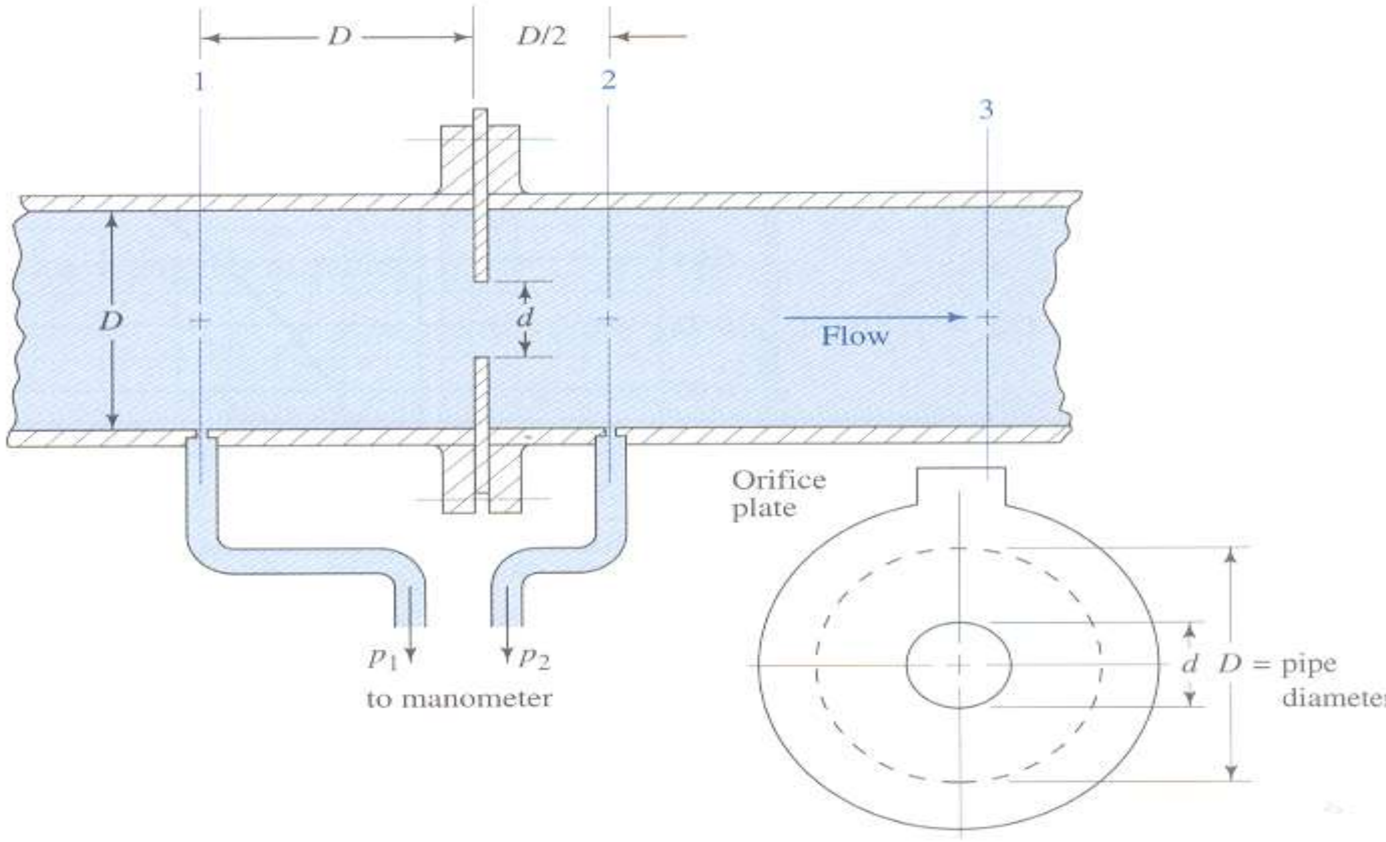
Orifice meter

- The venturi meter described earlier is a reliable flow measuring device.
  - Furthermore, it causes little pressure loss.
  - For these reasons it is widely used, particularly for large-volume liquid and gas flows.
  - However this meter is relatively complex to construct and hence expensive.
- Especially for small pipelines, its cost seems prohibitive, so simpler devices such as orifice meters are used.

Orifice meter



(b) Sketch of orifice installation

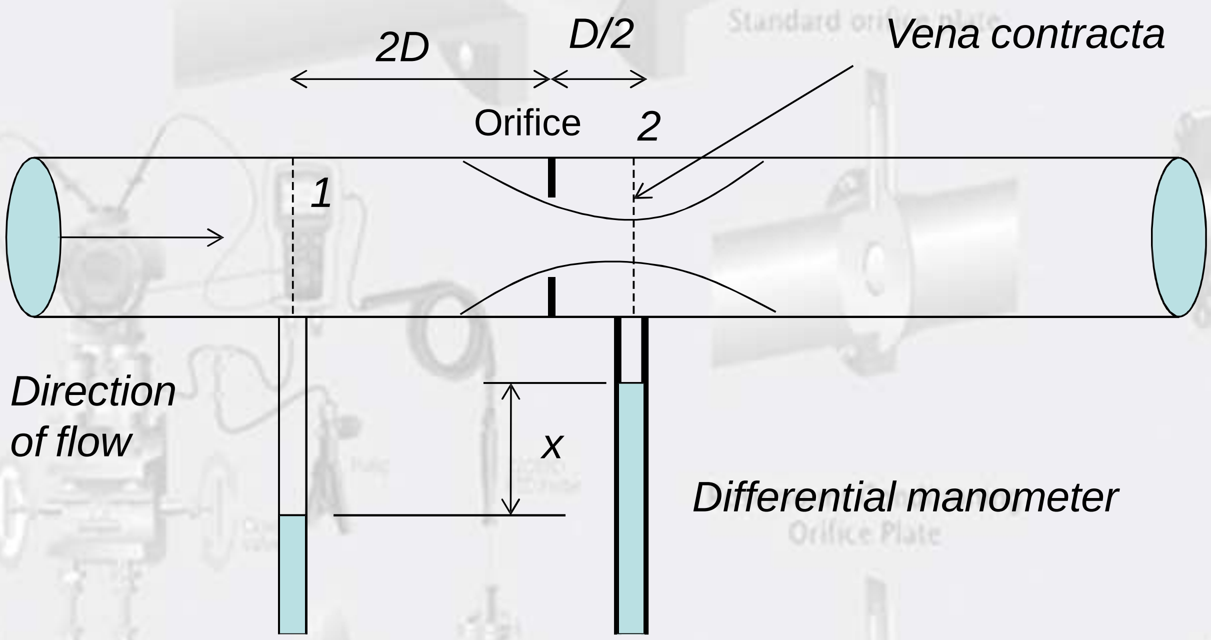
Orifice meter

- It is also known as Pipe orifice & Orifice plate.
- It may be installed in pipeline with a minimum of trouble and expense.
- Pipe orifice is a device used for measuring the rate of flow of a fluid through a pipe.
- It consists of a thin,circular plate with a hole in it.

Orifice meter

- The plate is held in the pipeline between two flanges.
- Pipe orifice is a cheaper device as compared to venturimeter.
- The diameter of orifice is generally 0.5 times the diameter of the pipe (D), although it may vary from 0.4 to 0.8 times the pipe diameter.

Discharge in orifice meter



Discharge in orifice meter

Let d_1 = diameter at section 1

p_1 = pressure at section 1

v_1 = velocity at section 1

A_1= area at section1

d_2, p_2, v_2, A_2 are the corresponding values at section 2.

Applying Bernoulli's equations at sections 1 and 2, we get

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2$$

$$\Rightarrow \left(\frac{p_1}{\rho g} + z_1 \right) - \left(\frac{p_2}{\rho g} + z_2 \right) = \frac{v_2^2 - v_1^2}{2g}$$

$$\Rightarrow h = \frac{v_2^2 - v_1^2}{2g}$$

$$\Rightarrow v_2 = \sqrt{2gh + v_1^2}$$

where *h* is the differential head.

Discharge in orifice meter

Let A_0 is the area of the orifice.

Coefficient of contraction, $C_c = \frac{A_2}{A_0}$

By continuity equation, we have

$$A_1 v_1 = A_2 v_2$$

$$\Rightarrow v_1 = \frac{A_0 C_c}{A_1} v_2$$

Hence,

$$v_2 = \sqrt{2gh + \frac{A_0^2 C_c^2 v_2^2}{A_1^2}}$$

$$\Rightarrow v_2 = \frac{\sqrt{2gh}}{\sqrt{1 - \frac{A_0^2}{A_1^2} C_c^2}}$$

Discharge in orifice meter

Thus, discharge, $Q = A_2 v_2 = v_2 A_0 C_c = \dfrac{A_0 C_c \sqrt{2gh}}{\sqrt{1 - \dfrac{A_0^2}{A_1^2} C_c^2}}$

If C_d is the co-efficient of discharge for orifice meter, which is defined as

$$C_d = C_c \frac{\sqrt{1 - \dfrac{A_0^2}{A_1^2}}}{\sqrt{1 - \dfrac{A_0^2}{A_1^2} C_c^2}}$$

$$\Rightarrow C_c = C_d \frac{\sqrt{1 - \dfrac{A_0^2}{A_1^2} C_c^2}}{\sqrt{1 - \dfrac{A_0^2}{A_1^2}}}$$

Discharge in orifice meter

Hence, $$Q = C_d \frac{A_0 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

The coefficient of discharge of the orifice meter is much smaller than that of a venturimeter.

Orifice meter