University of Mosul
College of Petroleum & Mining Engineering

Fluid Flow II

Lecture (5)

Fluid Dynamic

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LECTURE CONTENTS

Practical Applications of Bernoulli's Equition

Practical applications of Bernoulli's equation

Although Bernoulli's equation is applicable in all problems of incompressible flow where there is involvement of energy considerations but here, we shall discuss its applications in the following measuring devices

1. Venturi meter

2. Orifice meter

3. Rotameter and elbow meter

4. Pitot tube.

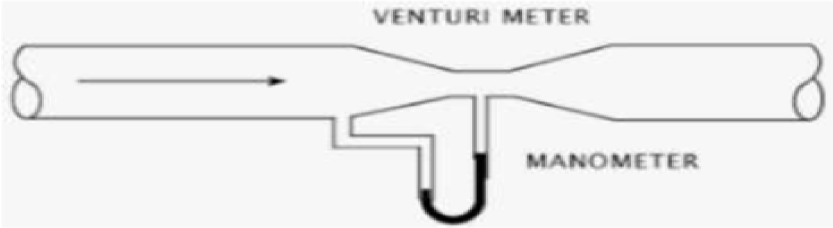
1. Venturi meter

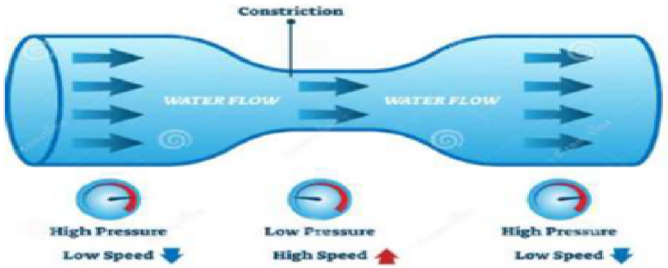
It is an instrument used to measure the rate of discharge in a pipeline and is often fixed permanently at different sections of the pipeline to know the discharges there.

Types of venturi meters

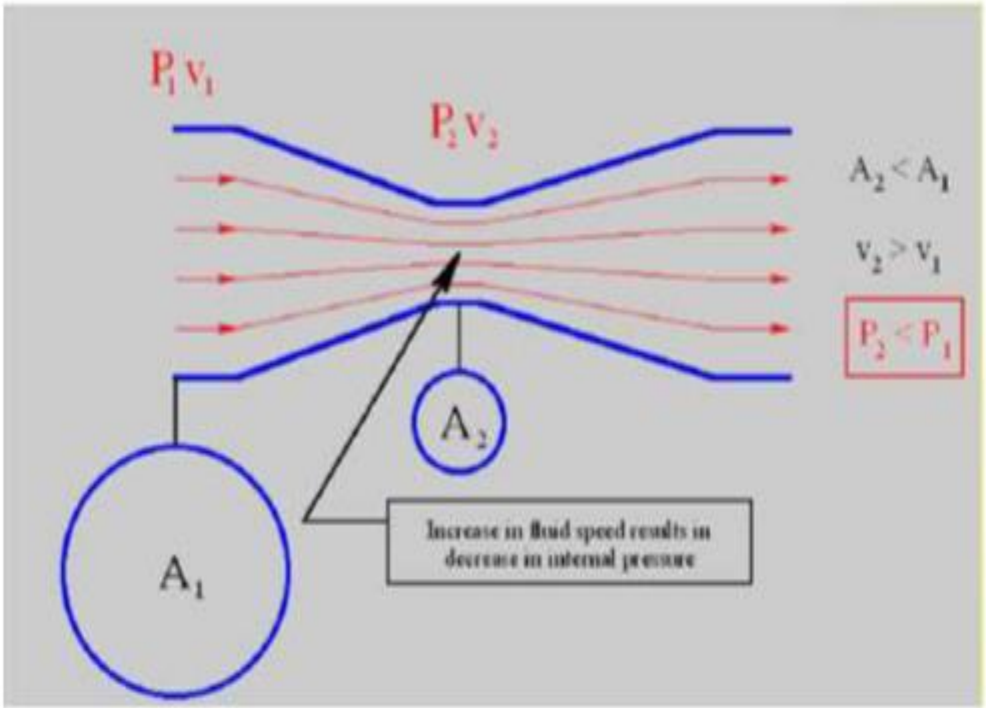
Venturi meters may be classified as follows

1. Horizontal venturi meters
2. Vertical venturi meters
3. Inclined venturi meters





The Venturi effects is the reduction in fluid pressure that results when a fluid flows through a constricted section (or choke) of a pipe



2. Orifice meter

Orifice meter or orifice plat is a device (cheaper than a venture meter) employed for measuring the discharge of fluid through a pipe. It also works on the same principle of a venturi meter.

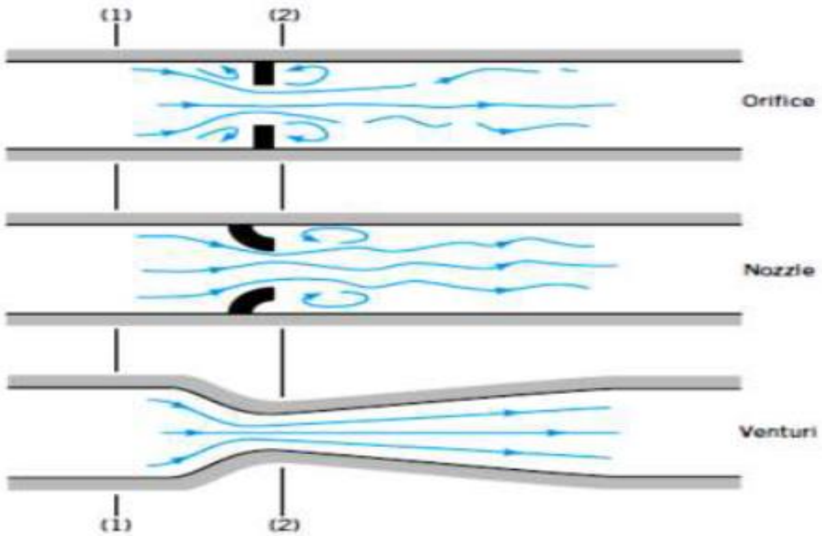
It consists of a flat circular plate having circular sharp-edged hole (called orifice)

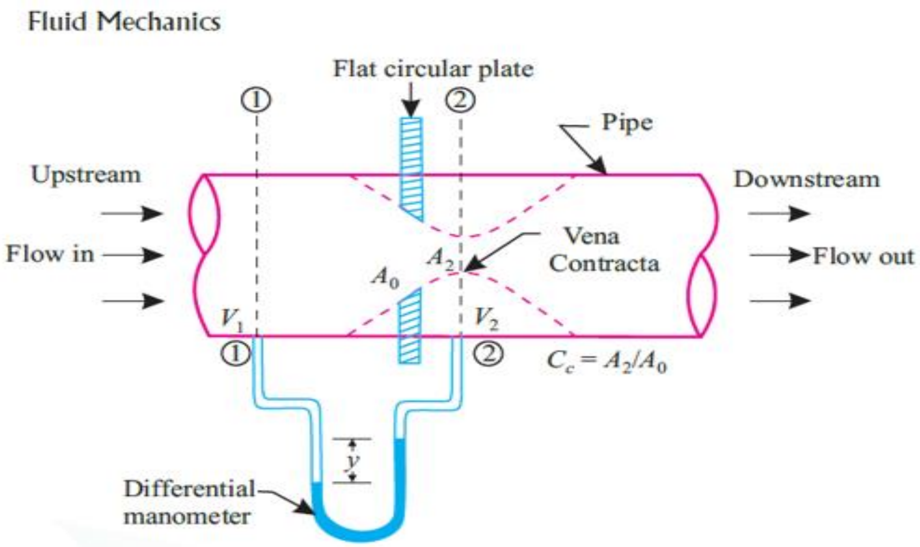
With the pipe. A differential is connected at sections (1) and (2)

An effective way to measure the flow rate a pipe is to place some type of restriction within the pipe as shown in figure below and to measure the pressure difference between the low- velocity, high- pressure upstream section(1) and high – velocity, low-pressure downstream section (2) . Three commenly used types of flow meters are illustrated : the orifice meter , the nozzle meter, and venturi meter . The operation of each is based on the same physical principles – an increase in velocity causes a decrease in pressure. The difference between them is a matter of cost, accuracy, and how losely their actialoperation obeys the idealized flow assumptions.

We assume the flow is horizontal $(z_1 = z_2)$,steady, inviscid, and incompressible between point (1) and (2) . The Bernoullis equation becomes

$$P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$$





If we assume the velocity profiles are uniform at sections (1) and (2) , the continuity equation can be written as

$$Q = A_1 V_1 = A_2 V_2$$

Where A_2 is the small($A_2 < A_1$) flow area at section (2). Combination of these two equations results in the following theoretical flowrate

$$Q = A_2 \sqrt{\frac{2(P_1 - P_2)}{\rho \left[1 - (\frac{A_2}{A_1})^2\right]}}$$

Pitot Tube

Pitot –Tube: Pitot tube is one of the most accurate devices for velocity measurement. It works on the principle that the velocity of flow at point become zero, the pressure there is increased due to conversion of kinetic energy into pressure.

The Pitot-static probe measures local velocity by measuring the pressure difference in conjunction with the Bernoulli equation. It consists of a slender double-tube aligned with the flow and connected to a differential pressure meter. The inner tube is fully open to flow at the nose, and thus it measures the stagnation pressure at that

location (point 1). The outer tube is sealed at the nose, but it has holes on the side of the outer wall (point 2) and thus it measures the static pressure. For incompressible flow with sufficiently high velocities (so that the frictional effects between points 1 and 2 are negligible), Apply Bernoulli's equation between points 1 &2 and can be

expressed as: