DEPARTMENT OF CIVIL ENGINEERING

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

FLUID MECHANICS SESSIONAL

CE 262

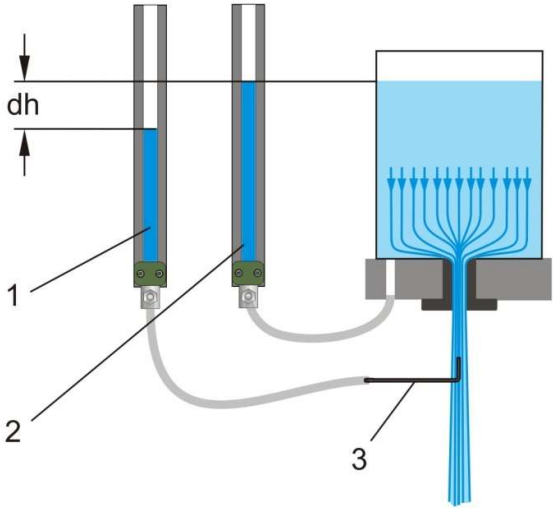
Experiment No. 9

Determination of co-efficient of discharge using orifice discharge apparatus

9.1 General

Orifice is a simple device used to measure fluid flow in pipes The Orifice Discharge Apparatus has been designed to enable students to determine the co-efficient of discharge of sharp edged orifice and nozzles. It consists of a vertically mounted cylindrical transparent plastic water tank. Water is supplied from the hydraulic bench or any closed circuit controlled water supply system. The orifice is fitted in the base of the tank using special fittings flush with the inside surface. The head above the orifice is maintained constant using adjustable overflow pipe and the level is indicated by the level scale.

The flow rate through the orifice can be varied by adjusting the level of the overflow pipe suitably and hence the head over the orifice. Water emerging from the orifice is collected in the measuring tank of the hydraulic bench to make actual discharge measurements. A pitot tube with a traversing device is provided to measure the jet diameter and locate the vena contracta to enable determination of contraction co-efficient. The pitot head and the total head over the orifice is measured using manometer tubes fixed adjacent to the tank. A set of four nozzles is also provided in addition to the sharp edged orifice to study the effect of geometry on the co-efficient of discharge.

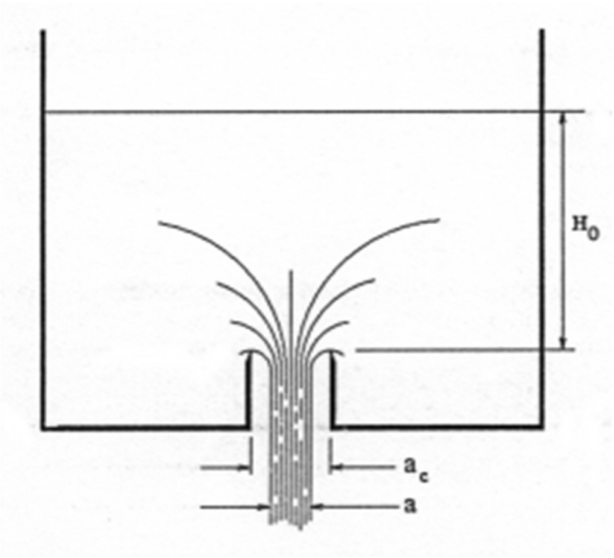


Measuring the pressures

1 total pressure in the free jet, 2 static pressure in the tank, 3 pitot tube; dh loss due to conversion of pressure into velocity

9.2 Practical application

The Orifice Discharge accessory enables full analysis of the flow through five different orifices over a range of flow rates. Determining the contraction and velocity coefficients and calculating the discharge coefficient.



9.3 Theory

Construction of the stream in the outlet produce additional friction in the wall zone decelerates the wall flow. Consequently, the meter velocity of the discharge stream is less than it would be without additional friction.
On discharge from constricted cross section, the energy loss due to friction thus takes the form of a loss of kinetic energy, as the drop in pressure in the outlet is fixed by specified discharge pressure and cannot be influenced by flow phenomena.

$V_{stream} < V_{theoretical}$

$V_{stream} = \Phi . V_{theoretical}$, where $\Phi < 1$

Φ is the velocity coefficients.

The discharge velocity of the stream is calculated in accordance with the equation below:

$V_{theoretical} = \sqrt{(2gh_{static})}$

And as follows for the stream measured with the pitot tube:

$V_{theoretical} = \sqrt{(2gh_{pitot})}$

Construction and edge deceleration of the discharge stream combine to produce a situation where the volumetric flow V actually discharged is less than it would be without the two flow phenomena.

$V = V_{stream} \cdot A_{stream}$
$V = \alpha A_a \Phi V_{theo}$

It is standard practice to combine the two flow coefficients and into a single value, namely the discharge coefficient $\boldsymbol{\mu}$.

$\boldsymbol{\mu} = \alpha \cdot \Phi$

Rearrangement of the formula and equations yields the following for calculations:

$\alpha = A_{stream} / A_a$

$= D_{stream} / d_a$

$\Phi = V_{stream} / V_{theo}$

$= \sqrt{h_{pitot}} / \sqrt{h_{stat}}$

With increasing flow rate, the diameter of the water stream expands, the contraction coefficients is following this tendency.

With increasing flow rate, the velocity coefficients Φ is remaining almost constant, so the increase in the values for the discharge coefficients μ has to be assigned to the increase of the contraction coefficients.

9.4Objectives

- Study of the outlet jet (diameter, velocity)
- Determination of pressure losses and contraction coefficient for different outlet contours
- Determination of flow rate at different discharge heads

9.5 Procedure

Pressure losses in the flow from tanks are essentially the result of two processes: the jet deflection upon entry into the opening and the wall friction in the opening. As a result of the pressure losses the real discharge is smaller than the theoretical flow rate. HM 150.12 determines these losses at different flow rates. Different diameters as well as inlet and outlet contours of the openings can be studied. Additionally, the contraction coefficient can be determined as a characteristic for different contours.

The experimental unit includes a transparent tank, a measuring device as well as a pitot tube and twin tube manometers. An interchangeable insert is installed in the tank's water outlet to facilitate the investigation of various openings. Five inserts with different diameters, inlet contours and outlet contours are provided along with the unit.

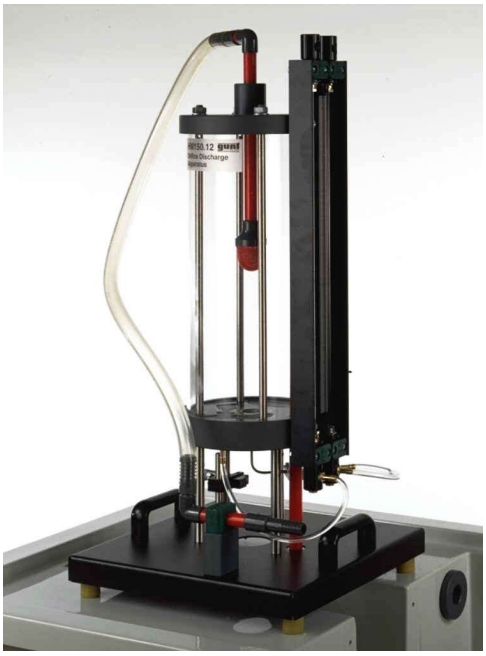
The issued water jet is measured using a measuring device. A pitot tube detects the total pressure of the flow. The pressure difference (read on the manometer) is used to determine the velocity.

The tank is fitted with an adjustable overflow and a measuring point for static pressure. In this way, the level can be precisely adjusted and read on the manometer. The experimental unit is positioned easily and securely on the work surface of the HM 150 base module. The water is supplied and the flow rate measured by HM 150. Alternatively, the experimental unit can be operated by the laboratory supply.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

9.6. Apparatus

Orifice discharge apparatus , hydraulic bench and stop watch.



Orifice discharge apparatus



Stop Watch



hydraulic bench

9.7 Experiment No. 8

Determination of co-efficient of resistance for change in cross section of pipe

Experimental Data Sheet

Group No	h_{static}	h_{pitot}	V_{theo}	V_{stream}	**Φ**	$d_{orifice}$	d_{stream}	**α**	Q_a	Q_t	C_d
1											
2											
3											
4											
5											
6											

Level / Term : **Dept. :**
Reg No. : **Section:**
Group No. : **Date :**

Signature of the Teacher

9.8 Discussion

Comments on results:

Sources of errors:

9.9 Practice Questions