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EXP. NO. 3: VENTURIMETER & ORIFICEMETER TEST RIG

AIM:

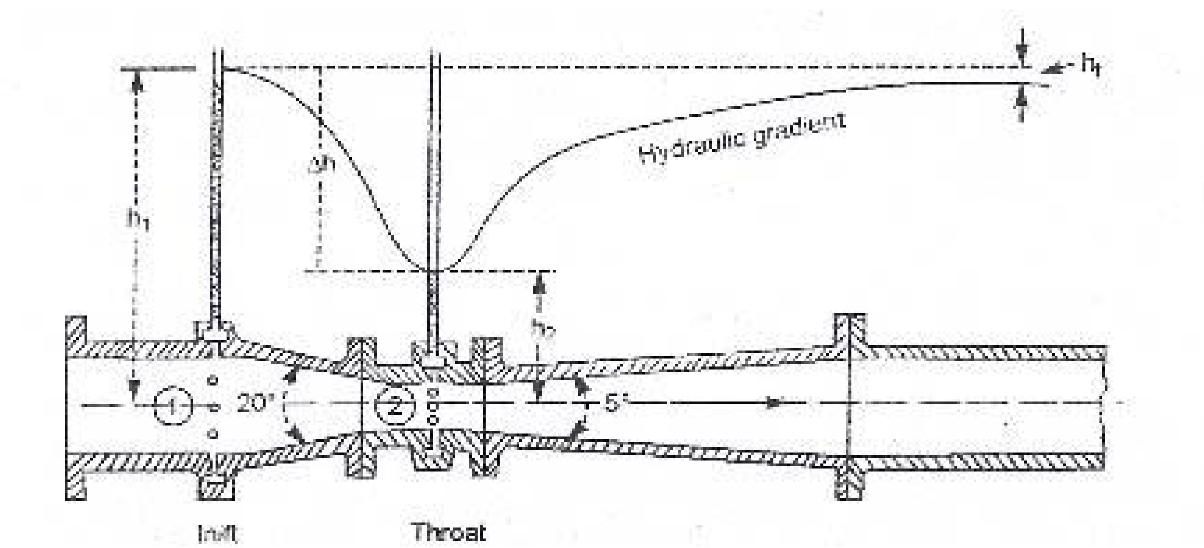
To find the co-efficient of discharge.

INTRODUCTION:

Venturimeter:-

A Venturi Meter is a device used for measuring the rate of a flow of a fluid flowing through a pipe. It consists of three parts:
(i). A short conversing part
(ii). Throat
(iii). Diverging part

A Venturi Meter apparatus is based on Principle of Bernoulli's equations.
The principle of apparatus is that, by reducing the cross section area of flow passes, pressure difference is created and the measurement of pressure difference enables the determination of the discharge through the pipe.



THEORY:

A Venturi meter consists of an inlet section followed by a convergent cone, a cylindrical throat and a gradually divergent cone.

By knowing the pressure difference across the inlet section and the throat, discharge can be calculated by the formula:

$$Q_a = C_d * \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$

Consider a venturimeter fitted in a horizontal pipe through which a fluid is flowing (say water), as shown:

Let d_1=diameter at inlet
p_1=pressure at inlet
v_1=velocity of fluid at inlet
a_1= area at inlet section= $\prod * d_1^2/4$
And d_2, p_2, v_2, a_2 are corresponding values at throat section (2).

Applying Bernoulli's equation at both the inlet and throat section, and considering the pipe to be horizontal,
The theoretical discharge Q is,

$$Q_t = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$

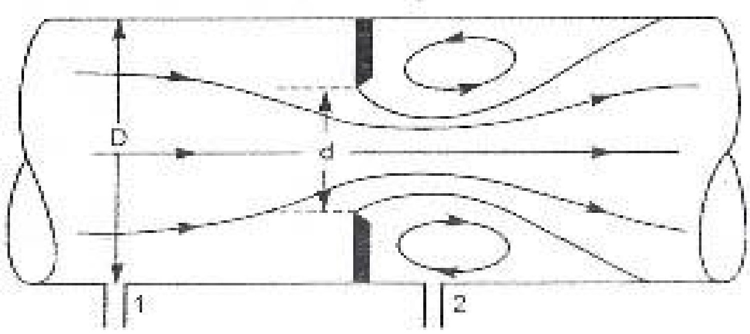
$Q_{act} = C_d * Q_t$

Where C_d = Co-efficient of venturimeter and its value is less than 1.

Orifice meter:-

An Orifice Meter is also a device used for measuring the rate of flow of a fluid through a pipe. It also works on the same principle as that of venturi meter. It consists of a flat circular plate which has a circular sharp edged hole called orifice, which is concentric with the pipe. The orifice diameter is kept generally 0.5 times the diameter of the pipe, though it may vary from 0.3 to 0.8 times the pipe diameter.

The principle of apparatus is that, by reducing the cross section area of flow passes, pressure difference is created and the measurement of pressure difference enables the determination of the discharge through the pipe.



THEORY:

An orifice meter is another device used for measuring the discharge through pipes. Orifice meter works on the same principle as that of venturimeter i.e. by reducing the cross sectional area of the passes a pressure difference between the two sections is developed and the measurement of the pressure difference enables the determinations of the discharges through the pipe.

An orifice meter consists of a flat circular plate with a circular hole called orifice, which is concentric with the pipe axis. The discharge through the orifice meter can be calculated by the formula

$$Q_{act}=C_d*\frac{a_1 a_2\sqrt{2gh}}{\sqrt{a_1^2-a_2^2}}$$

$$Q_{act}=C_d*Q_t$$

Consider an orificemeter fitted in a horizontal pipe through which a fluid is flowing (say water), as shown:

Let d_1=diameter at inlet

p_1=pressure at inlet

v_1=velocity of fluid at inlet

a_1=area at inlet section= $\prod*d_1^2/4$

And d_2, p_2, v_2, a_2 are corresponding values at downstream section (2).

Applying Bernoulli's equation at both the upstream and downstream section, and considering the pipe to be horizontal,

The theoretical discharge Q_t is,

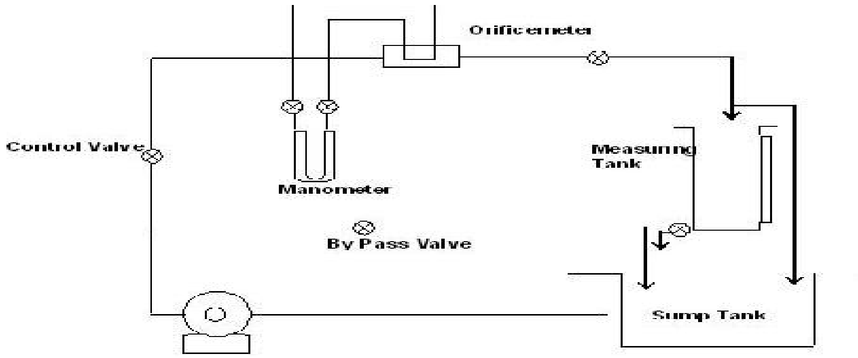
$$Q_t=\frac{a_1 a_2\sqrt{2gh}}{\sqrt{a_1^2-a_2^2}}$$

$$Q_{act}= C_d* Q_t$$

Where C_d = Co-efficient of orificemeter and its value is less than 1.

DESCRIPTION:

The apparatus consists of flow meters orificemeter & venturimeter made up of Clear Acrylic. The present experimental set-up for flow meter demonstration is a closed circuit apparatus consists of orificemeter & venturimeter. A control valve is fitted at the discharge of the pipe line to vary the flow through the Venturimeter & orificemeter. System is provided to operate either Venturimeter or Orificemeter at a time. Pressure tappings are provided and connected to differential manometer to conduct the experiment.



UTILITIES:

1. Water Supply (Initial fill).
2. Floor Drain.
3. Electricity 0.5 kW, 220V AC, Single Phase5-15 amp socket with earth connection.
4. Floor Area 1.5 x 0.75 m.

EXPERIMENTAL PROCEDURE:

Starting Procedure:

1. Clean the apparatus and make Tank free from Dust.
2. Close the drain valves provided.
3. Check the level of manometric fluid in all the manometer tube. It should be up to half. If it is less, then fill it.
4. Close all Pressure Taps of Manometer connected to manometers.
5. Ensure that On/Off Switch given on the Panel is at OFF position.
6. Now switch on the Main Power Supply (220V AC, 50 Hz).
7. Switch on the Pump.
8. Operate the Flow Control Valve to regulate the flow of water through desired test section (Orifice meter/Venturi meter).
9. Open the Pressure Taps of Manometer of related Test section, very slowly to avoid the blow of water on manometer fluid.
10. Now open the Air release Valve provided on the Manometer, slowly to release the air in manometer.
11. When there is no air in the manometer, close the Air release valves.
12. Adjust water flow rate to desired rate with the help of Control Valve.
13. Record the Manometers reading and measure the discharge with the help of measuring tank and stop watch.
14. Calculate the co-efficient of discharge from actual and theoretical discharge.
15. Repeat the same procedure for different flow rates of water, operating Control Valve and By-Pass Valve.
16. Repeat steps for different test section.

Closing Procedure:

1. When experiment is over, close all Manometers Pressure Taps first and stop the water supply to the setup.
2. Switch off Pump.

3. Switch off Power Supply to Panel.
4. Open the flow control valve.
5. Wait for a minute so that circulated water from the set up drains.

OBSERVATION & CALCULATIONS:

DATA:

g	=	Acceleration due to gravity	=	9.81 m/s^2
d_1	=	upstream section diameter	=	0.028 m
d_2	=	downstream section diameter	=	0.014 m
a_1	=	area of upstream orifice section	=	0.000616 m^2
a_2	=	area of downstream section	=	0.000154 m^2
ρ_m	=	Density of manometer fluid	=	13600 kg / m^3
ρ_w	=	Density of water	=	1000 kg / m^3
A	=	Area of measuring tank	=	0.125 m^2

OBSERVATION TABLE:

S.No.	Manometer Reading (h1)cm	Manometer Reading (h2)cm	Rise of water level R(cm)	Time to rise water level t(sec)

FORMULAE:

Actual discharge,

$$Q_a = \frac{A * R}{t} \; m^3/s$$

Pressure differences, (H)

$$h = (h_1 - h_2)/100 \; m$$

Theoretical discharge, (Q_t)

$$Q_t = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}} \; m^3/sec$$

$$Q_a = C_d * \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}} \; m^3/sec$$

Co-efficient of discharge (C_d)

$$C_d = \frac{Q_a}{Q_t}$$

NOMENCLATURE:

A	=	Area of measuring tank.
R	=	Rise of water level in measuring tank.
a	=	Cross section area of test section.
h	=	manometer difference.
C_d	=	Co-efficient of discharge.
d	=	diameter of pipe.
d_o	=	diameter of orifice.
g	=	acceleration due to gravity.
Q_a	=	Actual discharge.
Q_t	=	Theoretical discharge.
ρ_m	=	Density of manometer fluid.
ρ_w	=	Density of water.

CALCULATION TABLE:

Sr. No.	**h (m)**	**H (m)**	**Actual Discharge (Q_a)** m^3/sec	**Theo. Discharge Q_t** (m^3/sec)	**Co-efficient of discharge C_d**

CONCLUSION:-

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