

Notes and formulas – Lecture 1

Fluids

Fluids are those substances which can flow when an external force is applied on them.

Liquids and gases are fluids.

The key property of fluids is that they offer very little resistance to shear stress. Hence, fluids do not have finite shape but take the shape of the containing vessel.

In fluid mechanics, the following properties of fluid would be considered

- (i) When the fluid is at rest– **hydrostatics**
- (ii) When the fluid is in motion– **hydrodynamics**

Thrust

The total normal force exerted by liquid at rest on a given surface is called **thrust** of liquid.

The SI unit of thrust is newton.

Pressure

Pressure of liquid at a point is $p = \frac{\text{Thrust}}{\text{Area}} = \frac{F}{A}$.

Pressure is a scalar quantity, SI unit is Nm^{-2} and its dimensional formula $[\text{ML}^{-1}\text{T}^{-2}]$.

Pressure Exerted by the Liquid

The normal force exerted by a liquid per unit area of the surface in contact is called **pressure of liquid** or **hydrostatic pressure**.

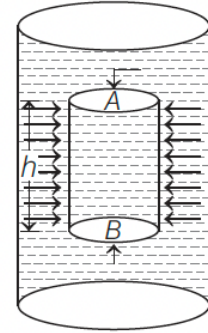
Pressure exerted by a liquid column, $p = h\rho g$

where, h = height of liquid column, ρ = density of liquid and g = acceleration due to gravity.

Mean pressure on the walls of a vessel containing liquid upto height h is $\left(\frac{h\rho g}{2}\right)$.

Variation of Pressure with Depth

Consider a fluid at rest having density ρ (roh) contained in a cylindrical vessel as shown in figure. Let the two points A and B separated by a vertical distance h .



The pressure p at depth below the surface of a liquid open is given by

Pressure,
$$p = p_a + h\rho g$$

where, ρ = density of liquid and g = acceleration due to gravity.

Atmospheric Pressure

The pressure exerted by the atmosphere on earth is called **atmospheric pressure**.

It is equivalent to a weight of 10 tones on 1 m^2 .

At sea level, atmospheric pressure is equal to 76 cm of mercury column. Then, atmospheric pressure

$$= hdg = 76 \times 13.6 \times 980 \text{ dyne/cm}^2$$

$$= 0.76 \times 13.6 \times 10^3 \times 9.8 \text{ N/m}^2$$

Thus, $1 \text{ atm} = 1.013 \times 10^5 \text{ Nm}^{-2}$ (or Pa)

┌ The atmospheric pressure does not crush our body because the pressure of the blood flowing through our circulatory system is balanced by this pressure. ┐

Atmospheric pressure is also measured in torr and bar.

$$1 \text{ torr} = 1 \text{ mm of mercury column}$$

$$1 \text{ bar} = 10^5 \text{ Pa}$$

Aneroid barometer is used to measure atmospheric pressure.

Pressure measuring devices are open tube manometer, tyre pressure gauge, sphygmomanometer etc.

Gauge Pressure

Gauge pressure at a point in a fluid is the difference of total pressure at that point and atmospheric pressure.