}{V}$ $\frac{N}{m^3}$

$w = \frac{M \times g}{V} = (\frac{m}{V}) g$, $w = \rho . g$, $w = \rho . g$.

Density (ρ) Mass per unit volume $\rho = \frac{m}{V}$.

Specific gravity (S) Ratio of specific weight of a fluid to the specific weight of a standard fluid

Specific Volume (v) Represents the volume per unit mass of fluid; Specific volume is the inverse of the mass density

* More Application in gases

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

2 litre of petrol weighs 14N, Calculate the (i) Specific weight (ii) mass density (iii) specific volume and (iv) specific gravity of petrol with respect to water.

$1 cm^3 = 1 ml$ $1 lit = \frac{1}{1000} m^3$. ($1 lit = 1000 cm^3$)

Solution: 2 litre $= 2 \times 10^{-3} m^3$

(i) Specific weight $w = \frac{14}{2 \times 10^{-3}} = 7000 N/m^3$

(ii) Mass density is related to specific volume by the relation $w = \rho g$.

$w = \frac{m \times g}{V} = \frac{w}{V}$, $= \rho . g$.

$w = \frac{m.g}{g} = \frac{m.g}{g} = \frac{kg}{m^3}$

$$\rho = \frac{w}{g} = \frac{7000}{9.81 m/s^2} = 713.56 kg/m^3$$

(iii) Specific volume v is the inverse of mass density

$$v = \frac{1}{\rho} = \frac{1}{713.56}$$

$$= 1.4 \times 10^{-3} m^3/kg$$

(iv) Specific gravity (s) $= \frac{\text{density of oil}}{\text{density of water}} = \frac{713.56}{1000}$

$(S) = 0.7136$