# DEWAN V.S. INSTITUTE OF ENGINEERING & TECHNOLOGY MEERUT PARTAPUR MEERUT

# FM LAB

## SUBJECT CODE: BME 351

## B.TECH SEM III

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## AFFILIATED TO

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# List of Experiments mapped with COs

| S. No | Aim of the Experiment | COs |
|---|---|---|
| 1. | To determine the coefficient of impact for vanes | CO4 |
| 2. | To determine coefficient of discharge of an orifice meter. | CO2 |
| 3. | To determine the coefficient of discharge of Notch (V, Rectangular and Trapezoidal types). | CO3 |
| 4. | To determine the friction factor for the pipes. (Major Losses). | CO3 |
| 5. | To determine the coefficient of discharge of Venturimeter. | CO1 |
| 6. | To determine the coefficient of discharge, contraction & velocity of an Orifice. | CO1 |
| 7. | To verify the Bernoulli's theorem. | CO5 |
| 8. | To find critical Reynolds number for a pipe flow | CO2 |
| 9. | To determine the Meta-centric height of a floating body. | CO3 |

# EXPERIMENT NO. 1

**Aim:** To determine the co efficient of impact for vanes

**Apparatus:** Collecting tank, Nozzle of given diameter, Vanes of different shape (flat, inclined or curved).

**Theory:** Momentum equation is based on Newton's second law of motion which states that the algebraic sum of external forces applied to control volume of fluid in any direction is equal to the rate of change of momentum in that direction. The external forces include the component of the weight of the fluid & of the forces exerted externally upon the boundary surface of the control volume. If a vertical water jet moving with velocity is made to strike a target, which is free to move in the vertical direction then a force will be exerted on the target by the impact of jet, according to momentum equation this force (which is also equal to the force required to bring back the target in its original position) must be equal to the rate of change of momentum of the jet flow in that direction.

**Formula Used:**

$F=\rho\ Q\ v(1-\cos\beta)$

$F=\rho\ Q2\ (1-\cos\beta)/A$ as $v=Q/A$

Where,

F =force (calculated)

$\rho$ = density of water

$\beta$=angle of vane
V =velocity of jet
Q =discharge
A =area of nozzle ($\pi$ /4d2)

(i) for flat vane $\beta$=90o

$$F' = \rho Q2/A$$

(ii) for hemispherical vane $\beta$=180o

for % error =F- F'/ F'x100

$$F' = 2 \rho Q2/A$$

F = Force (due to putting of weight)

(iii) for inclined vane

$$F'=\rho\ Q\ v(1-\cos\beta)$$

$$F'=\rho\ Q2\ (1-\cos\beta)/A$$

**Procedure:**

1. Note down the relevant dimension or area of collecting tank, diameter of nozzle, and density of water.

2. Install any type of vane i.e., flat, inclined or curved.

3. Note down the position of upper disk, when jet is not running.

4. Note down the reading of height of water in the collecting tank.

5. As the jet strike the vane, position of upper disk is changed, note the reading in the scale to which vane is raised.

6. Put the weight of various values one by one to bring the vane to its initial position.

7. At this position finds out the discharge also.

8. The procedure is repeated for each value of flow rate by reducing the water supply.

9. This procedure can be repeated for different type of vanes and nozzle.

**Observations & Calculations:**

Dia of nozzle =

Mass density of water $\rho$ =

Area of collecting tank =

Area of nozzle =

**Horizontal flat vane**

When jet is not running, position of upper disk is at =

| S.No. | Discharge measurement | | | | Balancing | | Theoretical Force F'= ρQ2/A | Error in % = F-F'/F' |
|---|---|---|---|---|---|---|---|---|
| | Initial (cm) | Final (cm) | Time (sec) | Discharge (cm3/sec) Q | Mass W (gm) | Force F | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Inclined vane**

When jet is not running, position of upper disk is at =

Angle of inclination $\beta = 45^{o}$

| S. No. | Discharge measurement | | | | Balancing | | Theoretical Force F'= ρQ2(1-cosβ)/A (dyne) | Error in % = F-F'/F' |
|---|---|---|---|---|---|---|---|---|
| | Initial (cm) | Final (cm) | Time (sec) | Discharge (cm3/sec) Q | Mass W (gm) | Force F | | |
| | | | | | | | | |
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**Curved hemispherical vane**

When jet is not running, position of upper disk is at =

| S.No. | Discharge measurement | | | | Balancing | | Theoretical Force F'= $2\rho Q2/A$ | Error in % = F-F'/F' |
|---|---|---|---|---|---|---|---|---|
| | Initial (cm) | Final (cm) | Time (sec) | Discharge (cm3/sec) Q | Mass W (gm) | Force F | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

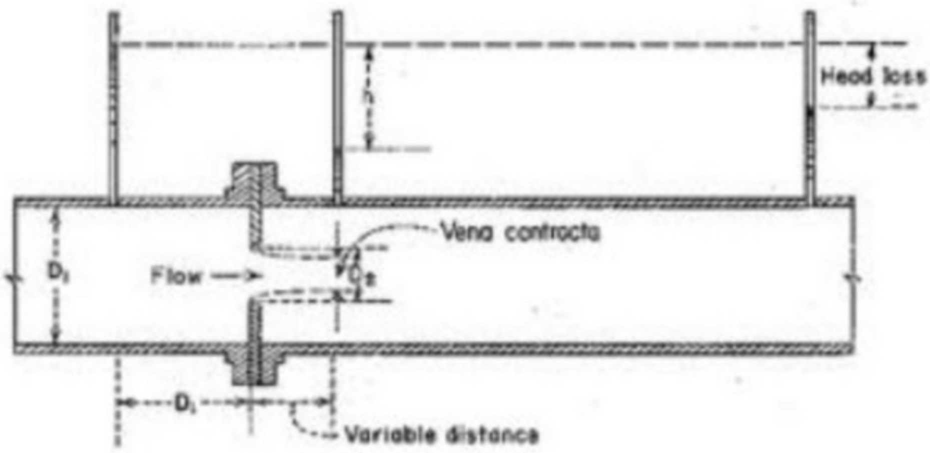
**Conclusion:** Hence the co efficient of impact for vanes is determined.

# EXPERIMENT NO. 2

**Aim:** To determine coefficient of discharge of an orifice meter.

**Apparatus:** Orifice meter, installed on different pipes, arrangement of varying flow rate, U-tube manometer, collecting tank.

**Theory:** Orifice meter are depending on Bernoulli's equation. Orifice meter is a device used for measuring the rate of fluid flowing through a pipe




**Formula Used:**

$$C_d = \frac{Q\sqrt{(A^2 - a^2)}}{Aa\sqrt{(2g\Delta h)}}$$

Where

A = Cross section area of inlet
a = Cross section area of outlet
$\Delta h$ = Head difference in manometer
Q = Discharge
Cd = Coefficient of discharge
g = Acceleration due to gravity

**Coefficient of discharge of orifice meter will be less than 1, but smaller than Cd value of venturimeter.**

Where

- $A$ = Cross section area of inlet
- $a$ = Cross section area of outlet
- $\Delta h$ = Head difference in manometer
- $Q$ = Discharge
- $C_d$ = Coefficient of discharge
- $g$ = Acceleration due to gravity

**Coefficient of discharge of orifice meter will be less than 1, but smaller than Cd value of venturimeter.**

**Procedure:**

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.
2. Now start the supply at water controlled by the stop valve.
3. One of the valves of any one of the pipe open and close all other of three.
4. Take the discharge reading for the particular flow.
5. Take the reading for the pressure head on from the u-tube manometer for corresponding reading of discharge.
6. Now take three readings for this pipe and calculate the Cd for that instrument using formula.
7. Now close the valve and open valve of other diameter pipe and take the three reading for this.
8. Similarly take the reading for all other diameter pipe and calculate Cd for each.

**Observations & Calculations:**

Diameter of Orifice meter =

Area of cross section =

Area of collecting tank =

| Discharge | | | | | Manometer Reading | | | | $C_d = \frac{Q\sqrt{A^2 - a^2}}{Aa\sqrt{2g\Delta h}}$ |
|---|---|---|---|---|---|---|---|---|---|
| Initial reading | Final reading | Difference | Time (sec) | Q | h1 | h2 | h2-h1 | $\Delta h = 13.6(h2-h1)$ | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Conclusion:** Hence the coefficient of discharge of Orifice meter is ___________.

## EXPERIMENT NO:3

**Aim:** To determine the coefficient of discharge of Notch (V, Rectangular and Trapezoidal types).

**Apparatus:** Arrangement for finding the coefficient of discharge inclusive of supply tank, collecting tank, pointer, scale & different type of notches

**Theory:** Notches are overflow structure where length of crest along the flow of water is accurately shaped to calculate discharge.

**Formula Used:-**

For V notch the discharge coefficient

$$C_d = \frac{Q}{\frac{8}{15}\sqrt{2g}\, H^{\frac{5}{2}} \tan\frac{\theta}{2}}$$

For Rectangular notch

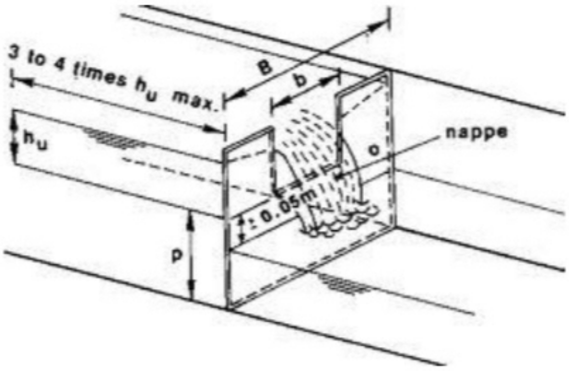
$$C_d = \frac{Q}{\frac{2}{3}\sqrt{2g}\;B\, H^{\frac{3}{2}}}$$

For Trapezoidal notch

$$C_d = \frac{Q}{\frac{2}{3}\sqrt{2g}\, H^{\frac{3}{2}}\, (\mathrm{B} + \tan\frac{\theta}{2})}$$

Where

Q = Discharge
H =Height above crest level
θ = Angle of notch
B = Width of notch




**Procedure:**

1. The notch under test is positioned at the end of tank with vertical sharp edge on the upstream side.
2. Open the inlet valve and fill water until the crest of notch.
3. Note down the height of crest level by pointer gauge.
4. Change the inlet supply and note the height of this level in the tank.
5. Note the volume of water collected in collecting tank for a particular time and find out the discharge.
6. Height and discharge readings for different flow rate are noted.

**Observations & Calculations:**

Breath of tank =
Length of tank =
Height of water to crest level for rectangular notch is =
Height of water to crest level for V notch =
Height of water to crest level for Trapezoidal notch =
Angle of V notch =
Width of Rectangular notch =

| Type Of notch | Discharge | | | | | Final height reading above width | Head above crest level | Cd |
|---|---|---|---|---|---|---|---|---|
| | Initial height Of tank | Final height Of tank | Difference In height | Volume | Q | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Conclusion:**

Hence

The coefficient of discharge of V Notch is ______________.

The coefficient of discharge of Rectangular Notch is ______________.

The coefficient of discharge of Trapezoidal Notch is ______________.

# EXPERIMENT NO:4

**Aim:** To determine the friction factor for the pipes.(Major Losses).

**Apparatus:** A flow circuit of G. I. pipes of different diameters, U-tube differential manometer, collecting tank.

**Theory:**

Friction factor in pipes or Major losses:-

A pipe is a closed conduit through which fluid flows under the pressure. When in the pipe, fluid flows, some of potential energy is lost to overcome hydraulic resistance which is classified as follows:

1. The viscous friction effect associated with fluid flow.
2. The local resistance which result from flow disturbances caused by
   a. Sudden expansion and contraction in pipe
   b. Obstruction in the form of valves, elbows and other pipe fittings.
   c. Curves and bend in the pipe.
   d. Entrance and exit losses

The viscous friction loss or major loss in head potential energy due to friction is given by

$$h_f = \frac{4flV^2}{2gd}$$

Where

hf =Major head loss
l = Length of pipe
4f = Friction factor
V = Inlet velocity
g = Acceleration due to gravity
d = Diameter of pipe

**Procedure:**

1. Note down the relevant dimensions as diameter and length of pipe between the pressure tapping, area of collecting tank etc.
2. Pressure tapping of a pipe is kept open while for other pipe is closed.
3. The flow rate was adjusted to its maximum value. By maintaining suitable amount of steady flow in the pipe.
4. The discharge flowing in the circuit is recorded together with the water level in the left and right limbs of manometer tube.
5. The flow rate is reduced in stages by means of flow control valve and the discharge & reading of manometer are recorded.
6. This procedure is repeated by closing the pressure tapping of this pipe, together with other pipes and for opening of another pipe.

**Observations & Calculations:**

Diameter of pipe d =

Length of pipe between pressure tapping l =

Area of collecting tank =

| SNo | Manometer Reading | | | Discharge Measurement | | | | $F = \pi^2 g d^5 / 8 l Q^2 \; hf$ |
|---|---|---|---|---|---|---|---|---|
| | Left limb h1 (cm) | Right limb H2 (cm) | Difference of head in terms of water hf =13.6(h1-h2) | Initial (cm) | Final (cm) | Time (sec) | Discharge Q ($cm^3$/sec) | |
| 1. | | | | | | | | |
| 2. | | | | | | | | |
| 3. | | | | | | | | |

$$F = 4f = \frac{\pi^2 g d^5}{8lQ^2 h_f}$$

**Conclusion:** Hence the friction factor for the pipes is F =_________.

# EXPERIMENT NO:5

**Aim**: To determine the coefficient of discharge of Venturimeter.

**Apparatus**: Venturimeter, installed on different diameter pipes, arrangement of varying flow rate, U- tube manometer, collecting tube tank.

**Theory**: Venturimeters are depending on Bernoulli's equation. Venturimeter is a device used for measuring the rate of fluid flowing through a pipe. The consist of three parts in short

1. Converging area part
2. Throat
3. Diverging part

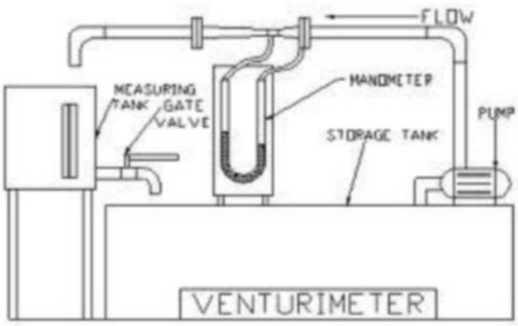
**Formula Used:**

$$C_d = \frac{Q\sqrt{(A^2 - a^2)}}{Aa\sqrt{(2g\Delta h)}}$$

Where

A = Cross section area of inlet
a = Cross section area of outlet
$\Delta$h = Head difference in manometer
Q = Discharge
Cd = Coefficient of discharge
g = Acceleration due to gravity

**Coefficient of discharge value of Venturimeter is closer to 1.**



**Procedure:**

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.
2. Now start the supply at water controlled by the stop valve.
3. One of the valves of any one of the pipe open and close all other of three.
4. Take the discharge reading for the particular flow.
5. Take the reading for the pressure head on from the u-tube manometer for corresponding reading of discharge.
6. Now take three readings for this pipe and calculate the Cd for that instrument using formula.
7. Now close the valve and open valve of other diameter pipe and take the three reading for this.
8. Similarly take the reading for all other diameter pipe and calculate Cd for each.

**Observations & Calculations:**

Diameter of Venturimeter =
Area of cross section =
Area of collecting tank =

| Discharge | | | | | Manometer Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Initial reading | Final reading | Difference | Time (sec) | Q | $h_1$ | $h_2$ | $h_2$-$h_1$ | $\Delta h$= 13.6(h2-h1) | $Cd = \frac{Q\sqrt{(A^2 - a^2)}}{Aa\sqrt{(2g\Delta h)}}$ |
| | | | | | | | | | |
| | | | | | | | | | |

**Conclusion:** Hence the coefficient of discharge of Venturimeter is __________.