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Effect of Varying Diameter of Orifice on Coefficient of Discharge

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Abstract

This work is carried out to study the effect of change in diameter of orifice on the flow characteristics. The measure flow characteristics are coefficient of discharge, coefficient of contraction & coefficient of velocity. The measure problem in fluid flow is the calculation of time in which the fluid is transferred at the destination through pipelines. But there is a measure issue is that how will calculate the time required in fluid transfer. So in this paper effect of varying diameter of orifice on coefficient of discharge is studied because during fluid transfer large diameter pipes are used. There is small increase in value of coefficient of discharge with increase in diameter of orifice.

Keywords: *Coefficient of Velocity, Coefficient of Contraction.*

1. Introduction

A plate having hole in its middle is called orifice plate and hole is called orifice .This plate is used to measure the discharge through pipe and hence this plate fitted with pipe. When the fluid reaches the orifice plate, the fluid is forced to converge to go through the small hole and area of fluid gets minimized downstream. The point at which area is minimum is called vena contracta . As area changes so velocity and pressure of fluid changes at vena contracta and after vena contracta .By measuring the difference in fluid pressure between the normal pipe section and at the vena contracta, mass flow rate is calculated by using Bernoulli's equation. The orifice plate is used where continuous measurement is required so orifice is used in small rivers and drains..

Flow Measurement Coefficients

i) Co-efficient of velocity, C_v
ii) Co-efficient of Contraction, C_c
iii) Co-efficient of Discharge ,C_d

Co-efficient of velocity (C_v) : It is defined as the ratio between the actual velocity of a jet at vena-contracta and the theoretical velocity of jet. It is defined by C_v. Mathematically, C_V is given by:

C_V= Actual velocity of a jet at vena-contracta / Theoretical velocity of jet

$= V/\sqrt{2gH}$

Where: V- Actual velocity of a jet at vena-contracta
g- Acceleration due to gravity

H-Head of the fluid over the center of orifice

The Values of Cv varies from 0.95 to 0.98 for different orifices depending upon the shape, size of the orifices and on the head under which flow takes places.

Co-efficient of Contraction (C_c): It is defined as the ratio of the area of the jet at vena-contracta to the area of the orifices. It is defined by C_c. Mathematically, C_c is given By :

C_c= Area of the jet at vena-contracta / Area of the orifice

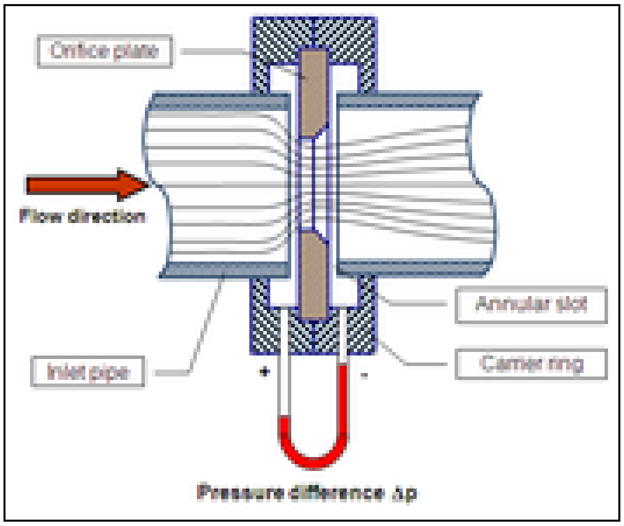
$= a_c/a$

Where: - a_c is area of the jet at vena-contracta
a- Area of the orifice

The Values of Cc varies from 0.61 to 0.69 for different orifices depending upon the shape, size of the orifices and on the head under which flow takes places.

Co-efficient of Discharge (C_d): It is defined as the ratio of the actual discharge from an orifice to the theoretical discharge from an orifice. It is defined by C_d. Mathematically, C_d is given By :

C_d= Actual discharge / Theoretical discharge
= Q/Q_{th}
Where: Q - Actual discharge from an orifice
Q_{th} - Theoretical discharge from an orifice
C_d= Actual velocity *Actual area / Theoretical velocity* Theoretical area
$C_d = C_v * C_c$
The Values of Cv varies from 0.61 to 0.65 for different orifices depending upon the shape, size of the orifices and on the head under which flow takes places.



2. Literature Review-

ESDU TN 07007, Incompressible flow through orifice plates - a review of the data in the literature. This Technical Note provides a review of the data in the literature for incompressible flow through orifice plates published prior to 2006. The result obtained from this study shows the pressure distribution over the orifice test plate in pipe.The pressure loss and coefficient of discharge is also calculated through study.
ESDU 82009, Pressure loss and discharge coefficient data for subsonic compressible flow of gases through single is presented by this technical report. This report showed that mass flow rate is function of ratio of actual mass flow function to the limiting value .
Method- given orifice plate fitted on a tank size 0.35 m x 0.24 m x .47 m, provided with piezometer and scale arrangement with zero of the coinciding with the centre of the Orifices & Mouthpieces with overflow outlet and drain plug and with provision for fixing and interchangeable Orifice & Mouthpiece.
A measuring tank size 0.32 m x 0.24 m x 0.34 m arranged with to overflow arrangement and provided with gauge glass, scale arrangement and a drain valve.
A scale and sliding apparatus to measure the X and Y co-ordinates of the jet suitable hook gauge & Horizontal scale are mounted on the supply tank for convenience of handling and stop watch. The orifice plate is made up of brass and each plate is stamped with orifice diameter.

Orifice plate of Dia 5 mm & 6 mm

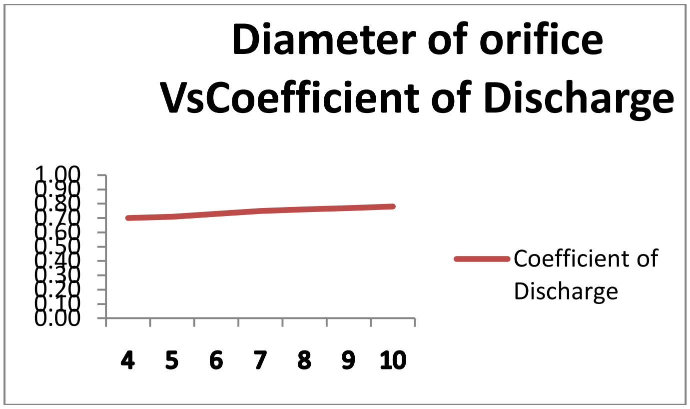
Orifice plate of Dia 5 mm & 6 mm

From above set up coefficient of discharge is calculated with different diameter of orifice i.e. 4 mm, 5mm, 6mm and 7mm.

3. Result-

The values of coefficient of discharge with respect to the various diameters of orifice is tabulated as below:

Sr No.	Dia of Orifice (mm)	Average Cd
1	4	0.70
2	5	0.71
3	6	0.73
4	7	0.75
5	8	0.76
6	9	0.77
7	10	0.78



4. Conclusion

In general, the factors on which orifice installation depends affect the overall errors in coefficient of discharge measurement. There are some errors in flow measurement. These errors are due to (A) Uncertainty in the physical properties of the fluid (B) Uncertainty in shape and size of flow meter. The most important assumption for the coefficient of discharge equation is systematic biasing of the equipment. Orifice plates whose bore diameters are less than 0.45 inches may have coefficient of discharge uncertainties as great as 3.0% because of problems with edge sharpness. The uncertainty can be reduced by removing the sharp edge of the orifice.

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