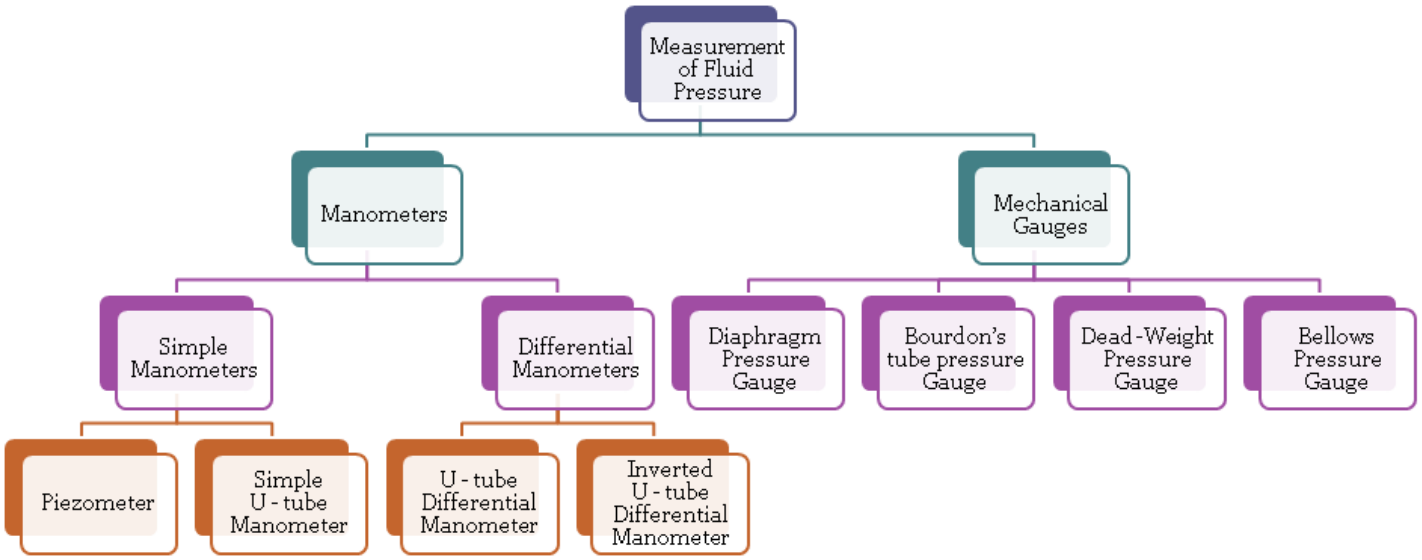
Unit – II

Pressure and Pressure Measurement

Session – VI

❑ Measurement of Fluid Pressure



The pressure of a fluid is measured by the fallowing devices.

- Manometers
- Mechanical gauges

❑ **Manometers :** Manometers are defined as the devices used for measuring the pressure at a point in a fluid by balancing the column of fluid by the same or another column of fluid.

They are classified as:

- Simple Manometers
- Differential Manometers

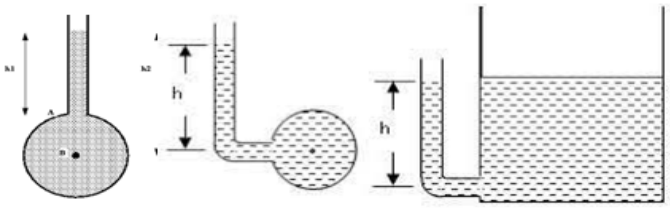
❑ **Mechanical Gauges:** These are defined as the devices used for measuring the pressure by balancing the fluid column by the spring or dead weight.

The commonly used Mechanical pressure gauges are:

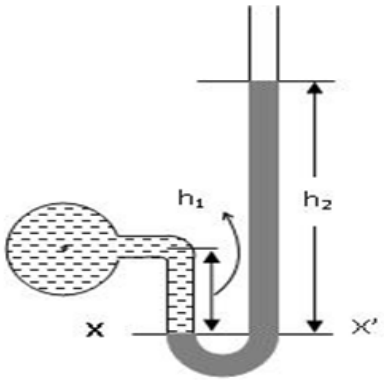
- Diaphragm pressure gauge
- Bourdon tube pressure gauge
- Dead – Weight pressure gauge
- Bellows pressure gauge

❑ Simple Manometer

- A simple manometer consists of a glass tube having one of its ends connected to a point where pressure is to be measured and the other end remains open to the atmosphere.
- The common types of simple manometers are:
  - ➢ Piezometer
  - ➢ Simple U-tube manometer



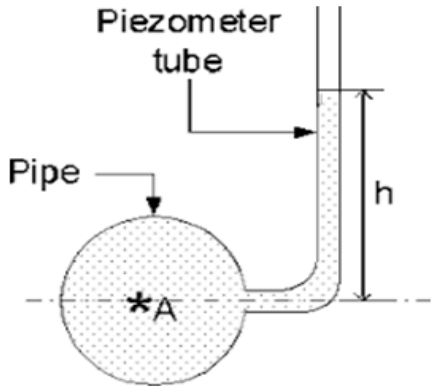
Piezometer



U-tube manometer

❑ Piezometer

- It is a simplest form of manometer used for measuring gauge pressure.
- One end of this manometer is connected to the point where pressure is to be measured and other end is open to the atmosphere.
- The rise of liquid in the Piezometer gives pressure head at that point A.
- The height of liquid say water is 'h' in piezometer tube, then



Pressure at A, $p_A = swh$ (s – sp. gr. of liquid & w – sp. wt. of water)

$p_A = wh$ (w – sp. wt. liquid)

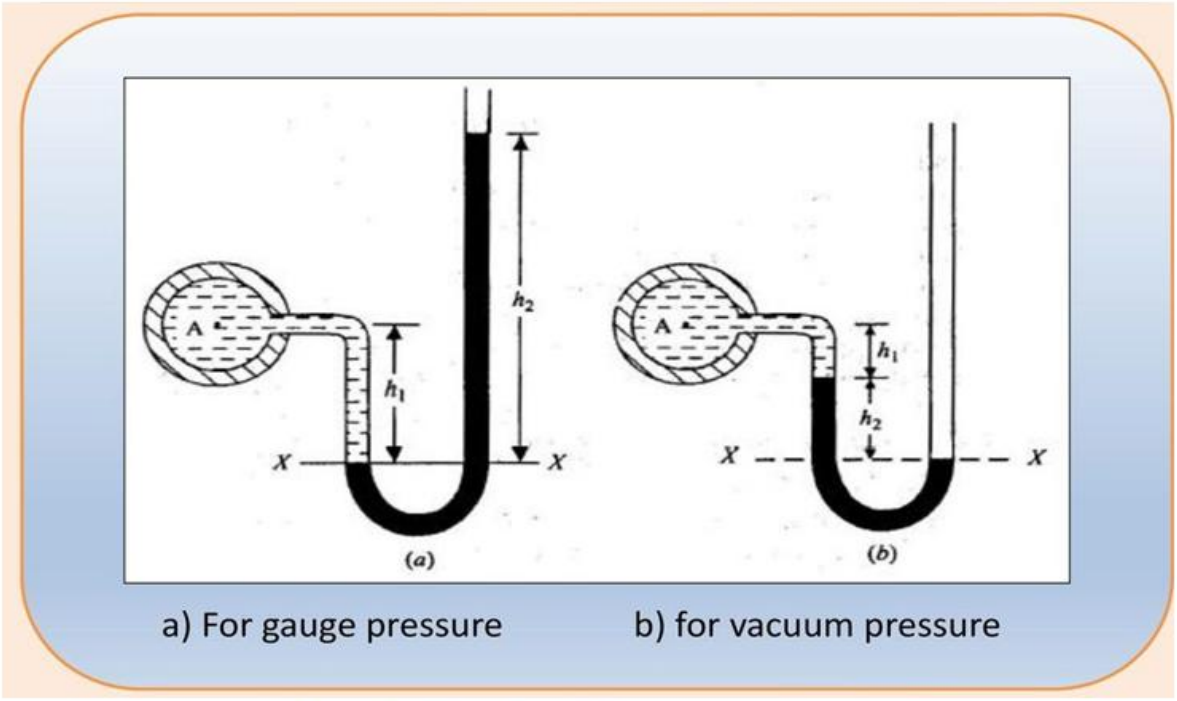
$p_A = \rho gh$ ($w = \rho g$)

Note -

- Pressure at two different points which are at the same level in continuous and homogeneous liquid, it should be equal.
- Rise of liquid in the tube is possible only when the pressure in the is above the atmospheric pressure (positive gauge pressure).
- If the pressure in the pipe is below the atmospheric pressure (vaccum pressure), there will no rise of liquid in the. Hence piezometers are not suitable measuring vaccum pressure.
- Piezmeters are generally used for measuring low positive gauge pressure.

❑ Simple U-tube Manometer

- Piezometers are not suitable for measuring negative as well as high positive gauge pressures. Therefore by modifying the shape of tube in 'U' form, such pressure can be measured.
- It consists of a glass tube bent in u-shape, one end of which is connected to a point at which pressure is to be measured and other end remains open to the atmosphere.
- The tube generally contains mercury or any other liquid whose specific gravity is greater than the specific gravity of the liquid whose pressure is to be measured.



Simple U-tube Manometer

A. Measurement Gauge pressure/Positive Gauge Pressure

Method - I

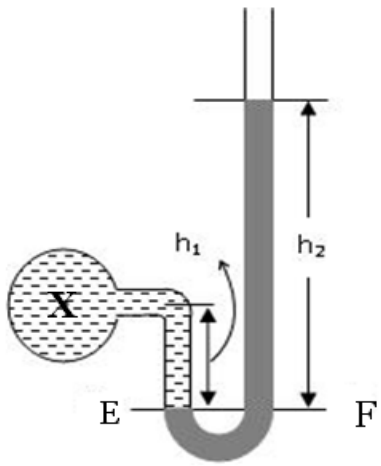
Pressure at E = Pressure at F

$$p_x + s_1 w h_1 = s_2 w h_2$$

$$p_x = -(s_2 w h_2 - s_1 w h_1) \quad N/m^2$$

Also $$p_x = s w h_x \quad (s - \text{sp. gr. of liquid in pipe})$$

$$h_x = \frac{p_x}{sw} \quad m \text{ of liquid}$$



A. Measurement Gauge pressure/Positive Gauge Pressure

Method - II

Pressure at E = Pressure at F

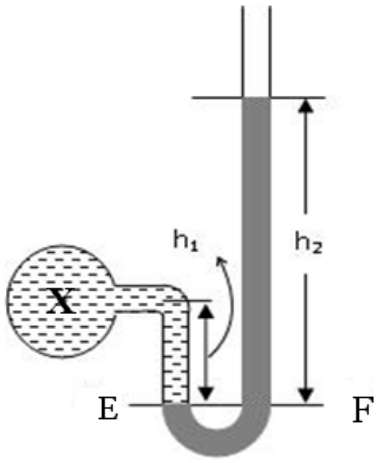
$$p_x + s_1 w h_1 = s_2 w h_2$$

Divide the equation by (sp.gr. and sp.wt. of water)

$$\frac{p_x}{w} + \frac{s_1 w h_1}{w} = \frac{s_2 w h_2}{w}$$

$$h_x + s_1 h_1 = s_2 h_2$$

$$h_x = (s_2 h_2 - s_1 h_1) \quad \text{m of water}$$



$h_x =$ m of liquid (Conversion of pressure head)

Also $p_x = swh_x \quad N/m^2 \quad$ (s – sp. gr. of liquid in pipe)

B. Measurement Vaccum pressure/Negative Gauge Pressure

Method - I

Pressure at E = Pressure at F

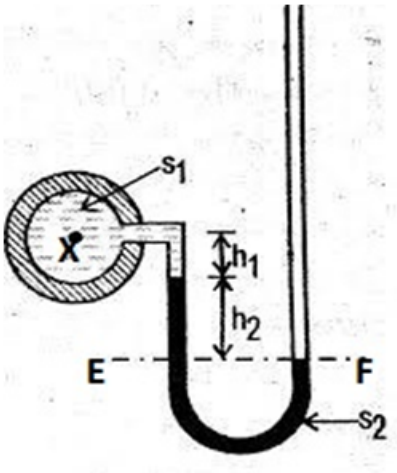
$$p_x + s_1 w h_1 + s_2 w h_2 = 0$$

$$p_x = -(s_1 w h_1 + s_2 w h_2) \quad N/m^2$$

Vaccum pressure, $p_x = (s_1 w h_1 + s_2 w h_2) \quad N/m^2$

Also $p_x = swh_x \quad N/m^2 \quad$ (s – sp. gr. of liquid in pipe)

$$h_x = \frac{p_x}{sw} \quad \text{m of liquid Vaccum}$$



Problems :

1. Calculate the pressure at a point X as shown in Fig.

Soln

Pressure at E = Pressure at F

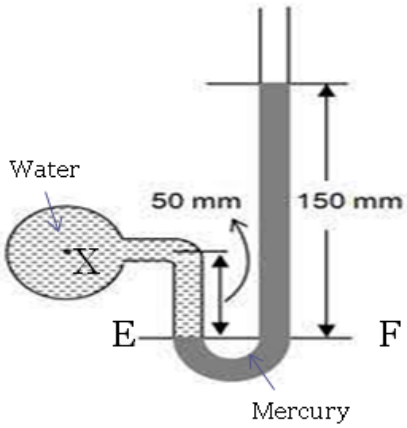
$$p_x + s_1 w h_1 = s_2 w h_2$$

$$p_x = -(s_2 w h_2 - s_1 w h_1)$$

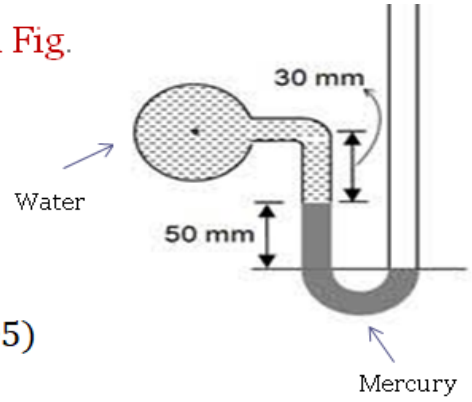
$$p_x = (13.6 \times 9810 \times 0.15 - 1 \times 9810 \times 0.05)$$

$$p_x = 19.52 \times 10^3 \ N/m^2$$

$$p_x = 19.52 \ KN/m^2$$



2. Calculate the pressure at a point X as shown in Fig.



Sol^{n}

Pressure at E = Pressure at F

$p_x + s_1 w h_1 + s_2 w h_2 = 0$

$p_x = -(s_1 w h_1 + s_2 w h_2)$

$p_x = -(1 \times 9810 \times 0.03 + 13.6 \times 9810 \times 0.05)$

$p_x = -6.965 \times 10^3 \text{ N/m}^2$

$p_x = -6.965 \text{ KN/m}^2$

$p_x = 6.965 \text{ KN/m}^2$ (vaccum pressure)