ANJUMAN
COLLEGE OF ENGINEERING & TECHNOLOGY
(MANAGED BY : ANJUMAN HAMI-E-ISLAM, NAGPUR)

Fluid Mechanics - I Lab Manual

CIVIL ENGINEERING DEPARTMENT

Roll No:____
Name:__________________
Year:____ Semester:___

ANJUMAN COLLEGE OF ENGINEERING & TECHNOLOGY

ESTD. 1999

Approved by A.I.C.T.E. New Delhi, Recognized by DTE, Mumbai, Affiliated to RTM Nagpur University, Nagpur.

CERTIFICATE

Certified that this file is submitted by

Shri/Ku.____

Roll No.________a student of ________ year of the course __________________

_______________________________________ as a part of PRACTICAL/ORAL as prescribed by the Rashtrasant Tukadoji Maharaj Nagpur University for the subject_____________________________________ in the laboratory of ___________________________________during the academic year _________________________ and that I have instructed him/her for the said work, from time to time and I found him/her to be satisfactory progressive.

And that I have accessed the said work and I am satisfied that the same is up to that standard envisaged for the course.

Date:-

Signature & Name of Subject Teacher

Signature & Name of HOD

Anjuman College of Engineering and Technology

Vision

- To be a centre of excellence for developing quality technocrats with moral and social ethics, to face the global challenges for the sustainable development of society.

Mission

- To create conducive academic culture for learning and identifying career goals.
- To provide quality technical education, research opportunities and imbibe entrepreneurship skills contributing to the socio-economic growth of the Nation.
- To inculcate values and skills, that will empower our students towards development through technology.

Vision and Mission of the Department

Vision:

- To be the centre of excellence for developing quality Civil Engineers with moral and social ethics to face global challenges for the sustainable development of society.

Mission:

- To create conductive academic culture for learning and identifying career goals.
- To impart quality technical education along with research opportunities.
- To impart knowledge and generate entrepreneurship skills contributing to socio-economic growth of the nation.
- To inculcate values and skills, that will empower our students, towards National development through technology, to preserve nature and its resources.

Program Educational Objectives (PEOs)

- Apply technical knowledge to find solution to the challenges in various areas and to develop independent thinking in the field of Civil Engineering.
- Have analyze, design, technical and soft skills, for solving problem Civil Engineering.
- Inculcate morality professionals and ethical sense and self confidence.
- Take higher education or lifelong learning and contribute in research and development throughout life.

Program Specific Outcomes (PSOs)

- An ability to plan, analyze, design and execute low cost housing and construction works.
- An ability to provide the basic facilities with optimal utilization of resources to meet the societal needs.

PROGRAM: CE	DEGREE: B.E
COURSE: Fluid Mechanics-I	SEMESTER: V CREDITS:
COURSE CODE: BECVE503P	COURSE TYPE: REGULAR
COURSE AREA/DOMAIN:	CONTACT HOURS: 2 hours/Week.
CORRESPONDING LAB COURSE CODE :	LAB COURSE NAME : Fluid Mechanics-I

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
BECVE503P			V

LAB COURSE OBJECTIVES:

- Determine fluid pressure and forces plates,pipes,bends etc.
- Apply the Bernoulli's equation to solve the problems in fluid.
- Understand the basic concepts related to laminar and turbulent flow.
- To study about various fluid measuring devices.

COURSE OUTCOMES: Design Patterns

After completion of this course the students will be able -

SNO	DESCRIPTION
CO.1	Determine the discharge of Venturimeter , Orifice meter, Rectangular Notch, Triangular Notch
CO.2	Determine the coefficient of velocity and the coefficient of contraction of the orifice and mouth piece.
CO.3	Discuss the knowledge of laminar flow, turbulent flow & Reynolds number
CO.4	Verify Bernoulli's theorem and momentum equation.
CO.5	Determine the variation of friction factor 'f' for turbulent flow in commercial pipes

Lab Instructions:

- Students should come to the lab on time unless prior permission is obtained from the supervisor. As per department policy, a grace period of 10 minutes will be given to late students. Student arriving after 10 minutes of the starting time will be considered absent. Hence, he/she will automatically receive "zero" mark for the lab report.
- Students will be divided in to groups (preferably 2/3 students in a group). Each group will be given a handout. This will serve as a guide for them throughout the experiment.
- All students must have to submit the lab report just after the entrance and before the class start.
- Lab reports have to be submitted serially.
- Students have to complete the sample calculations and graphs in class and take sign from the course teacher. (In some experiment which require more times, should be completed as possible in class time.)
- Students should be very careful about any test. They should conduct the tests by taking maximum care of the equipment during test.
- Thoroughly clean your laboratory work space at the end of the laboratory session.
- Keep work area neat and free of any unnecessary objects.
- Never block access to exits or emergency equipment.
- Food and drink, open or closed, should never be brought into the laboratory.
- Know the location of all the exits in the laboratory and building at the time of emergency.

Continuous Assessment Practical

Exp No	NAME OF EXPERIMENT	Date	Sign	Remark
1	To verify Bernoulli's theorem			
2	To determine the coefficient of discharge of Venturimeter			
3	To determine the coefficient of discharge of Orifice meter			
4	To determine the coefficient of discharge of Rectangular Notch			
5	To determine the coefficient of discharge of Triangular Notch			
6	To determine the coefficient of discharge of an orifice of a given shape. Also to determine the Coefficient of velocity and the coefficient of contraction of the orifice and mouth piece			
7	To verify the momentum equation using the experimental set-up on diffusion of submerged air jet			
8	To determine the variation of friction factor 'f' for turbulent flow in commercial pipes.			
9	To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number			

CONTENTS

EXPERIMENT NO – 1

EXPERIMENT NO:_______________.

Aim:- To verify Bernoulli's Theorem.

Theory:-
When an incompressible fluid is flowing through a closed conduit, is may be subjected to various forces, which cause change of velocity, acceleration or energies involved. The major forces involved are pressure and body forces. Due to elevation of conduit, pressure may change or due to change of cross section, velocity of fluid may change. But, through there is change of velocity, pressure also change accordingly. In other words, if velocity energy of fluid is raised, its pressure will drop i.e. total energy of fluid is constant at any two points in the path of flow. The theorem is known as Bernoulli's theorem. Hence, when applied to steady irrotational flow of incompressible fluids.

Formula: Total Energy $= \frac{P}{w} + \frac{V^2}{2g} + Z = C$

Where, P = Pressure
V = Velocity at the point
Z = potential head from datum

Apparatus:- The apparatus consist of a rectangular flow channel which is tapered along the length. Flow area at inlet is maximum and it goes on reducing towards outlet. Water is fed to flow channel through a supply tank. Outlet is also collected through outlet tank. A collector fitted can be directed either in drain or flow measurement tank.

Procedure:-
1. Connect the water pipe to the inlet valve.
2. Reduce flow by inlet gate valve, so that there is only a small rise of water in the lst pressure tapping.
3. Allow the levels to stabilies and note down the heads.
4. Close outlet valve of the measuring tank, put the collector in the measuring tank and measure the time to rise water level by 10 litres.
5. Now, repeat the procedure by changing the discharge and note the drop of head towards outlet for each observation.

Observation Table:-

Sr. No.	Head in cms Tappings														Discharge time for 10 litres of water flow
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

Calculations:-

(Consider section at 1st tapping)

Area of flow channel **A = m²** (refer table)

1) Discharge, $\mathbf{Q = \frac{0.01}{T}\ m^3/sec}$

$\mathbf{Q = \underline{0.01}\ m^3/sec}$

$\mathbf{Q = \quad m^3/sec}$

2) Velocity of water, $\mathbf{V = \frac{Q}{A}\ m/sec}$

V = ______ m/sec

V = m/sec

Hence,

3) Velocity energy or head = $\mathbf{\frac{V^2}{2g}}$

Velocity energy or head =

4) Pressure head, $\mathbf{H = \frac{P}{w}}$

OR

Pressure head, **H = h + h1**

H =

where, h = water rise from top channel, (m)

h1 = Distance from top of channel to its centre (see chart)

5) Now, datum line is same at inlet and outlet

Hence, Z1 = Z2 = Z3= 0

According to Bernoulli's equation,

$$\frac{P1}{w} + \frac{V1^2}{2g} + Z1 = \frac{P2}{w} + \frac{V2^2}{2g} + Z2$$

$$\text{or } H1 + \frac{V1^2}{2g} + Z1 = H2 + \frac{V2^2}{2g} + Z2$$

as Z1 = Z2 for the channel,

$$\mathbf{H1} + \frac{\mathbf{V1^2}}{\mathbf{2g}} = \mathbf{H2} + \frac{\mathbf{V2^2}}{\mathbf{2g}} = \mathbf{C}$$

Find out the value of C for each section (at same flow rate). It is same for all section.

NOTE:- Practically, value of C goes on reducing slightly towards outlet, due to various factors which are not considered e.g. friction, turbulence etc.

$$\mathbf{H1} + \frac{\mathbf{V1^2}}{\mathbf{2g}} = \mathbf{H2} + \frac{\mathbf{V2^2}}{\mathbf{2g}}$$

Conclusion:-

1. As value of C is fairly constant, total energy of flow is same over the entire length.
2. As velocity of flow increases, pressure head drops.
3. Bernoulli's equation i.e.

$\frac{P}{w} + \frac{V^2}{2g} + Z = C$ is thus verified

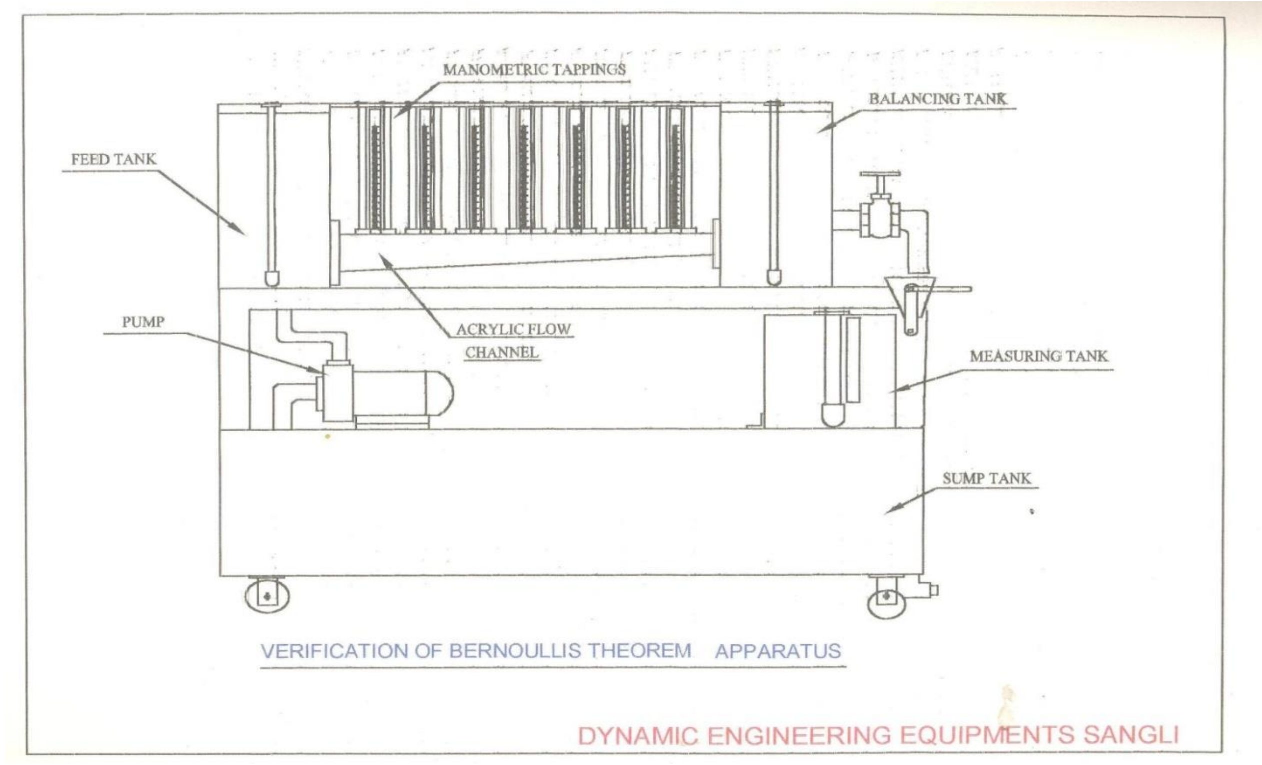
Precautions:-

1. Note down the head readings after the level has been stabilized.
2. After noting the discharge drain the measuring tank.
3. After completion of experiment drain all the water from the equipment.

Table

Tapping Sr. No.	h1 m	Area m^2
Inlet		7.5×10^{-4}
1	0.03000	7.2×10^{-4}
2	0.02925	6.90×10^{-4}
3	0.02825	6.60×10^{-4}
4	0.02700	6.30×10^{-4}
5	0.02600	6.00×10^{-4}
6	0.02525	5.70×10^{-4}
7	0.02450	5.40×10^{-4}
8	0.02325	5.10×10^{-4}
9	0.02220	4.80×10^{-4}
10	0.02150	4.50×10^{-4}
11	0.02050	4.20×10^{-4}
12	0.01950	3.90×10^{-4}
13	0.01800	3.60×10^{-4}
14	0.01750	3.30×10^{-4}
Outlet		3.00×10^{-4}

Diagram



EXPERIMENT NO:____________

Aim:- To determine coefficient of discharge of Venturimeter.

Apparatus:- Venturimeter are widely used for determination of flow of fluid. While using the Venturimeter their calibration is important. The equipment enables to determine the coefficient of discharge of Venturimeter.

Procedure:-
1. Check all the clamps for tightness.
2. Open the gate valve and start the flow.
3. Open the outlet valve of the venturimeter and close the valve of orificemeter.
4. First open air cocks then open the venturimeter cocks, remove all the air bubbles and close the air cocks slowly and simultaneously so that mercury does not run away into water.
5. Close the gate valve of measuring tank and measure the time for 10 liters water discharge and also the manometer difference.
6. Repeat the procedure by changing the discharge and also for orificemeter.

Observation Table:-

For venturimeter:

Sr. No.	Manometer difference h (m)	Time for 10 liter water discharge t (sec.)
1		
2		

Calculations:-
For venturimeter:

Actual discharge, $\mathbf{Q_a = \frac{0.01}{t}}$ **m^3/sec**

$\mathbf{Q_a =}$

Let H be the water head across manometer in, m.

Therefore, H= Manometer difference (Sp. Gravity of mercury – sp. Gravity of water)
Or, H = Manometer difference x (13.6-1)=12.6 x h
A = cross sectional area at inlet to venturimeter = 3.63×10^{-4} m^2
a = cross sectional area at throat to venturimeter = 1.76×10^{-4} m^2

Therefore, **Theoretical discharge,**

$$Q_{th} = \frac{A.\ a.\ \sqrt{2gH}}{\sqrt{A^2 - a^2}}$$

Or , $\mathbf{Q_{th} = 0.00318 \sqrt{h}}$ **m^3/s------ (h in mtr.)**

Coefficient of discharge $C_d = \frac{Q_a}{Q_{th}}$

C_d = _______

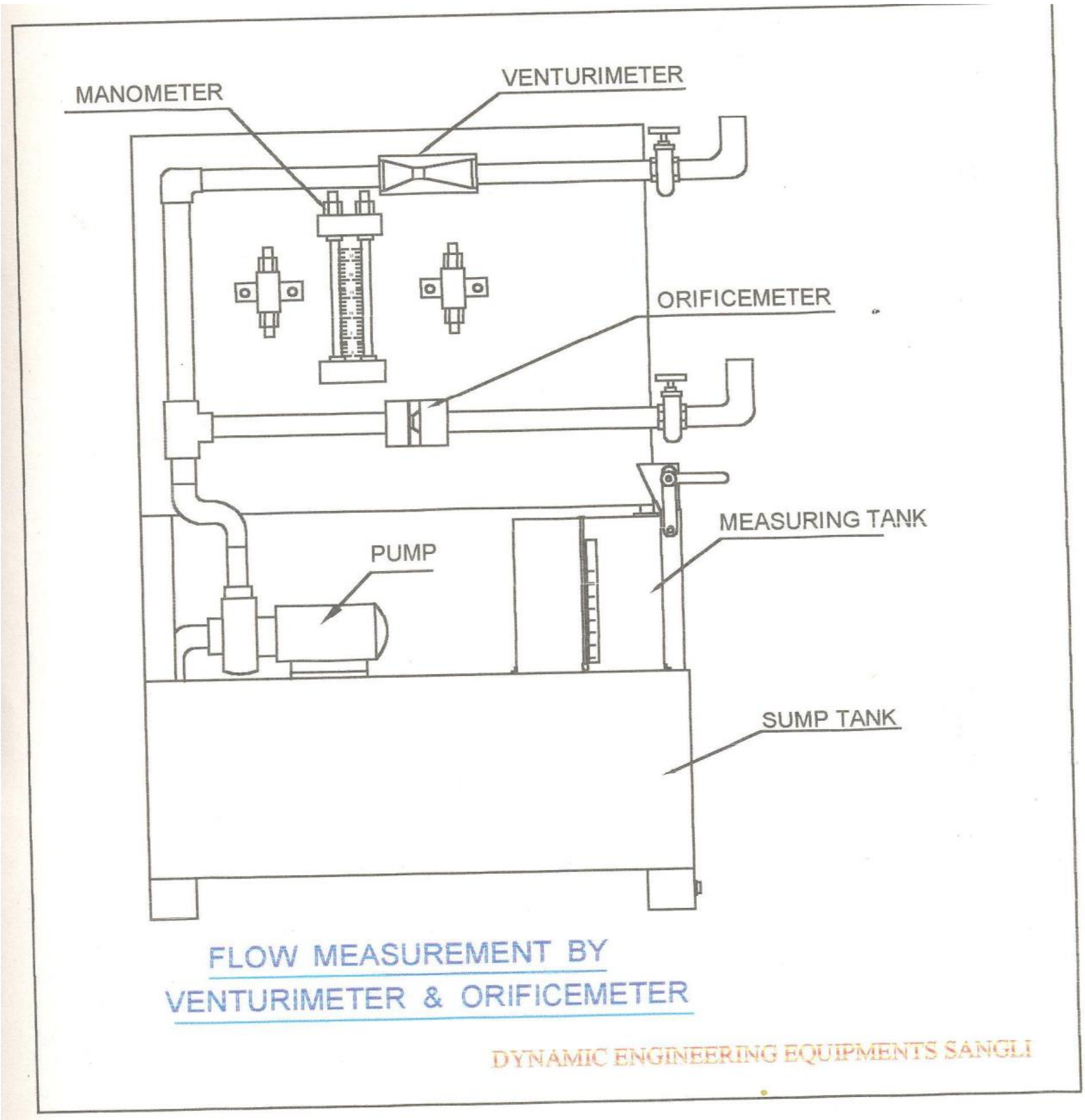
C_d =

Result:-

1. Calibrated values of coefficient of discharge for venturimeter is __________

Precautions:-

1. Operate manometer valve gently while removal of air bubble so that mercury in manometer does not run away with water.
2. Do not close the outlet valve completely.
3. Drain all the water after completion of experiment.


MANOMETER
VENTURIMETER
ORIFICEMETER
MEASURING TANK
PUMP
SUMP TANK
FLOW MEASUREMENT BY
VENTURIMETER & ORIFICEMETER
DYNAMIC ENGINEERING EQUIPMENTS SANGLI

Experiment No.___________

AIM : To Determine the Coefficient of Discharge (Cd) for Orificemeter.

APPARATUS : Orificemeter, pipe line, supply valve, manometer with mercury, collecting tank.

THEORY:

Venturimeter are widely used for determination of flow of fluid.It consists of a flat circular plate which has a circular sharp edged 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 differential manometer is connected at the 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 down stream side from the orifice plate.

EXPERIMENTAL PROCEDURE:

1. Check all the clamps for tightness.
2. Open the gate valve and start the flow.
3. Open the outlet valve of the orificemeter..
4. First open air cocks then open the orificemeter cocks, remove all the air bubbles and close the air cocks slowly and simultaneously so that mercury does not run away into water.
5. Close the gate valve of measuring tank and measure the time for 10 liters water discharge and also the manometer difference.
6. Repeat the procedure by changing the discharge for orificemeter.

OBSERVATIONS:

Sr. No.	Manometer difference h (m)	Time for 10 liter water discharge t (sec.)
1		
2		

Actual discharge, $\mathbf{Q_a = \frac{0.01}{t}\ m^3/sec}$

$\mathbf{Q_a =}$

Let H be the water head across manometer in, m.

Therefore, H= Manometer difference (Sp. Gravity of mercury – sp. Gravity of water)

Or, H = Manometer difference x (13.6-1)=12.6 x h

A = cross sectional area at inlet to orificemeter = 3.14×10^{-4} m^2
a = cross sectional area to orificemeter = 1.54×10^{-4} m^2
Therefore, **Theoretical discharge,**

$$Q_{th} = \frac{A.\ a.\ \sqrt{2gH}}{\sqrt{A^2 - a^2}}$$

Or , $Q_{th} = 0.00277 \sqrt{h}$ **m^3/s------ (h in mtr.)**

Coefficient of discharge $C_d = \frac{Q_a}{Q_{th}}$

Coefficient of discharge $C_d = \frac{Q_a}{Q_{th}}$

C_d = ________

C_d =

RESULT: The average Co-efficient of discharge Cd for orifice meter from calculations is found to be __________.

Precautions:-
1. Operate manometer valve gently while removal of air bubble so that mercury in manometer does not run away with water.
2. Do not close the outlet valve completely.
3. Drain all the water after completion of experiment.

Experiment No.-_____

FLOW THROUGH A RECTANGULAR NOTCH

AIM : To Study the coefficient of discharge of a Rectangular notch.

APPARATUS : Rectangular Notch, collecting tank, hook guage, stop clock etc.

The apparatus consists of a channel of 2m long and 0.6 m wide. The supply to the channel is taken from the bottom, at one end of channel. At the other end a Rectangular notch is fitted. Upstream from the face of notch a guage well is provided where a hook gauge is fitted.

THEORY : The notch is a standard device for the measurement of flow in open, channels. It is an obstruction in the channel that causes the water to raise behind the notch and then flow over it. By measuring the height of upstream liquid surface, the rate of flow is determined. The trapezoidal notch has an opening of the Rectangular shape and may be regarded as a combination of a rectangular and a triangular notch.

This type of a Rectangular notch in which the sides have a slope of I horizontal in 4 vertical is known as cippolletti notch. This claims to have an advantage over a rectangular notch and that is "the decrease in discharge due to end contractions is balanced by the discharge through the triangular portion and that a rectangular notch formula can then be used to compute the discharge.

EXPERIMENTAL PROCEDURE : The following steps are to be carried out in a sequential order to determine the 'Cd' of a Trapezoidal Notch.

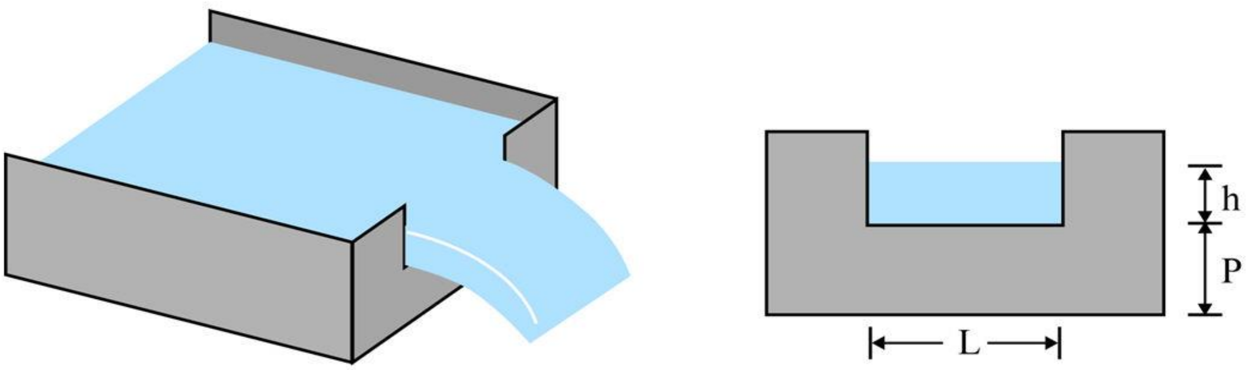
1. The inlet supply valve is opened. Water flows into the channel ad spills over trapezoidal notch.

2. Now the supply valve is closed, e water is allowed to flow over the Trapezoidal Notch f e water level is in level with the sill or crast of the Trapezoidal & notch, i.e, the water just ceases to spill over the crest. This is called the crest level, and the reading is noted down with the help of hook gauge.

3.Now the inlet supply valve is opened, so that water spills over the Trapezoidal notch, with a certain head above the crest level. This reading is noted down after attaining steady state. The difference between the above noted reading and crest level reading gives the head of water flowing over the Trapezoidal Notch.

4.The actual discharge flowing over the Trapezoidal Notch can be determined by noting down the time taken for a certain rise of water level in the collecting tank.

5.Steps 3 and 4 are repeated six times, to get six set of observations



Rectangular Weir

OBSERVATIONS:

Actual discharge, $Q_a = \frac{V}{t} = \frac{AH}{t}$

Theoretical Discharge, $Q_{th} = \frac{2}{3} b\sqrt{2.g}.(H)^{3/2}$

Where, V = Volume of water collected in tank

t = Time required for 10lit rise of water

A = Area of Notch

H = Head of water over sill

b = Width of Notch

Coefficient of discharge $C_d = \frac{Q_a}{Q_{th}}$

Base width for Trapezoidal Notch L = 10 cm

Plan area of collecting tank 'A' = 89 x 89 cm^2 7921 cm^2

Sill level reading, S= 13.2 cm.

SAMPLE CALCULATIONS*:*

Actual discharge , Qa = ...cm^3 / sec

The critical discharge = Qth =........cm^3 / sec

Coefficient of discharge = Cd =.......

RESULT :

Coefficient of discharge for rectangular notch has been successfully studied

Experiment No.-____

FLOW THROUGH A V- NOTCH

Aim :- To Study the coefficient of a V-notch.

Apparatus :- Measuring tank, stop watch, supply pump, hook gauge

The apparatus consist of a channel 2 meter long and 0.6 m wide, This supply to the channel is taken from the bottom, at one end of the channel. At the other end a V-Notch is fitted. Upstream from the face of the notch a gauge well is provided a hook gauge is fitted.

THEORY :

A weir is an obstruction placed in the liquid passage over which the liquid flow. It is used measure the rate of flow. A notch is a plate weir. The sheet of liquid flowing over the weir is called the nappe or vein. A hook gauge is used to measure the head over the crest. In triangular or V-Notch the flow is through the V-shaped opening.

1) The inlet supply valve is opened. Water flows into the channel and spills over the V-notch.

2) Now the supply valve is closed, and the water is allowed to flow over the V-notch till the water level is in level with the still or crest of the V-notch i.e, the water just ceases to spill over the crest. This is called the crest level of the V-notch and the reading is noted down with the help of hook gauge.

3) Now in inlet supply valve is opened, so that water spills over the V-notch, with a certain head above the crest level. This reading is noted down after attaining steady state. The difference between the above noted reading and crest level reading gives the head water flowing over the V-notch.

4) The actual discharge flowing over the V-notch can be determined by noting down the time taken for 10cm rise of water in the collecting tank.

5) Steps 3 and 4 are repeated six times, to get set of observations.

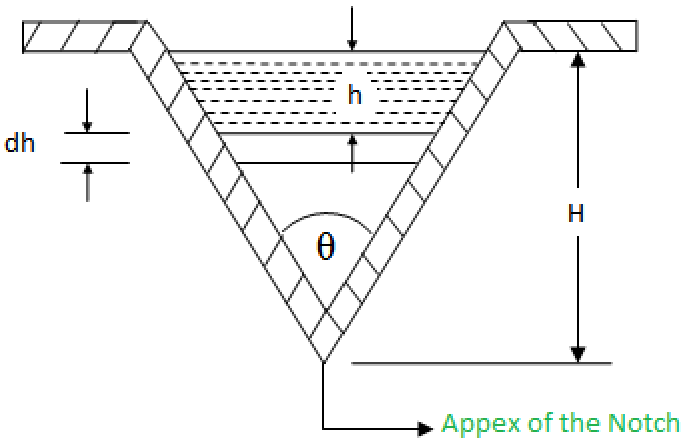


Fig : Triangular Notch

OBSERVATIONS:

Actual discharge, Qa = $\frac{V}{t} = \frac{AH}{t}$

Theoretical Discharge, **Qth = 8/15 (tan(ɵ/2))$\sqrt{2.g}$ (H)**

Where, V = Volume of water collected in tank

t = Time required for 10lit rise of water

A = Area of Notch

H = Head of water over sill

b = Width of Notch

Coefficient of discharge C_d = $\frac{Q_a}{Q_{th}}$

Result: Coefficient of discharge of triangular notch has been successfully studied.

Experiment No.-____

Aim:- To determine the coefficient of discharge of orifice and mouthpiece.

Theory:- An orifice is an opening made in the side or bottom of tank, having a closed perimeter, through which the fluid may be discharged. A mouthpiece is short tube fitted to s same size circular opening provided in a tank so that fluid may be discharged through it. Orifice and mouthpiece are used to measure the rate of flow of liquid. The apparatus is designed to measure the coefficient of discharge of orifice and mouthpiece.

Apparatus:- The apparatus consist of a supply tank, at the side of which a universal fixture for mounting orifice or mouthpiece is attached. A centrifugal pump supplies the water to supply tank. Head over the orifice/mouthpiece is controlled by a bypass valve provided at pump discharge. A measuring tank is provided to measure the discharge. A gauge for measuring X and Y coordinates of jet from the orifice is provided, which is used to calculate Cv of orifice.

Procedure:-

I) Orifice:

1. Fill up sufficient water in sump tank & supply tank, upto the level of orifice fixture.
2. Fit the required orifice to the tank.
3. Start the pump. Adjust the supply valve. Wait for some time for water level in supply tank to become steady.
4. When water level become steady, note down time required for 10 lit. level rise in measuring tank.
5. Measure X and Y coordinates of two points in jet , one of which should be closed to orifice and the other away from the orifice.
6. Repeat the procedure for different heads and for the other orifice.

II) Mouthpiece:

1. Fit the required mouthpiece and start the pump.
2. When water level in supply tank becomes steady, note down the time required for 10 lit. level rise in measuring tank.
3. Repeat the procedure for different heads and different mouthpiece & complete the observation table.

Observation Table:-

1. Orifice diameter:-__________

Sr. No.	Head m	Time for 10 litres level rise in measuring tank, t (sec)	X1 cm	Y1 cm	X2 cm	Y2 Cm

2.Mouthpiece:-

Sr. No.	Mouthpiece used	Head m	Time for 10 litres level rise in measuring tank, t (sec)

Calculations:-
1. Orifice:

1. Diameter of orifice, d = m
Therefore, area of orifice, A = (∏/4) d^2 = m^2
Head over orifice, h = m
Therefore, theoretical discharge, Qth = A $\sqrt{2gh}$ m^3/sec.

2. Actual discharge,
Qact = 0.01/t m^3/sec

3. Coefficient of discharge,
Cd = Qact/Qth

4. Coefficient of velocity,
Let X = X2-X1 & Y = Y2-Y1

Then, Cv = $\sqrt{X^2 / 4.h.Y}$
Where, h = head over the orifice, m

2. Mouthpiece:

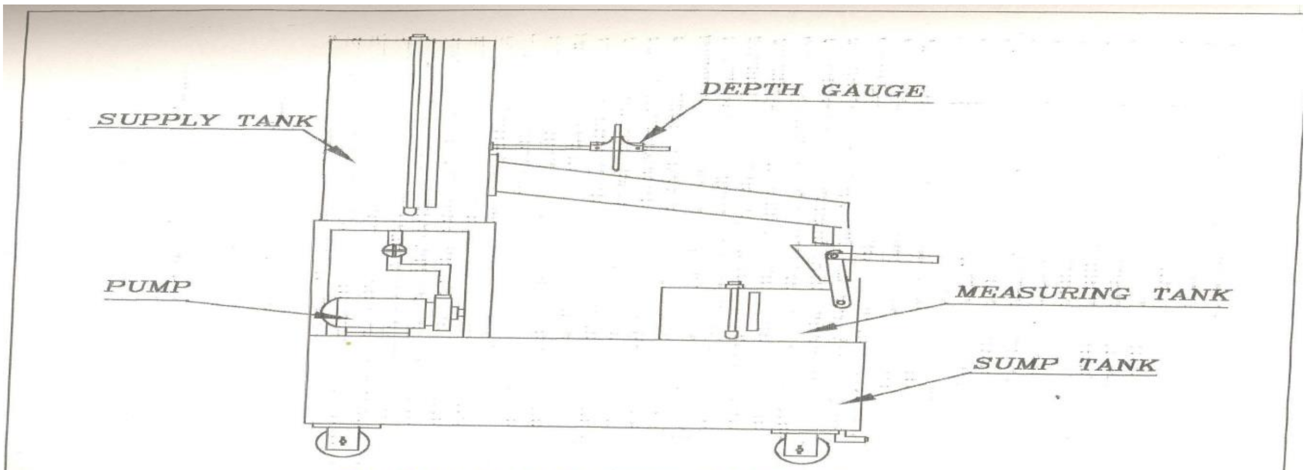
1. Diameter of orifice, d = m
Therefore, area of orifice, A = (∏/4) d^2 = m^2
Head over orifice, h = m
Therefore, theoretical discharge, Qth = A $\sqrt{2gh}$ m^3/sec.

2. Actual discharge,
Qact = 0.01/t m^3/sec

3. Coefficient of discharge,
Cd = Qact/Qth

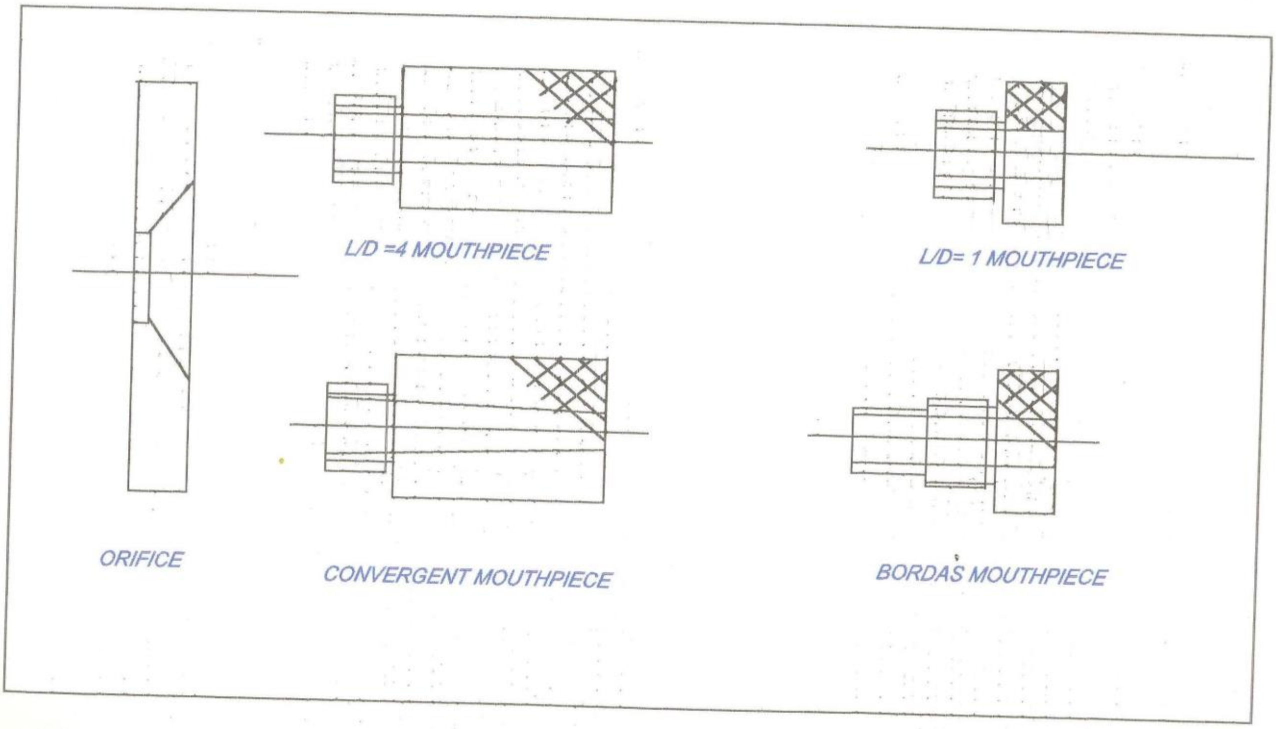
Result: The mean values of hydraulic coefficient are as follows:

1) Coefficient of discharge for Orifice is Cd =
2) Coefficient of velocity for Orifice is Cv =
3) Coefficient of discharge for mouthpiece is Cd =



FLOW THROUGH ORIFICE &
MOUTHPIECE APPARATUS

DYNAMIC ENGINEERING EQUIPMENTS SANGLI.



EXPERIMENT NO:_______________.

Aim:- To determine losses in pipe friction

Apparatus:- The apparatus consist of four pipes with inner diameters 23 mm G.I. pipe, 16.5 mm G.I. pipe, 14 mm copper and 13 mm aluminium pipe, so that loss of head can be compared for different diameters and different materials. A flow control valve is provided at outlet of pipes. This enables experiment to be conducted at different flow rates i.e at different velocity.
Tappings are provided along the length of pipes, so that drop of head can be visualized along the length of pipe. Each pipe is provided with valve at outlet which enables heads to control.

Procedure:-
1. Fill up water in the sump tank (This water should be free of any oil content).
2. Open all the outlet valves and start the pump.
3. Check for leakages by closing three of outlet valves, for each pipe and correct the leaks, if any.
4. Open the outlet valves of the pipe to be tested.
5. Remove all the bubbles from manometer and connecting pipes.
6. Reduce the flow. Adjust outlet valves, so that water heads in manometer are to the readable height.
7. Note down the heads and flow rate.
8. Now, increase the flow and accordingly adjust the outlet valve, so that water will not overflow. Note down heads and flow.
9. Repeat the procedure for other pipes.
(Note:- During measuring the heads, slight variation may occur due to voltage changes, valves etc. in such cases average readings may be taken)

Observation Table:-

Sr. No.	Pipe Type	Head Drop (h) (m)	Flow rate t sec (Time for 10 lit. Rise in sec.)
1	23 mm G.I. pipe		
2	16.5 mm G.I. pipe		
3	14 mm Copper pipe		
4	13 mm aluminum pipe		

Calculations:-
1) Φ 23 mm G.I. Pipe
Area of pipe, $\mathbf{A = \frac{\prod}{4} x\, D^2 \quad m^2}$

$= \_\_\_\_\_\_\_\_ \ \mathbf{m^2}$

Discharge, $\mathbf{Q} = \dfrac{\mathbf{0.01}}{\mathbf{t}}$ **m³/sec**

Q =

Velocity of water, $\mathbf{V} = \dfrac{\mathbf{Q}}{\mathbf{A}}$ **m/sec**

V =

Let f be the coefficient of friction. Test length of pipe is 1 meter.
For 1 meter length, drop of head h_f
Therefore, h_f = manometer difference
According to Darcy's Weish batch equation,

$$h_f = \frac{f.L.V^2}{2.g.d}$$

Where, f = coefficient of friction.
L= Length of pipe = 1m
V= velocity of water m/sec.
g = gravitational acceleration = 9.81 m/s^2
d = Inside diameter of pipe m

Then,

$$f = \frac{2.\,h_f.g.d}{L.V^2}$$

The value of coefficient of friction is not constant and depends upon roughness of pipe inside surface and Reynold's number. Any oil content in water also affects value of f
(Repeat the same procedure for other pipes)

Conclusion:-

1. Loss of head due to friction is proportional to length of pipe and square of velocity.
2. Loss of head is inversely proportional to inside diameter of pipe.

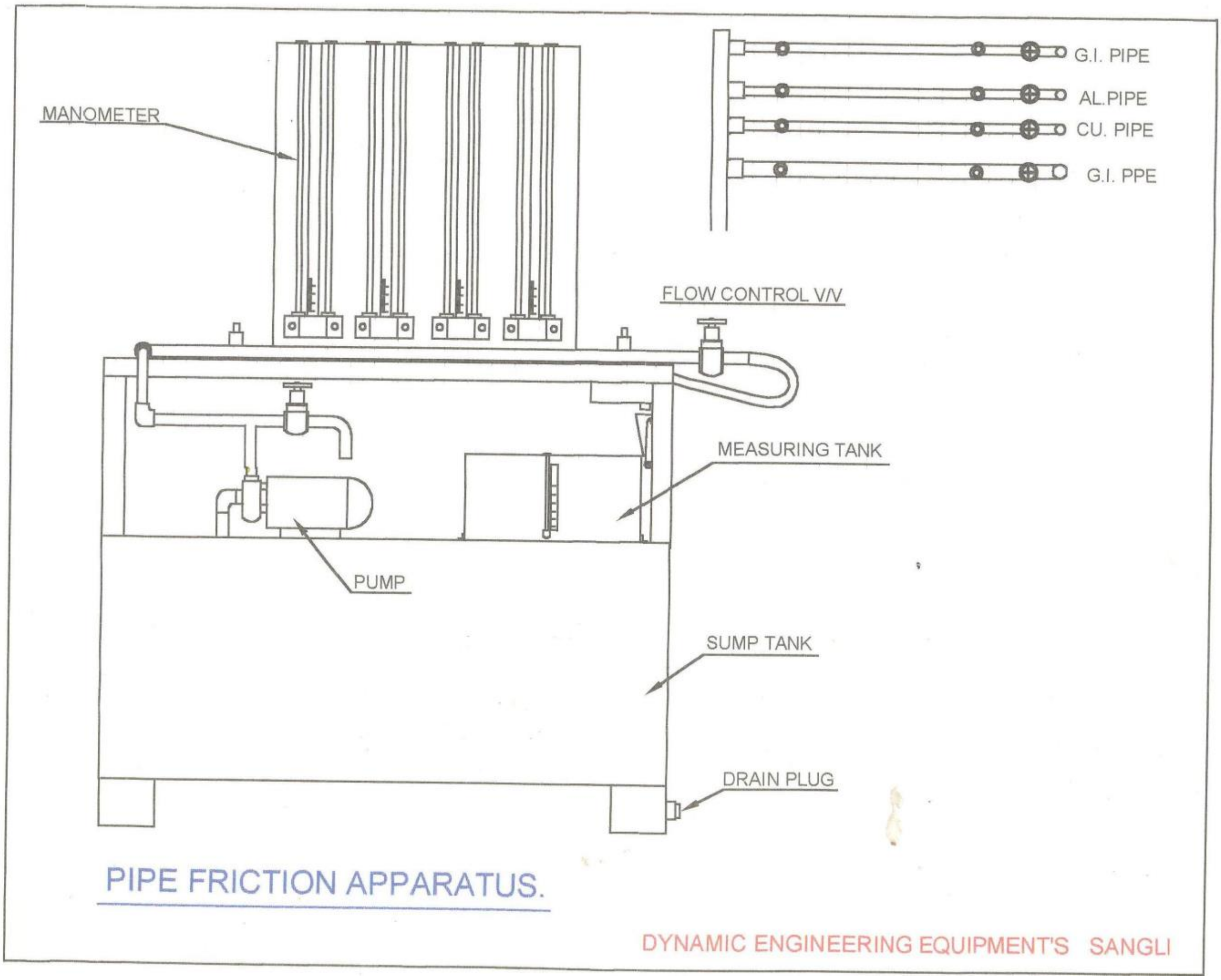
3. Average value of f for:

a) 23 mm G.I. pipe =______________________

b) 16.5 mm G.I. pipe =____________________

c) 14 mm Copper pipe =___________________

d) 13 mm aluminium pipe =_______________


MANOMETER
G.I. PIPE
AL.PIPE
CU. PIPE
G.I. PPE
FLOW CONTROL V/V
MEASURING TANK
PUMP
SUMP TANK
DRAIN PLUG
PIPE FRICTION APPARATUS.
DYNAMIC ENGINEERING EQUIPMENT'S SANGLI