OBSERVATIONS:

Length of collection tank, L = m, Breadth of collection tank, B = m

Dia of inlet pipe , d_1 = m, Dia of outlet pipe , d_2 = m

Area of inlet pipe , a_1 = m^2, Area of outlet pipe , a_2 = m^2

CALCULATION – COEFFICIENT OF EXPANSION

Sl. No.	Difference in mercury level $X = h_1 \sim h_2$ (cm)	$h_f = X \times 12.6$ (cm)	Time for 10 cm rise 't' sec.	$Q = A\,y / t$ cm^3/s	$V_1 = Q / a_1$ cm/s	$V_2 = Q / a_2$ cm/s	$h_e = (V_1 - V_2)^2 / 2g$
1.							
2.							
3.							
4.							
5.							
6.							
7.							

MODEL CALCULATION:

1. Area of pipe, a $= \pi d^2 / 4$

$=$ mm^2

2. Internal plan area of collecting tank

$= L \times B$

$=$ mm^2

3. Actual Discharge

$Q_a = AH/t$

$=$ mm^3/s

4. Velocity

$V = Q_a / a$

$=$ mm/s

5. Coefficient of friction

$f = 2gdh_f / 4Lv^2$

$=$

GRAPH:

A graph h_f vs. v^2 is drawn taking v^2 on X axis.

RESULT:

The Coefficient of friction of the given pipe (f)

1. Theoretically =
2. Graphically =

L = Length of pipe between pressure tapping cocks.	mm
V = Velocity of flow in the pipe = Q_a/a	mm/s
Q_a = Actual Discharge = AH/t	mm^3/s
A = Internal Plan area of the collecting tank	mm^2
H = Height of collection in the collecting tank	mm
T = time of collection	sec
a= cross sectional area of the pipe = $\pi d^2/4$	mm^2
d = diameter of pipe	mm
g = acceleration due to gravity = 9810	mm/s^2

PROCEDURE:

1. The diameter of the pipe, the internal plan dimensions of the collecting tank and the length of the pipe line between the pressure tapping cocks are measured,
2. Keeping the outlet valve fully closed, the inlet valve is opened completely.
3. The outlet valve of the collecting tank is closed tightly and the time t required for H rise of water in the collecting tank is observed using a stop watch.
4. The above procedure is repeated by gradually increasing the flow and observing the required readings.
5. The observations are tabulated and the coefficient of friction is computed.

OBSERVATIONS:

Diameter of the pipe d = mm

Length of the pipe L = mm

Internal plan dimensions of collecting tank, Length, L = mm

Breadth, B= mm

Acceleration due to gravity, g = 9810 mm/sec^2

TABULATION:

Sl. No.	Manometric Readings			Time for H = 100mm rise of water(t)	Actual Discharge Q_a = AH/t	Velocity = Q_a/ a	V^2	Co-efficient of friction f= $2gdh_f/4LV^2$
	h_1	h_2	$h_f=h_1-h_2$					
	mm of water			Sec	mm^3/s	mm/s	(mm/s)^2	
1								
2								
3								
4								
5								
6								

Mean Value of f =

Ex. no: 2.4

STUDY OF FRICTION LOSSES IN PIPES

AIM:

To determine the coefficient of friction (f) of the given pipe material.

APPARATUS REQUIRED:

1. A pipe provided with inlet and outlet valves
2. U tube Manometer
3. Collecting tank
4. Stop watch
5. Metre scale

THEORY:

When liquid flows through a pipe line, it is subjected to frictional resistance. The frictional resistance depends upon the roughness of the inner surface of the pipe. The loss of head between a selected length of pipe is observed for a measured discharge. The coefficient of friction (f) is calculated by using the expression

$$h_f = 4fLv^2 / 2gd$$

Where,

h_f = loss of head due to friction = $h_1 - h_2$ mm

h_1 = Manometric head in one limb of the manometer mm

h_2 = Manometric head in other limb of the manometer mm

h= Height of water collected in tank = 10cm

a_1= Area of inlet pipe in m^2

a_2= Area of throat in m^2

t=time taken for h cm rise of water

$H= (H_1-H_2)(S_m/S_1-1)$

Where H_1 and H_2 are Manomertic heads in first and second limbs

S_m and S_1 are Specific gravity of manometric fluid (mercury) and water flowing through the pipeline system.

Density of the manometer liquid ρ_m= 13.6 x 1000 kg/m^3

Density of the flowing liquid ρ= 1000 kg/m^3

Coefficient of Discharge $C_d = Q_{actual}/ Q_{theo}$

Volume of Collecting tank (Ah) =30cm (L) * 30cm (W) * 10cm (h) =

Diameter of the inlet pipe = 25 mm

Diameter of the throat = 12.5 mm

a_1= Area of inlet pipe in m^2 =

a_2= Area of throat in m^2 =

OBSERVATION TABLE

Sl. No.	H_1 (m)	H_2 (m)	$H=(H_1H_2)*12.6$ (m)	Time taken for 10cm rise of water (sec)	Q_{actual} (1)	$Q_{theo.}$ (2)	C_d= (1)/(2)
1							
2							
3							
4							
5							
6							

Mean Coefficient of Discharge =

Sample Calculation

Result and Discussion

Experiment No. 2.3(b)

ORIFICE METER

Aim: To determine the coefficient of discharge of orifice meter.

Apparatus: Orifice meter, Stop watch, Collecting tank, Differential U-tube manometer.

Description:

Orifice meter is a device used for measuring the rate of flow of a fluid through a pipe. Orificemeter works on the same principle as that of Venturimeter i.e. by reducing the area of flow passage a pressure difference is developed between the two sections and the measurement of pressure difference is used to find the discharge.

It consists of a flat circular plate which has a circular sharp edge 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 0.4 to 0.8 times the pipe diameter.

A mercury U-tube manometer is connected at section (1), which is at a distance of about 1.5 to 2.0 times the pipe diameter upstream from the orifice plate, and at section (2) which is at a distance of about half the diameter of the orifice on the downstream side from the orifice plate to know the pressure head between the two tappings.

Procedure:

The pipe is selected for conducting experiment.

The motor is switched on; as a result water flows through pipes.

The readings of H_1 and H_2 are noted.

The time taken for 10cm rise of water in collecting tank is noted.

The experiment is repeated for different discharges in the same pipe.

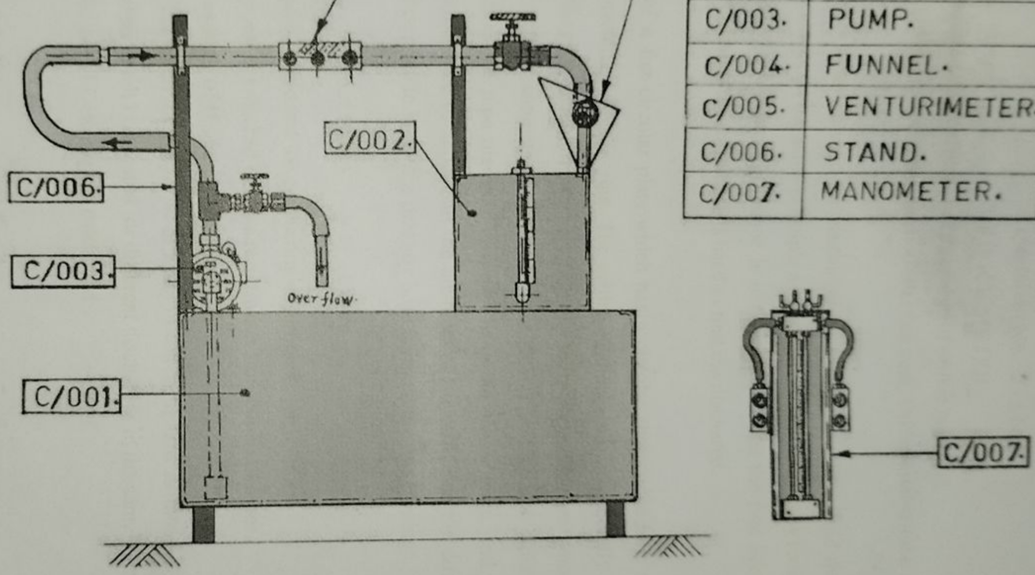
Coefficient of Discharge is calculated

Formulae

Actual Discharge: $Q_{actual} = Ah/t$ (m^3/sec)

Theoretical Discharge $Q_{theo.} = a_1 a_2 \sqrt{\dfrac{2gH}{a_1^2 - a_2^2}}$ (m^3/sec)

Where A= Area of collecting tank in m^2



Part No.	PART.
C/001.	SUMP TANK.
C/002.	Measuring TANK.
C/003.	PUMP.
C/004.	FUNNEL.
C/005.	VENTURIMETER.
C/006.	STAND.
C/007.	MANOMETER.

SCHEMATIC LAY-OUT OF:- **VENTURIMETER APPARATUS.**

C/00. 3 TAPPING.

OBSERVATION AND TABULATION

Dia at the inlet (d_1) =
Dia at the throat (d_2) =
Dimensions of collecting tank: L = B=

Sl. No.	Manometer Readings			Venturi head	Time taken for x m rise In coll. tank	Actual discharge Qa	Theor. Discharge Qt	Coeff. Discharge cd
	L	R	Deflection $h_1 - h_2$	$x\left(\frac{s_2}{s_1} - 1\right)$				
	h_1	h_2	x	h	t			
	m	m	m	m	Sec	m^3/s	m^3/s	--
1								
2								
3								
4								
5								
6								

Sample calculation (Reading No....)

Dia at inlet (d_1) =

Area at inlet (a_1) = $\frac{\pi d_1^2}{4}$

Dia at throat (d_2) =

Area at throat (a_2) = $\frac{\pi d_2^2}{4}$

Manometer readings, $h_1 = h_2$

Manometer delflection (x) = $h_1 - h_2$

Venturi head (h) = $x\left(\frac{s_2}{s_1} - 1\right)$

Taking g = 9.81 m/s^2

Theoretical discharge Qt = $\frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ m^3/s

Area of Coll. Tank A = L x B =

Rise of water level
in the coll. tank x =

Time Taken for x $_m$ level rise in C/T, t =

Actual discharge 'Qa' = $\frac{A.x}{t} \frac{m^3}{s}$

=

$C_d = \frac{Q_a}{Q_{th}}$ =

Procedure

1.Note the dimensions of the venturimeter.(inlet dia & throat dia) .

2. Open the bypass valve and outlet valve fully and start the pump.

3. Close the bypass valve such that some water is flowing through the venturimeter.

4. Note the manometer deflection (x) h_1 and h_2 time (t) taken to R_m level rise in C/T.

5.Repeat the steps 3 to 4 for different rates of flow of water through the venturimeter.

6.Tabulate the readings (x and t) and calculate the co-efficient of discharge.

Result

Co – efficient of discharge of the given venturimeter =

Inference

Ex. No 2.3(a)

Date :

EXPERIMENT ON VENTURIMETER

Aim:

To determine the co-efficient of discharge of the given venturimeter and plot the graph, Qa Vs h

Objectives : To appreciate the venturimeter and its co-efficient of discharge.

Apparatus:

1. Venturimeter with differential manometer.
2. Measuring tank
3. Stop watch

Principle :

Venturimeter is a device based on Bernoulli's theorem, used to measure discharge of water flowing through a pipe.

Co- efficient of discharge of a Venturimeter is the ratio between actual and theoretical discharge.

theoretical discharge $Q_{th} = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$

where a_1 = area at inlet

a_2 = area at throat

g = acceleration due to gravity

h = venturi head (ie, difference of pressure heads between inlet and throat)

$= x\,(\frac{S2}{S1} - 1)$ where x = deflection of mercury in the limbs of the manometer, $h_1 - h_2$

s_2 and s_1 = specific gravities of mercury and water

Actual discharge 'Qa' = $\frac{A.R}{t}\ m^3/5$ A = Area of c/T in m^2

R = Level rise in c/T m

t = time for Rm level rise in C/T

$\therefore Cd = \frac{Qa}{Qth}$

Observation

Length of the collecting tank = ...

Breadth of the collecting tank = ...

Length of rectangular notch, L = ...

Number of end contractions, n =...

Angle of v notch =

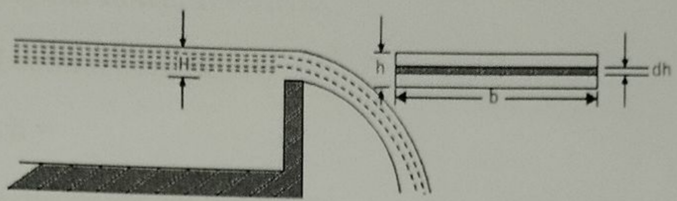
Co- efficient of discharge for v-notch =

Theoretical discharge, Q_{th}= ....

Actual discharge, Q_{act} = ...

Results :-

Let us consider a horizontal strip of water of thickness dh at a depth of h from the water level as shown in figure.



Let,

H = Height of water above sill of notch

b = Width or length of the notch

Cd = Coefficient of discharge

$\therefore$ Area of the strip $= b \cdot dh$

The theoretical velocity of water through the strip $= \sqrt{2gh}$

Discharge through the strip,

$dq = C_d \times \text{Area of strip} \times \text{Theoretical velocity}$

$\Rightarrow dq = C_d \times b \cdot dh \times \sqrt{2gh}$

the total discharge over the whole notch may be found out by integrating the above equation within the limits 0 and H.

$$Q = \int_0^H C_d \times b \cdot dh \sqrt{2gh}$$

$$\Rightarrow Q = C_d \times b\sqrt{2g} \int_0^H h^{1/2} \cdot dh$$

$$\therefore Q = \frac{2}{3} \times C_d \times b \cdot \sqrt{2g}\, H^{3/2}$$

Procedure:-

1. Start the pump by pressing start button.
2. Open the inlet valve and allow the water to fill in the channel till crest level.
3. Note the theoretical discharge of the Rectangular Notch.
4. Note actual discharge reading of the V- notch from the collecting tank.
5. Stop the pump by pressing the stop button.

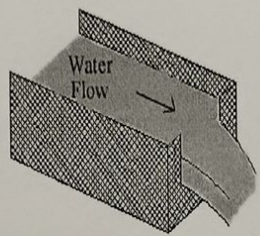
Expt - 2.2

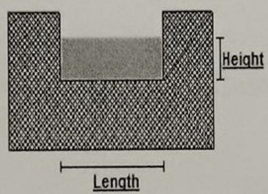
Rectangular Notch

Name of Experiment:- To determine the coefficient of discharge of Rectangular notch.
Apparatus Required:- Rectangular Notch, V- notch, hook gauge, measuring scale etc.

Theory:- A Notch is a device used for measuring the rate of flow of a liquid through a small channel or a tank. It may be defined as an opening in the side of a tank or vessel such as liquid surface in the tank is below the level of opening.

Notches can be of different shapes such as triangular, rectangular, trapezoidal, stepped notch, etc. the bottom of the notch over which the water flows is known as crest or sill and the thin sheet of water flowing through the notch is known as nappe or vein. The edges of the notch are bevelled on the downstream side so as to have a sharp-edged sides and crest resulting in minimum contact with the flowing fluid.

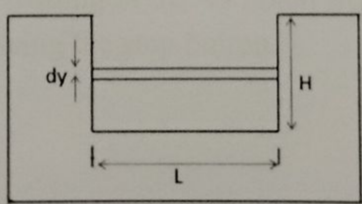




Classifications of notch:

Rectangular notch:

It takes its name from the shape of its notch. The discharge through a weir or notch is directly related to the water depth or head (H). This head is affected by the condition of the crest, the contraction, the velocity of approaching stream and the elevation of the water surface downstream from the weir.



Observation and Tabulation

Dimensions of measuring tank,

L = B=

	1	2	3	4	5	6	7	8	9	10	11
Distance											
Area of Cross section											
$(z+\frac{P}{pg})$											
$(V^2/2g)$											
Total Head (H)											

Sample calculation (Section No.............................)

$(z+\frac{P}{pg})$ =

Dimensions of measuring tank,

L = B =

Area of measuring tank, (A) = L×B)

=

Rise in water level in the measuring tank, (x)=

Time taken for the water rise in the tank (t) =

Actual Discharge (Q) $=\frac{A \times x}{t}$

Area of cross section of the duct (a) =

velocity (v) = Q/a

velocity head $= V^2/2_g$ ($g = 9.81 m/s^2$)

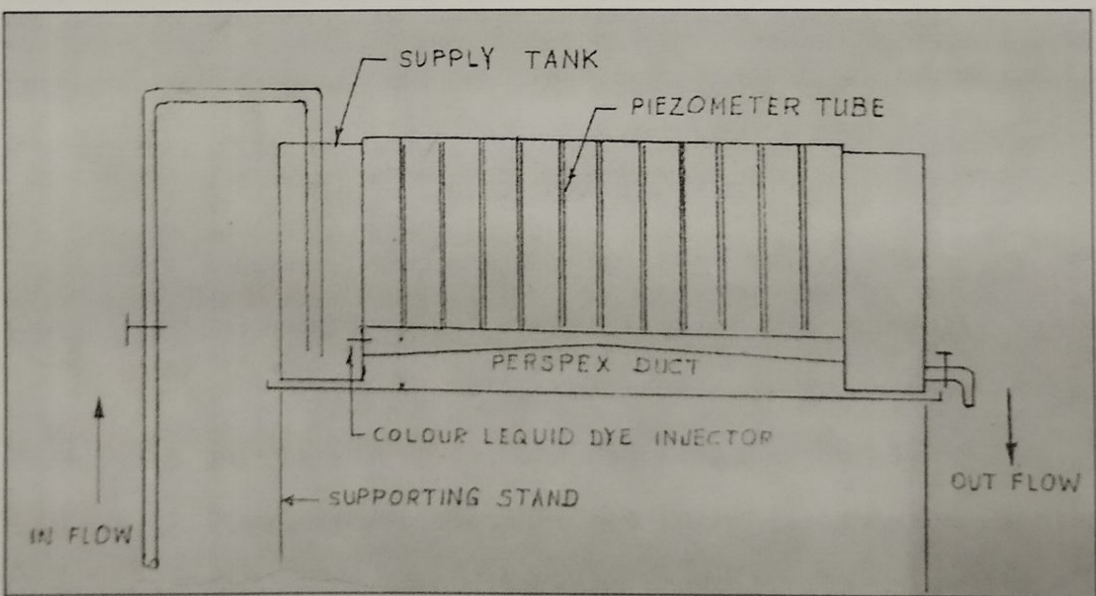
=

Total head (H) = $z+\frac{P}{pg}+\frac{V^2}{2g}$ =

STUDY OF BERNOULLI'S THEOREM APPARATUS

The experimental set up consist of a horizontal Perspex duct made up of smooth variable cross section of convergent and divergent in 40x40mm at the entrance and exist and 40x20 mm at middle. The total length of duct in 90 cm. The piezometric pressure P at the locations of pressure tappings is measured by means of piezometers installed along with the length of conduit. The duct is connected with the small tanks. By maintaining suitable amount of steady head difference between these two tanks, there establishs a steady nonuniform flow in the conduit whose dimension at different cross section are known. Knowing the discharge flowing in the conduit, velocity v at different sections are computed. Arrangement to supply the coloured liquid dye in the middle of duct through a dye injector needle is provided to visualize the flow pattern.

Since the conduit is horizontal, the total energy at any section with reference to the centre line of the conduit is the sum of pressure head and velocity head. One can compare the values of the total energy at different sections and comment about the constancy of energy in converging and divergin conduit. The observation and computations can be suitably computed and the result presented in a graphical form by plotting hydraulic gradient line and total energy line.



Ex.No : 2.1
Date:

Verification of Bernoulli's Theorm

Aim : To verify the Bernoulli's theorem and plot the graphs.

Length of pipe Vs velocity head ($v^2/2g$)

Apparatus :

1. Meter Scale
2. Stop watch.

Principle : Bernoulli's theorem states that " when water is continuosly flowing through a conduit, and no extra energy is taken out or added the total energy (or total head) will remains a constant at all sections"

ie $H_1 = H_2 = H_3 = H$ (Total Head)

Total head H = Potential head (Z)+

Pressure head ($\frac{P}{pg}$)+

Velocity head ($v^2/2_g$)

ie $H = Z + \frac{P}{pg} + \frac{V^2}{2g}$

Where Z = Potential head, ie the height by which the water particle is situated from a datum.

p = intensity of pressure

S = density of water

g = acceleration due to gravity

v = velocity of flowing water

The apparatus consists of a duct of varying cross-sectional area and piezgometers are installed at various sections. A supply tank and a collecting tank are provided with the apparatus. A centrifugal pump with an electric motor is also provided to circulate the water.

Procedure

1. Observe the area of cross section and the distance of each section from a reference axis
2. Close the outlet valve of the centrifugal pump and start the pump. .
3. Open the outlet valve of the pump gradually and water is allowed to enter the supply tank, and water flows through the duct to the reservoir.
4. Maintain a steady flow through the duct by operating the outlet valves
5. Consider a datum and measure the vertical height to the level of water in the pizgometer from the datum, by using a meter scale ie (z+p/pg)..
6. Observe the dimensions of the measuring tank and close the outlet valve of the tank firmly .
7. The water flowing through the duct is collected in the measuring tank and note the time (t) taken for a particular rise in water level (x)in the measuring tank. by using a stop watch.
8. After taking the time, open the outlet valve of the measuring tank .
9. Close the outlet valve of the centrifugal pump and switched off. The pump.

Result:

Bernoulli's theorem is verified and it is found that total head decreases when the flow progresses.

Infernce:

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(FOR 5^{TH} SEMESTER CIVIL ENGINEERING STUDENTS UNDER SCTE&VT,ODISHA,BHUBANESWAR)

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