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THEORETICAL AND EXPERIMENTATION COMPARISON OF PRESSURE DROP IN ORIFICEMETER

[1]P.H.J.Venkatesh, [2]Asit Kumar Meher, [3] M.S.R.Viswanath

[1]Assistant Professor , [2]Assistant Professor, [3]Assistant Professor

[1]Department of Mechanical Engineering ,

[1]Vignan's Institute of Information Technology (A),Visakhapatnam, A.P., India

Abstract: Orificemeter is used as flow meters in chemical industries,water treatment industry,oil industry and other mechanical equipment's.They are available at the lowest cost ,less maintenance and can be used for long life .The draw back with the orifice meter is that the amount of pressure drop occurs in the pipeline due to the presence of orifice (small opening) in these types of flow meters and the permanent pressure loss depend on the shape of obstruction, diameter ratio and properties of the fluids. Generally the shapes are in cross section of circular,eccentric,ellipse and many other . In this present paper,experiment is conducted in fluid mechanics & hydraulic machinery and the values are taken,tabulated and calculated and compared with the theory values to determine the permanent pressure loss and relative pressure loss for incompressible fluid for orifice plate.

Index Terms - Fluid mechanics & hydraulics,orifice,orificemeter, pressure drop

I. INTRODUCTION

Orifice plate is simple shape with long operating life and reliable for measurement of fluid flow , it is mostly used in chemical processing industries , natural gas, Petrochemicals and refineries,Water Treatment Plants,Oil Filtration Plants,and steam,In applications of orificemeter, the most important drawback is to confirm the pressure drop, which is usually influenced by the β ratio, Re_D, roughness of the tube and the viscosity.The orifice meter have high pressure loss and correspondingly high pumping cost, they are still the most common meters used for fluid flow measurement because these are rugged, simple in construction and replacement, without having any moving parts, economic, measurement flexibility with high range ability, can be used for liquids, gases or slurries, well suited for use under extreme weather conditions, etc.High pressure drop is frequently required in the process line of Nuclear and Powerplants.In the situation of low pressure drop, some throttling components such as nozzle, Venturitube, orifices are mostly used.Orifice meter is the application of Bernoulli's Equation.

Bernoulli's Statement: It states that in a steady, ideal flow of an incompressible fluid, the total energy at any point of the fluid is constant. The total energy consists of pressure energy, kinetic energy and potential energy or datum energy. Mathematically,

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

Most of these orifices are circular type, with the hole having a certain finish to its edge. The major advantage of using these orifice flow meter are they don't have moving parts, requires no lubrication or maintenance and the cost of manufacturing is less compared to the venturimeter with the pipe size.

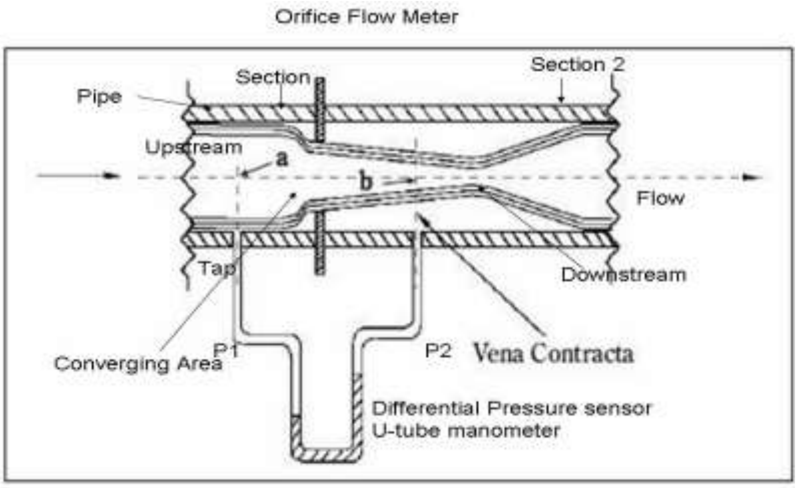

Figure.1.Orificemeter with manometer

II. CONSTRUCTION AND WORKING

In the construction, orifice plate is made up of stainless steel, the pipe is made up of Galvanize, and flanges are made up of cast iron orifice meter is a device used for measuring the rate of flow of a fluid flowing through a pipe. It consists of flat circular plate which has a circular hole, in concentric with the pipe.This is called orifice. The orifice plate inserted in the pipeline causes an increase in flow velocity and a corresponding decrease in pressure. The flow pattern shows an effective decrease in cross section beyond the orifice plate, with a maximum velocity and minimum pressure at the venacontracta. The flow pattern and the sharp leading edge of the orifice plate which produces it are of major importance. The sharp edge results in an almost pure line contact between the plate and the effective flow, with the negligible fluid-to-metal friction drag at the boundary.The important components of orificemeter are as follows,

Inlet section

A linear extending section with the same diameter as the inlet pipe for an end connection for the incoming flow.There we measure the inlet pressure of the fluid or steam or gas based on the medium of flow choosen

Orifice plate

An Orifice Plate is inserted between the Inlet and Outlet Sections to create a pressure drop and to measure the flow.

Outlet section

A linearly extending section similar to the Inlet section,the diameter is the same as that of the outlet pipe for an end connection for an outgoing flow. Here we can measure the Pressure of the media at this discharge, a gasket is used to seal the space between the Orifice Plate and the Flange surface, prevent leakage.

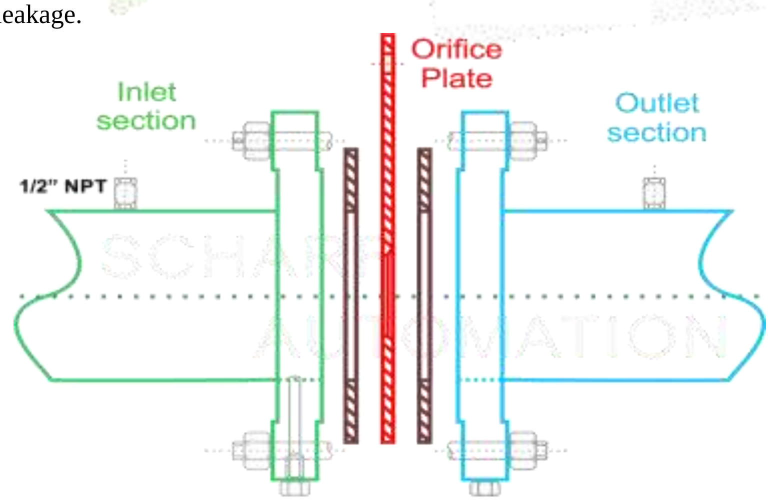

Figure.2.Orificemeter cross section

Orifice meters are built in different forms depending upon the application specific requirement, The shape, size and location of holes on the Orifice Plate some shapes of the plates are Concentric Orifice Plate, Eccentric Orifice Plate,Segment Orifice Plate and Quadrant Edge Orifice Plate

III. THEORETICAL ANALYSIS

The specifications of the orificemeter experiment are

Area of the collecting tank =0.25 m^2

Diameter of the orifice = 0.015m

Diameter of the pipe = 0.030m

Area of the orifice A_2 $= \frac{\pi d^2}{4} = 0.0001767\ m^2$

Area of the pipe A_1 $= \frac{\pi d^2}{4}$ =0.00007068 m^2

Q $= A_1 \times A_2 \times \frac{\sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

δp $= \rho \times V^2 \times \frac{A_1^2 - A_2^2}{2A_2^2}$

δp $= 1000 \times 1.72^2 \times \frac{0.000000468}{6.24 \times 10^{-8}}$

δp = 22,306 Pa

Similar way the other calculations are performed and tabulated

IV. EXPERIMENT ANALYSIS

The following values are taken from orificemeter experiment the pressure drop is calculated and tabulated below

Figure.3.Orificemeter Experiment

Table 4.1.Pressure Head value in m of H_2O

S.NO	HEAD 'H' in m of H_2O
1	2.32
2	3.12
3	3.89
4	1.98
5	1.49
6	2.89

Experiment value taken from the manometer reading in terms of m of H_2O after conversion from mm of hg.

δp Pressure drop $= \rho\times g\times H$

ρ = 1000kg/m^3 (Density of the water = 1000kg/m^3)

g = 9.81m/sec^2

H = Head in terms of meter of water

δp $= 1000\times 9.81\times 2.32$

δp = 22,759 Pa

Similar way the values are taken and tabulated in the below tables as shown.

During the experimentation the major importance was given to know the pressure drop by using a orifice plate rather than considering about coefficient of discharge.The coefficient of discharge for the orificemeter is varied from 0.63 to 0.68 ,in this paper work how the pressure drop is varied with respect to head and velocity only. The experiment values are taken by the valve opening with 1/4th then continued by different opening of the valve.

V. RESULTS AND DISCUSSION

Table 5.1. Pressure drop values

S.NO	H in m of H_2O	Pressure drop δp(Pa)
1	2.32	22,759
2	3.12	30,657
3	3.89	38,160
4	1.98	19,423
5	1.49	14,616
6	2.89	28,350

Table 5.2. velocity and pressure drop values

S.NO	Velocity(m/sec)	Pressure drop(Pa)
1	1.72	22,306
2	2.01	30,320
3	2.36	39,701
4	1.63	19,940
5	1.41	14,920
6	1.93	27,955

5.1.1.Graphs of the tabulated results

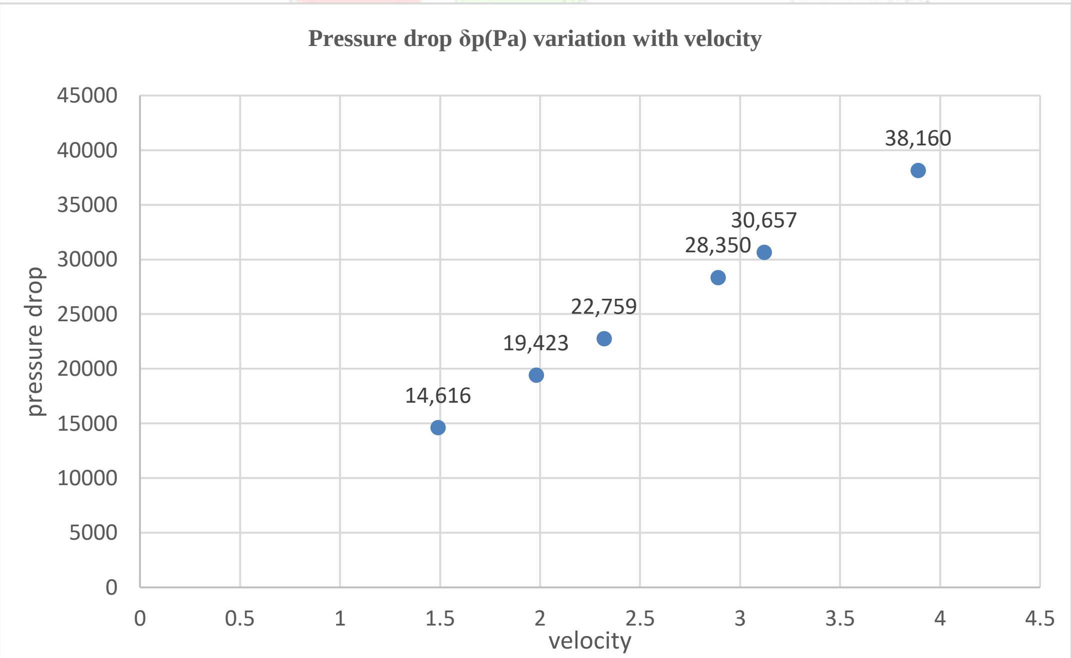

Figure.4.Pressure drop δp (Pa) variation with velocity

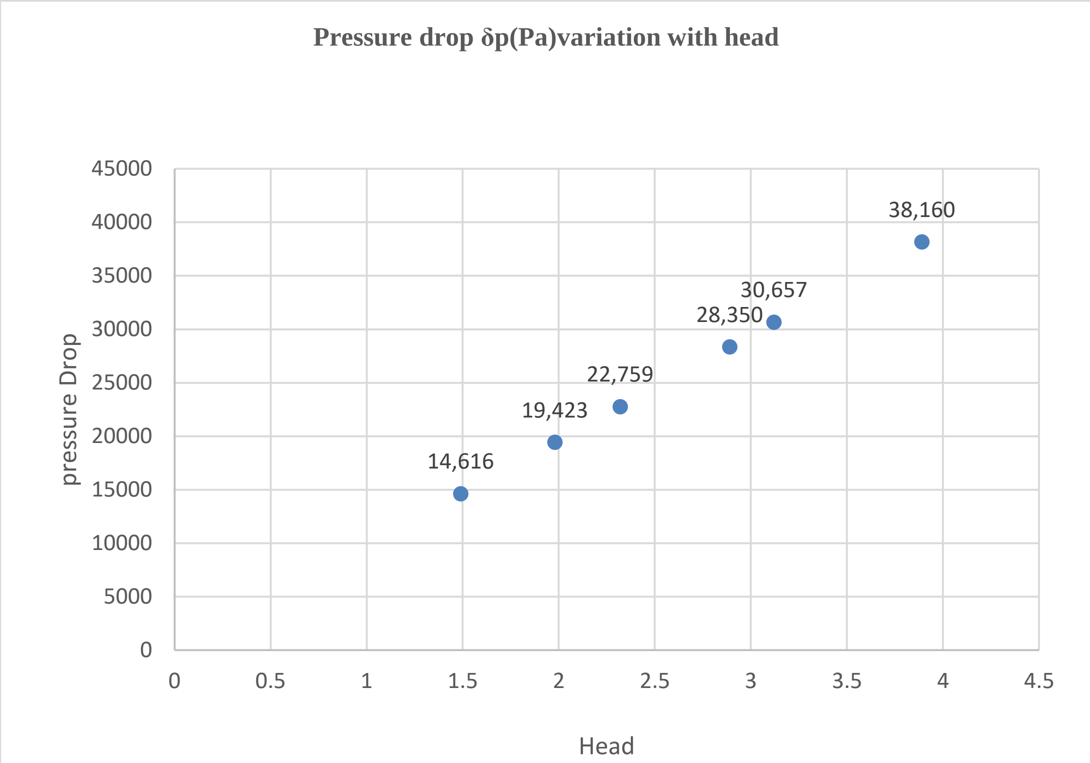

Figure.5.Pressure drop δp(Pa)variation with head

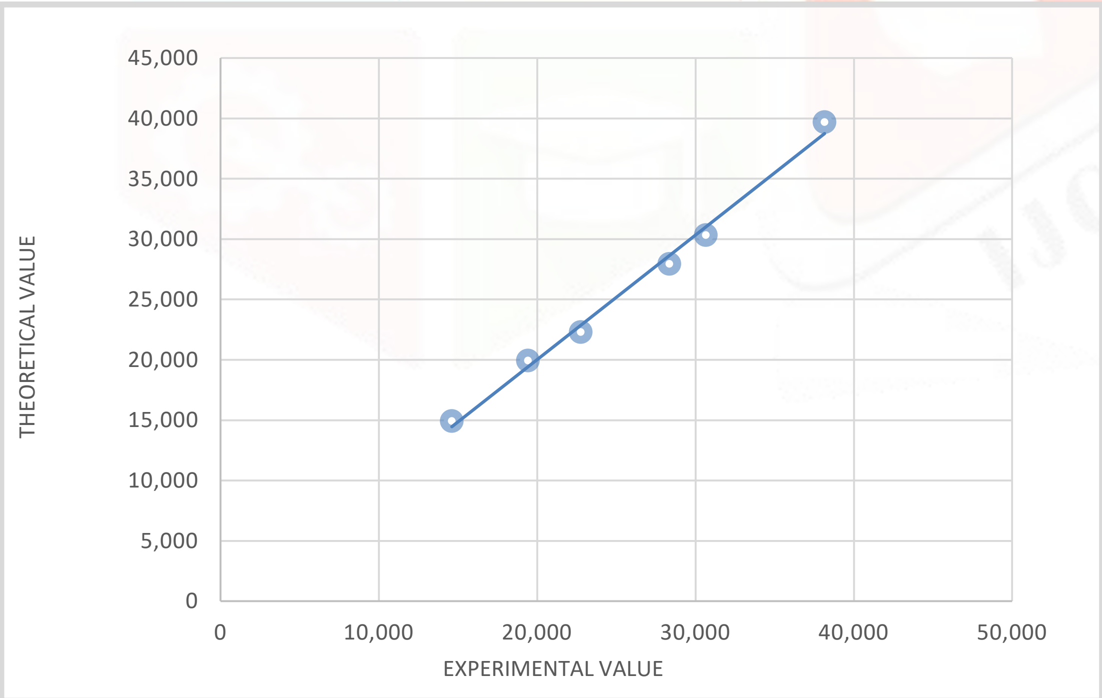

Figure.6.Comparison between Experimental values and Theoretical values

VI. CONCLUSION

The results obtained from both theoretical and experimental are compared to each other and from the graph representation it is observed that the pressure drop is increased with increase of velocity and head and also both experimental and theoretical values are near with small difference of 1.3% but the pressure drop when compared to the other flow meter device venturimeter The orificemeter is around 65%to 70% loss of pressure due to the presence of obstruct small opening called an orifice,the pressure drop can be reduced by changing the cross section of orifice plate other than a circular cross section.The future work can be done on by considering the pressure drop varied with the coefficient of discharge ,Reynolds number and the loss coefficient value for the orificemeter can be estimated.

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