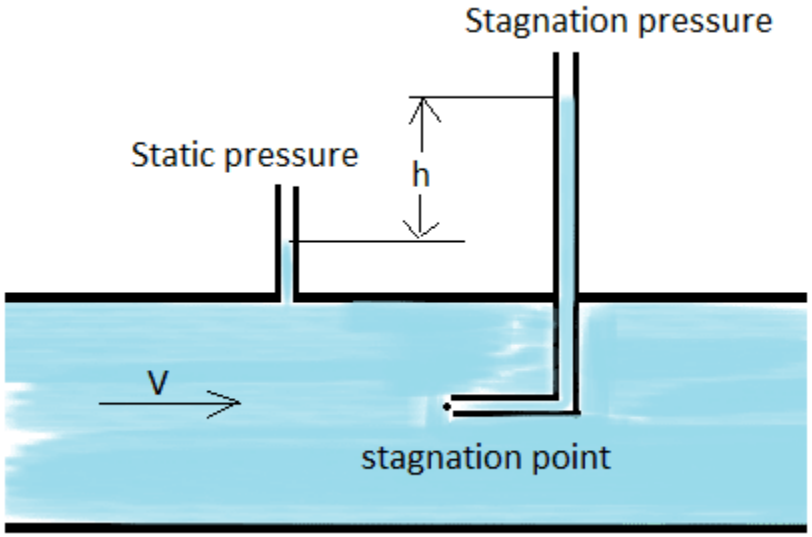
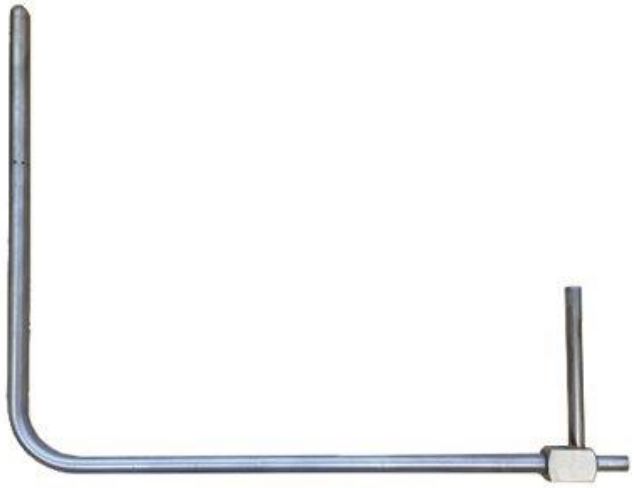
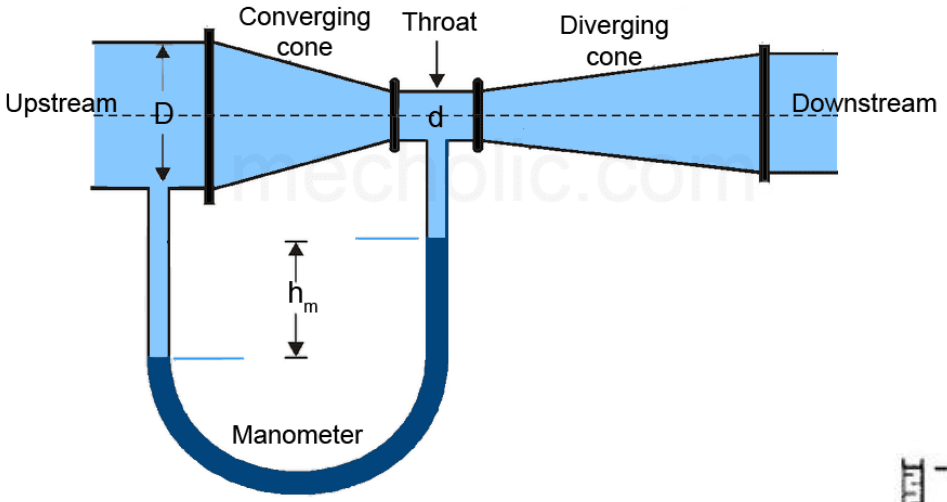
Module 6
Flow measurement

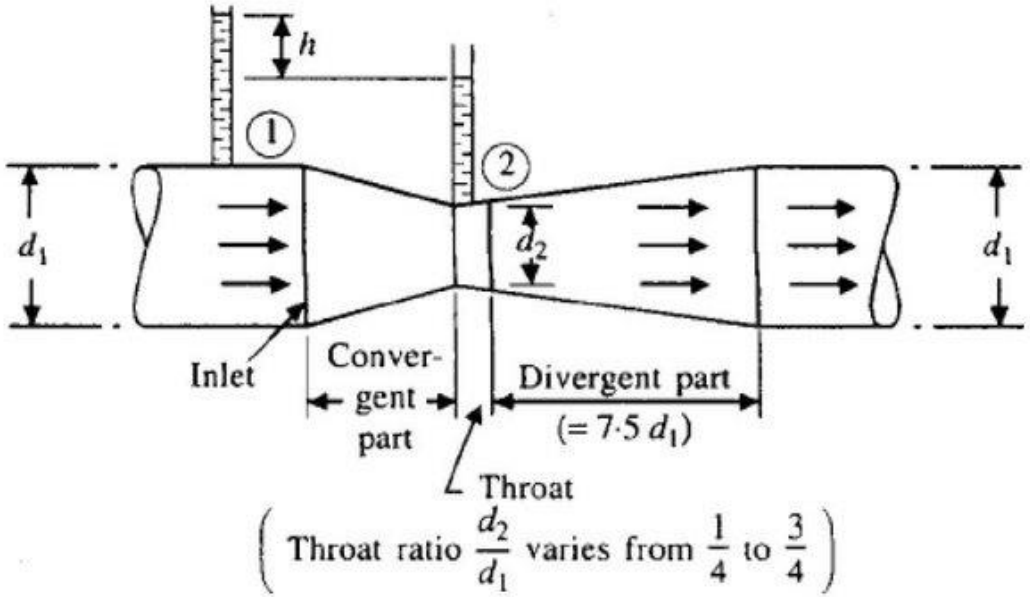
Pitot tube



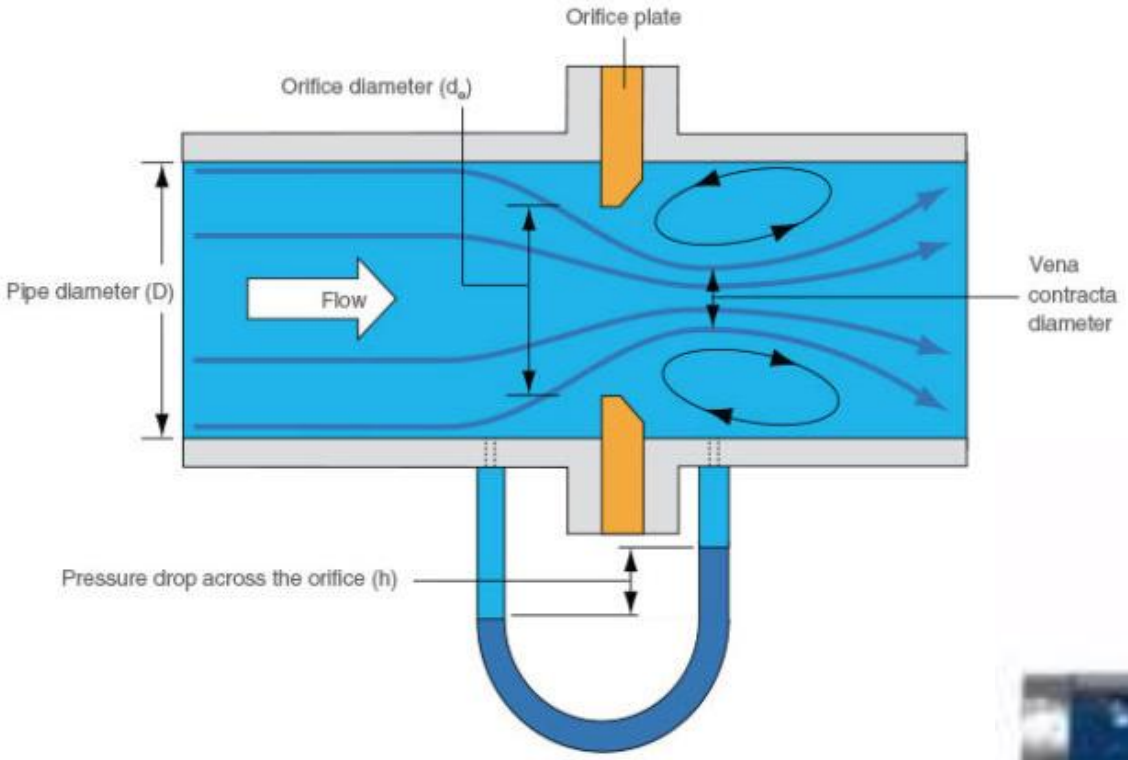


Venturi meter





Orifice meter



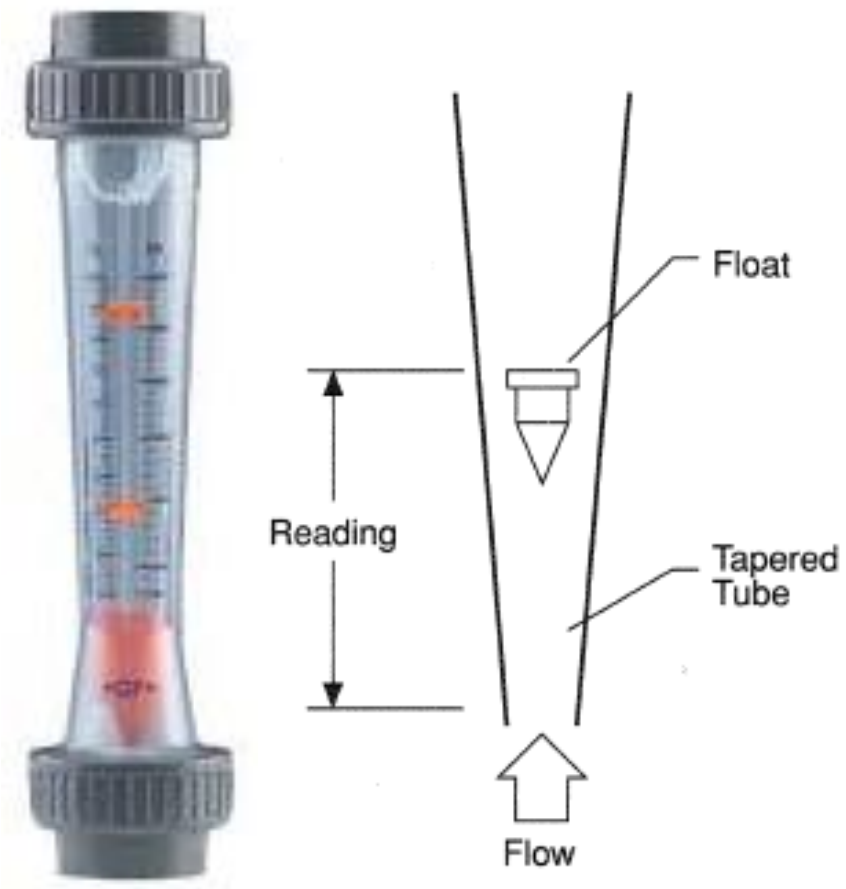
An orifice plate with vena contracta

Orifice Flowmeter

Variable differential pressure (head) meters

Pitot tube	venturimeter	orificemeter
$v = C_p \sqrt{\frac{2(p_1 - p_2)}{\rho}}$	$v_2 = \frac{C_v}{\sqrt{1-(D_2/D_1)^4}} \sqrt{\frac{2(p_1 - p_2)}{\rho}}$	$v_0 = \frac{C_0}{\sqrt{1-(D_0/D_1)^4}} \sqrt{\frac{2(p_1 - p_2)}{\rho}}$
0.98<Cp<1	Cv =0.98 for pipe dia <0.2m Cv =0.99 for pipe dia >0.2m & Re>10000	Co=0.61 for Do/D1=0.5 &Re>20000
Effective measures moderate gas velocity or pressure change less than 10% of total pr	Effective to measure liquid flow rate and very low pressure drops in gas	Less expensive and compact compared to venturi meter. Permanent head loss is much higher.
It is used to measure local or point velocity	It is used to measure flows in large pipe	

Rota meter (variable area meter)



- Mass flow rate

$$m_A = K\sqrt{\frac{(\rho_f - \rho_A)\rho_A}{\rho_f}}$$

- K is constant and determined experimentally
- Reading on rota meter should be taken at the highest and widest point of the float.
- Differential head or pressure drop is held constant.
- The float is move to keep the pressure drop constant.

Problems

1. A sharp-edge orifice having a dia of 0.0566m is installed in a 0.1541 m pipe through which oil having a density of 878 kg/m3 and viscosity of 4.1cp is flowing. The measured pressure difference across the orifice is 93.2 kN/m2. calculate the volumetric flow rate.
2. A pitot static tube is used to measure the velocity of air flowing through a duct. The manometer shows a difference in head of 5 cm of water. If the density of air and water are 1.13 kg/m3 and 1000 kg/m3 determine the velocity of air. Assume the coefficient of the pitot tube as 0.98.

3. A venturimeter of 150 mm × 75 mm size is used to measure the flow rate of oil having specific gravity of 0.9. The reading shown by the U tube manometer connected to the venturimeter is 150 mm of mercury column. Calculate the coefficient of discharge for the venturimeter if the flow rate is 1.7 m3/min. (Note : The size of venturimeter generally specified in terms of inlet and throat diameters)

4. A venturimeter is used to measure liquid flow rate of 7500 litres per minute. The difference in pressure across the venturimeter is equivalent to 8 m of the flowing liquid. The pipe diameter is 19 cm. Calculate the throat diameter of the venturimeter. Assume the coefficient of discharge for the venturimeter as 0.96.

5. A venturimeter is fitted in a pipe of 30 cm diameter inclined at 40° to the horizontal to measure the flow rate of petrol having a specific gravity of 0.8. The ratio of areas of main pipe and throat is 5 and the throat is at 1 m from the inlet along its length. The difference in manometer head is 40 mm of mercury. Assuming the coefficient of discharge as 0.96. Calculate the discharge through the venturimeter and the pressure difference between the throat and the entry point of the venturimeter.