

1.3 Pressure Measurement

Manometers

Manometers are devices which are used to measure fluid pressure. They vary in construction, sensitivity and response according to the magnitude of the pressure to be measured and the required accuracy.

Pressure within fluids

Experiment shows that pressure within a fluid

- acts equally in all directions at a point within the fluid
- increases with depth

The pressure, p , due to a height h of fluid, with density ρ , can be shown to be:

$$p = \rho gh$$

Piezometer tube

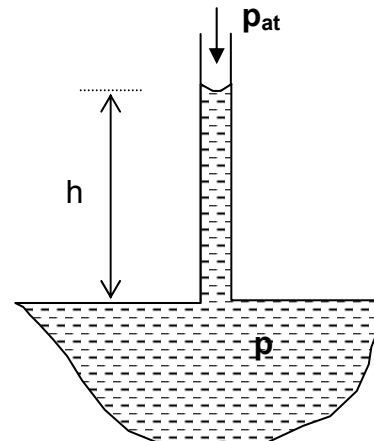
This is the simplest form of manometer and consists of a transparent, open-ended vertical tube. The pressure of a liquid in a vessel can be determined by inserting the tube into the vessel:

The pressure of the fluid, $p = p_{at} + \rho gh$

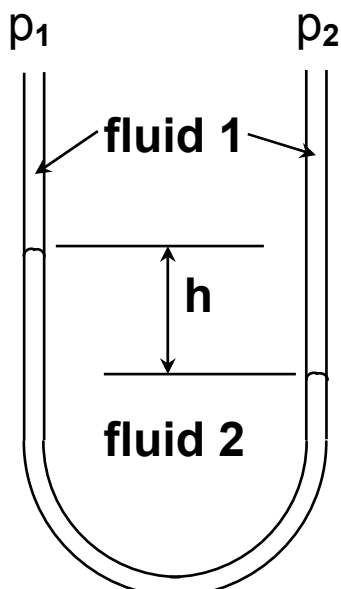
where ρ is the density of the fluid, and p_{at} is atmospheric pressure.

The difference, $p - p_{at} = \rho gh$

is the **gauge pressure**.

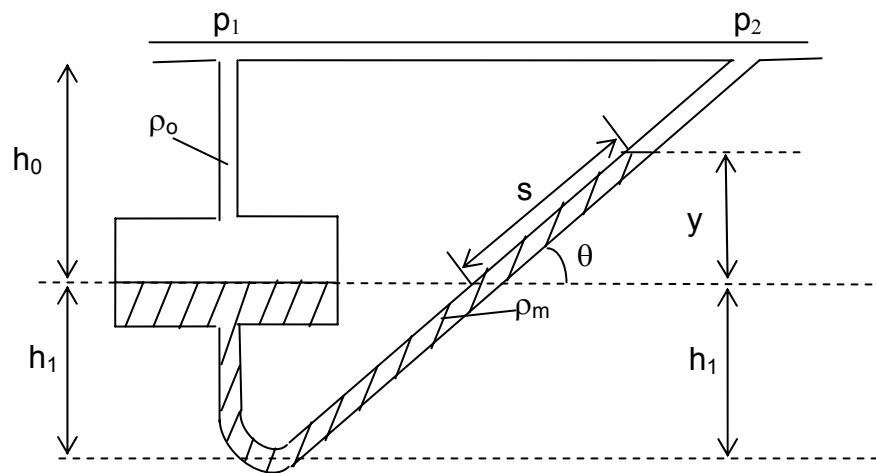


Simple U-tube manometer



- usually interested in pressure differences between
 - 2 points
 - 1 point and atmosphere (gauge pressure)
- fluid 1 - liquid or gas
- fluid 2 - liquid

$$\Delta p = (\rho_2 - \rho_1) \cdot g \cdot h$$

Inclined U-tube manometer

$$p_1 + \rho_o g h_0 + \rho_m g h_1 - \rho_m g h_1 - \rho_m g y - \rho_o g (h_0 - y) = p_2$$

$$\text{Therefore, } p_1 - p_2 = (\rho_m - \rho_o) g y$$

$$\text{But } y = s \sin \theta$$

$$\text{Therefore } p_1 - p_2 = (\rho_m - \rho_o) g s \sin \theta$$

The use of an inclined manometer tube therefore increases the sensitivity of the manometer, since the length s is always longer than the length y , and is therefore easier to read and to subdivide into smaller lengths.

A **barometer** measures **atmospheric pressure**.

Often the pressure of a fluid is measured relative to atmospheric pressure. This is called the **gauge pressure**.

The absolute pressure = gauge pressure + atmospheric pressure.

References

Davies, T. F., MECH108A notes on Mechanics, University of Plymouth

Further reading:

Bacon and Stephens, Fluid Mechanics for Technicians 3/4	Chapter 2
Bacon and Stephens, Mechanical Technology	29.2, 29.3
Massey, Mechanics of fluids	2.3
White, Fluid Mechanics	2.10