

FLUID MECHANICS
1. FLUID MECHANICS

- The liquids and gases together are termed as fluids, in other words, we can say that the substances which can flow are termed as fluids.
- We assume fluid to be incompressible (i.e., the density of liquid is independent of variation in pressure and remains constant) and non-viscous (i.e. the two liquid surfaces in contact are not exerting any tangential force on each other).

1.1 Fluid Statics
1.1.1 Fluid Pressure

Pressure p at every point is defined as the normal force per unit area.

$$p = \frac{dF_{\perp}}{dA}$$

The SI unit of pressure is the Pascal and $1 \text{ Pascal} = 1 \text{ N/m}^2$

- Fluid force acts perpendicular to any surface in the fluid, no matter how that surface is oriented. Hence pressure, has no intrinsic direction of its own, it is a scalar.

Pressure

- (a) Pressure at two points in a horizontal plane or at same level when the fluid is at rest or moving with constant velocity is same.



- (b) Pressure at two points which are at a depth separation of h when fluid is at rest or moving with constant velocity is related by the expression



$p_2 - p_1 = \rho gh$, where ρ is the density of liquid.

- (c) Pressure at two points in a horizontal plane when fluid container is having some constant horizontal acceleration are related by the expression



$p_1 - p_2 = \rho a$

and $\tan \theta = a/g$, where θ is the angle which the liquid's free surface is making with horizontal.

- (d) Pressure at two points within a liquid at vertical separation of h when the liquid container is accelerating up are related by expression



$p_2 - p_1 = \rho(g + a)h$

If container is accelerating down, then $p_2 - p_1 = \rho(g - a)h$.

1.1.2 Atmospheric Pressure

- It is the pressure of the earth's atmosphere. Normal atmospheric pressure at sea level (an average value) is 1 atmosphere (atm) that is equal to $1.013 \times 10^5 \text{ Pa}$.
- The excess pressure above atmospheric pressure is called gauge pressure, and total pressure is called absolute pressure.
- Barometer is a device used to measure atmospheric pressure while U-tube manometer or simply manometer is a device used to measure the gauge pressure.

1.1.3 Pascal's Law

- A change in the pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid and to the walls of the containing vessel.
- There are a lot of practical applications of Pascal's law one such application is hydraulic lift.

1.1.4 Archimedes Principle

- When a body is partially or fully dipped into a fluid, the fluid exerts contact force on the body. The resultant of all these contact forces is called buoyant force (upthrust).
- $F =$ weight of fluid displaced by the body.
- This force is called buoyant force and acts vertically upwards (opposite to the weight of the body) through the centre of gravity of the displaced fluid.

$F = V\rho g$

where, $v =$ volume of liquid displaced

$\rho =$ density of liquid.

Mechanical Operations Lecture Notes

Daniel F McAuley



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