SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF AGRICULTURE ENGINEERING

III SEMESTER

AG3365 - FLUID MECHANICS LABORATORY

Regulation – 2023

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Prepared by

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PREFACE

This instruction manual has been prepared by the department of civil engineering to facilitate instructions during practical classes and further to be used as a reference manual by the agricultural engineering students of this college. These manual covers explanation of experiments included in the latest syllabus of autonomous regulation in fluid mechanics laboratory for the B.E degree course. Any suggestions for the improvement of the manual will be gratefully received.

Dr. E. Maheswari,

AG3365 FLUID MECHANICS LABORATORY **L P T C**
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OBJECTIVES:

- To have a knowledge on flow measurements using various devices.
- To give hands on experience on the flow through different types of notches.
- To gain experimental knowledge on computation of major losses in pipes.
- To train students on determination of minor losses in pipes.
- To study the characteristics of various pumps.

LISTOFEXPERIMENTS

1. FLOWMEASUREMENT
    - Calibration of Rotameter
    - Flow through Venturimeter
    - Flow through a circular Orifice
    - Determination of mean velocity by Pitottube
    - Flow through a Triangular Notch
    - Flow through a Rectangular Notch
2. LOSSES IN PIPES
    - Determination of friction coefficient in pipes
    - Determination of losses due to bends, fittings and elbows

OUTCOMES:

- The students will be able to measure flow through pipes.
- The students will be able to measure flow in open channel.
- The students will be able to compute the major and minor losses in pipes.
- The students will be able to study the characteristics of pumps.
- The students will be able to analyse the performance of pumps.

TOTAL: 30 PERIODS

REFERENCEBOOKS:

1. “Hydraulic Laboratory Manual”, Centre for Water Resources, Anna University,2004.

2. Modi P.N. and Seth S.M.,“Hydraulics and Fluid Mechanics”, Standard Book House,NewDelhi, 2000.

3. Subramanya,K.,“Flow in Open Channels”, Tata McGraw- HillPub.Co.1992.

4. Subramanya, K., “Fluid Mechanics”,TataMcGraw-HillPub. Co.,New Delhi,1992.

LISTOFEQUIPMENTSREQUIRED

- Rotameter–1no.
- Venturi meter–1no.
- Orifice meter–1no.
- Pitot tube–1no.
- Bernoulli's theorem apparatus–1no.
- Triangular notch and rectangular notch–1each (with a lined open channel setup)
- Coefficient of friction apparatus
- Pipe setup with bends, fittings and elbows for estimating minor losses
- Centrifugal pump, Reciprocating pump, Submersible pump, Jet pump–1 each
- Collecting tank, Stop watch–1no.foreachexperiment.

LABORATORY SAFETY PROCEDURE

Safety

Safety is our prime concern at all times and you will be asked to leave the lab if your conduct is deemed to compromise safety regulations. Do not perform unauthorized experiments by yourself. Never leave unattended an experiment that is in progress. The students are strictly advised to wear shoes when they come to the laboratory as a measure of safety.

Do's

1. Bring observation note books, lab manuals and other necessary things for the class.
2. Check the instruments for proper working conditions while taking and returning the same.
3. Thoroughly clean your laboratory work space at the end of the laboratory session.
4. Maintain silence and clean environment in the lab

Dont's

1. Do not operate the machines without the permission of the staff
2. Do not put hands or head while equipment is in running condition.
3. Do not fix or remove the test specimen while the main is switch on.

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EX.NO: 1 DATE:………

CALIBRATION OF ROTAMETER

AIM:

To determine the Co-efficient of discharge of the Rotameter and to obtain the calibration error.

APPARATUS REQUIRED:

- Rotameter fitted with pipe line setup
- Stop watch
- Measuring scale & Tape

THEORY:

The Rotameter is the most popular flow meter. It consists essentially of a plummet or float which is free to move up or down in a vertical slightly tapered tube having its small end down. The fluid enters the lower end of the tube and causes the float to rise until the annular area between the tube and the float is such that the pressure drop across this construction is just sufficient to support the float. Typically, the tapered tube is of glass and caries etched upon it a nearly linear scale on which the position of the float may be usually noted as an indication of the flow.

Rotameter have proved satisfactory both for gasses and for liquids at high andlow pressures. Rotameter required straight runs of pipe before or after the point of installation. Pressure losses are substantially constant over the whole flow rang. In experimental work, for greatest precision, a Rotameter should be calibrated with the fluid which is to be entered. However, most modern Rota meters are precision-mode such that their performance closely corresponds to a mater calibration plate for the type in question.

FORMULA:

Co-efficient of discharge

$$C_d = \frac{\text{Actual discharge}}{\text{Theoretical discharge}} = \frac{Q_a}{Q_t}$$

OBSERVATION:

Internal plan dimensions of the collecting tank

Length of the tank (L) = --------------- cm

Breath of the tank (B) = ---------------- cm

Sl.No	Rotameter Reading *Kg/cm²*	Time For 5 CM raise of water (t) *sec.*	Actual Discharge (Qact) *m³/sec.*	Actual Discharge (Qtheo) *m³/sec*	Co-efficient of Discharge (Cd)	Calibration error

Actual discharge,

$$Q_a = \frac{A*h}{t} \quad m^3/sec$$

Where,

A - Area of the measuring tank m2.

H - Rise of water level meters (say 5 cm)

t - Time in seconds for rise of water level (say 5 cm)

Theoretical discharge, Q_t = Rotameter reading × 1000 x 60 m^3/s

Model calculation

1. Actual discharge,

$$Q_a = \frac{A*h}{t} \quad m^3/sec = \text{-------------} \ m^3/sec$$

2. Theoretical discharge, Q_t = Rotameter reading × 1000 x 60 m^3/s

   = -------------- m^3/s

3. Co-efficient of discharge

$$C_d = \frac{Q_a}{Q_t}$$

= ------------

4. Calibration error

$$= \frac{Q_t - Q_a}{Q_t}$$

= ------------

PROCEDURE:

- Note the cross-section area of collecting tank.
- Slowly open the delivery valve of Rotameter.
- The actual discharge is measured with the help of Rotameter.
- Note down the value of Rotameter.
- The theoretical discharge is measured with the help of the Rotameter
- Refitted the above procedure for different values of Rotameter.

GRAPH

- Actual Q_a Vs Co-efficient of discharge.
- Actual Q_a Vs calibration of an error

RESULT:

• Average co-efficient of discharge (C_d) =

• Average calibration error =

Thus, the given Rotameter was calibration and connected at parameter.

VIVA VOCE QUESTIONS ROTAMETER

1. Define Rotameter

The rotameter is an industrial flowmeter used to measure the flowrate of liquids and gases.

2. What are the Advantages of rotameter?

A rotameter requires no external power or fuel, it uses only the inherent properties of the fluid, along with gravity, to measure flow rate, A rotameter is also a relatively simple device that can be mass manufactured out of cheap materials, allowing for its widespread use.

3.What are the Dis-advantages of rotameter?

Rotameters are not easily adapted for reading by machine; although magnetic floats that drive a follower outside the tube are available and Rotameters are not generally manufactured in sizes greater than 6 inches/150 mm, but bypass designs are sometimes used on very large pipes.

4. What is steady flow?

Flow doesn‟t vary with time. In steady flow, velocity of fluid is constant on every point at a specific time.

5. What is the application of Pitot-Static tubes

Pitot-Static tubes measures velocity at a point of fluid in a stream.

6. A magnetic flow meter will not properly measure? It is used to measure the flow rate of oil.

7. What is ROTAMETER?

The rotameter is an industrial flowmeter used to measure the flowrate of liquids and gases. The rotameter consists of a tube and float. The float response to flowrate changes is linear, and a 10- to-1 flow range or turndown is standard

8. What is the source of error in Rotameter?

The major source of error in rotameter is due to the variation of density of the fluid. Besides, the presence of viscous force may also provide an additional force to the float.

9. What is the working principle of Rotameter ?

Rotameter works as a constant pressure drop variable area meter.

10. Write the disadvantage of Rotameter Rotameter can be only be used in a vertical pipeline.

EX. NO:2 DATE: ………….

DETERMINATION OF COEFFICIENT OF DISCHARGE OF VENTURIMETER

OBJECTIVE:

To determine the coefficient of discharge for the venturimeter

APPARATUS REQUIRED:

- A venturimeter with known diameters at the mouth and throat fitted with stopcocks at the mouth and throat.
- A U-tube manometer containing mercury.
- Water measuring tank.
- A stopwatch. Theoretical discharge

THEORY:

Venturimeter is a device, which works on the principle of Bernoulli's equation. It is used for measuring the rate of flow of fluid through a pipe. It consists of these parts.

- A short converging part.
- Throat
- Diverging part

A U-tube manometer is connected to the pipe and through which shows the head difference between them. There will not be any datum head H the water is horizontal. Hence, the pressure head is equal to the velocity head. The main principle involved is that the pressure at throat has maximum due to decreasing cross section, which is measured by using manometer. Thus, we measure discharge as well as co- efficient.

FORMULA:

Co-efficient of discharge (C_d) = $\frac{Q_a}{Q_t}$

Theoretical Discharge, Q_t $= C_d * \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} * \sqrt{2gh}$ m^3/ sec

Where,

A_1 - cross sectional area of pipe, m^2
A_2 - cross sectional area of throat, m^2
d_1 - diameter of the pipe
d_2 - throat/orifice diameter
g - Acceleration due to gravity = 9.81 m/s^2
H - Total head = h*12.6

Co-efficient of discharge of venturimeter

S.No	Manometer Reading in (cm)			Total Head (cm)	Time taken 10cm rise of water level *(Seconds)*	Discharge (Q) m^3/sec		Co-efficient of discharge (Cd)
	h1	h2	H			Actual discharge (Qa)	Theoretical discharge (Qt)	

MODEL CALCULATIONS:

1. Total head ,

$$H = (h_1 – h_2) * 12.6$$

= ……… cm

2. Theoretical Discharge,

$$Q_t = C_d * \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} * \sqrt{2gh} \ m^3/sec$$

= ----------- m^3/sec

3. Actual Discharge,

$$Q_a = \frac{A*h}{t}$$ = ----------- m^3/sec

4. Co-efficient of discharge,

$$C_d = \frac{Q_a}{Q_t}$$

= --------------

Actual Discharge

$$Q_a = \frac{A*h}{t} \quad m^3/\,sec$$

Where,

A - Area of collecting tank (m^2)

R - Rise in water level of the collecting tank (cm)

t - Time for 'R' cm rise of water (sec)

PROCEDURE:

1. Check whether all the joints are leak proof and watertight.
2. Close all the pipes with cocks in the pressure feed pipes and manometer to prevent damage and over loading of the manometer.
3. Open the inlet value of the pipe. Switch on the pump and adjust and the control value to allow the meter to flow through Venturimeter.
4. Open the downstream and upstream cocks that connect the manometer to the Venturimeter for which the co-efficient of discharge is to be calculated.
5. Prime the manometer properly. Adjust the control value to maintain the flow and for the deserved rate of flow.
6. Measure the manometer head to find the venture discharge. Measure the time taken for 10mm rise in the collecting tank to find the actual discharge.
7. Calculate the co-efficient of discharge and repeat the procedure for the different flow rates.

GRAPH:

A graph is drawn between actual discharge vs √h by taking in X-axis and Qa in Y-axis

RESULT:

The co-efficient of discharge for the Venturimeter is found out and the necessary graph is plotted.

(i) From the table Cd =

(ii) From the graph Cd =

VIVA VOCE QUESTIONS VENTURIMETER

1. How the rate at which fluid flows through a closed pipe can be determined?

Either by Determining the mass flow rate or Determining the volume flow rate

2. What are the devices used for flow obstruction?

Orifice plate, Venturi tube and Flow nozzle and dall flow tube

3. Venturimeter is based on integral form of Euler's equation.

4. Which device is used to measure the discharge? Venturimeter

5. The Size of a venturimeter is specified by **pipe diameter**

6. What happens Venturimeter is placed in a pipe?

When a venturimeter is placed in a pipe carrying the fluid whose flow rate is to be measured, a pressure drop occurs between the entrance and throat of the venturimeter.

7.What an ideal flow of any fluid must satisfy?

It must satisfy continuity equation

8.Define Turbulent flow

Turbulent flow, type of fluid (gas or liquid) flow in which the fluid undergoes irregular fluctuations, or mixing, in contrast to laminar flow, in which the fluid moves in smooth paths or layers.

9.Define laminar flow.

In fluid dynamics, laminar flow (or streamline flow) occurs when a fluid flows in parallel layers, with no disruption between the layers.

10. what is the coefficient of discharge of venture?

Cd = 0.9 - 0.95.

EX NO - 3 **DATE ------------**

DETERMINATION OF COEFFICIENT OF DISCHARGE OF ORIFICE METER

AIM

To determine the coefficient of discharge (C_d) of the given orificemeter.

APPARATUS REQUIRED

1. Orificemeter with all accessories
2. Stop Watch
3. Meter Scale

THEORY

An orifice generally means an opening that allows something to pass. And, a flow meter is an instrument that measures the amount of liquid, gas, or vapour flowing through a pipe. Thus, the orifice meter in fluid mechanics is a type of flow meter used to measure the flow rate of fluids (liquids or gases) based on the principle of differential pressure measurement.

$$Q_t = C_d * \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} * \sqrt{2gh} \text{ m}^3/\text{ sec}$$

Where,

a_1 = Area of inlet

a_2 = Area of orifice

g = Acceleration due to gravity

h = Orifice head in terms of flowing liquid

= [$h_1 - h_2$]

h_1 = Manometric head in one limb of the manometer

h_2 = Manometric head in other limb of the manometer

Actual Discharge, $Q_a = \frac{A*H}{t}$

Where,

A = Internal plan area of collecting tank

H = Rise of liquid

t = Time of collection

Co-efficient of orificemeter,

$$C_d = \frac{Q_a}{Q_t}$$

Procedure:

1. First open the inlet gate valve of the apparatus. Adjust the control valve kept at the exit end of the apparatus to a desired flow rate and maintain the flow steadily.

2. Check whether all the joints are leak proof and water tight. Fill the manometer to about half the height with mercury.

3. While taking readings, close all the cocks in the pressure feed pipes except the two (Down-stream and upstream) cocks which directly connect the manometer to the required flow meter, for which the differential head is to be measured. (Make sure while taking reading that the manometer is properly primed. Priming is the operation of filling the manometer upper part and the connecting pipes with water and venting the air from the pipes). Close all the cocks, pressure feed pipes and manometer to prevent damage and over loading of the manometer.

4. Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.

5. Check proper electrical connections to the switch, which is internally connected to the motor.

6. Start the motor keeping the delivery valve close. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.

7. By regulating the valve control the flow rate and select the corresponding pressure tapings (i.e. of orifice meter).

8. Make sure while taking readings, that the manometer is properly primed. Priming is the operation of filling the manometer s upper part and the connecting pipes with water by venting the air from the pipes. Note down the difference of head “h” from the manometer scale.

9. Note down the time required for the rise of 10cm (i.e. 0.01m) water in the collecting tank by using stop watch.

Co-efficient of discharge of orificemeter

S.No	Manometer Reading in (cm)			Total Head *(cm)*	Time taken 10cm rise of water level *(Seconds)*	Discharge (Q) m^{3}/sec		Co-efficient of discharge (Cd)
	h1	h2	H			Actual discharge (Qa)	Theoretical discharge (Qt)	

MODEL CALCULATIONS:

1. Total head,

$$H = (h_1 - h_2) * 12.6$$

$$= \ldots\ldots\ldots \text{ cm}$$

2. Theoretical Discharge,

$$Q_t = C_d * \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} * \sqrt{2gh} \text{ m}^3/\text{ sec}$$

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

3. Actual Discharge,

$$Q_a = \frac{A*h}{t} \quad m^3/\text{ sec}$$

= ----------- m^3/sec

4. Co-efficient of discharge,

$$\mathbf{C_d = \frac{Q_a}{Q_t}}$$

= **---------------**

Actual Discharge

$$Q_a = \frac{A*h}{t} \quad m^3/\text{ sec}$$

GRAPH:

A graph Q_a vs $\sqrt{h}$ is drawn taking $\sqrt{h}$ on X axis

RESULT:

Coefficient of discharge of the Orificemeter (C_d)

1. Theoretically =
2. Graphically =

Ex no : 4 Date:

Flow through a small orifice

Aim: -

1. To investigate the discharge characteristics of circular orifices subjected to a constant head.

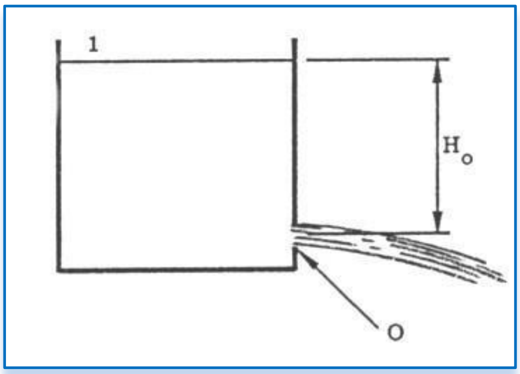
2. To investigate the trajectory of a horizontal jet issuing from an orifice and hence determine the coefficient of velocity for the orifice.

Apparatus Required: -

1. Constant head inlet tank (Figure 1).
2. Circular orifices with different diameters.
3. Hook gauge and scale.
4. Hydraulic bench.

Theory: -

Consider a small orifice in the side of a vessel with the head of water above the orifice kept constant.



Discharge through an orifice

Applying Bernoulli's theorem between the surface of the water 1 and the orifice O yields

$$\text{H is constant} \Rightarrow v_A = 0$$

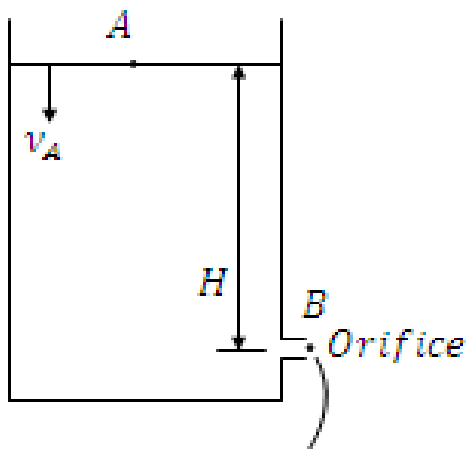
$$TH_A = TH_B + h_{L_{A-B}}$$

$$0 + 0 + H = \frac{v_B^2}{2g} + 0 + 0$$

$$\Rightarrow \boxed{v_B = \sqrt{2gH}}$$

$$\therefore Q_{th} = A\sqrt{2gH}$$

$$Q_{act} = \frac{volume}{time} = C_d A\sqrt{2gH}$$



Two reasons for the difference between theoretical and actual discharge.

First: The velocity of jet is less than the velocity calculated because there are losses of energy between point A and B.

$$V_{actual} = C_v V_{Theor} = C_v \sqrt{2gh}$$

C_v is the coefficient of velocity

Second: The stream line of the orifice contract reducing the area of flow. (Vena Contraction).

$$A_{actual} = C_c * A$$

Where. C_c is the coefficient of contraction.

$$Q_{actual} = C_v . C_c . A\sqrt{2gh}$$

$$Q_{actual} = C_d A\sqrt{2gh}$$

C_d in the range [0.6-0.65]

Consider the trajectory of a jet formed by the discharge of water through an orifice mounted in the side of a tank. The jet will be subjected to a downward acceleration of g due to gravity. Taking the origin of co-ordinates at the vena-contracta and applying the laws of motion in the horizontal and vertical planes then ignoring any effect of air resistance on the jet.

$v = v_o + at$

$v^2 = v_o{}^2 + 2ax$

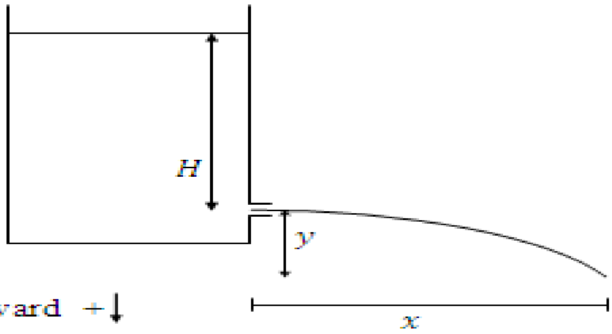
$x = v_o t + \frac{1}{2}at^2$

In x-direction:

$x = vt \Rightarrow t = \frac{x}{v}$

In y-direction:

$y = v_{oy}t + \frac{1}{2}gt^2$, assuing positive is downward $+\downarrow$



$y = \frac{1}{2}gt^2$

$y = \frac{1}{2}g\left(\frac{x}{v}\right)^2 = \frac{1}{2}g\frac{x^2}{v^2}$

$$v = \sqrt{\frac{1}{2}g\frac{x^2}{y}} \Rightarrow \boxed{v_{act} = \sqrt{\frac{gx^2}{2y}}} = \frac{x}{\sqrt{\frac{2y}{g}}}$$

Procedures:

1. Fit the 5mm diameter orifice into the side of the inlet head tank. Remove the overflow extension pipe. Start the pump and set up an inlet head of 25cm.
2. Measure the trajectory of the jet using the hook gauge. Record the horizontal and vertical distances.
3. Replace the overflow extension tube and establish an inlet head of 500mm. Measure the trajectory of the jet
4. Repeat the experiment using the 8mm diameter orifice.

Model Calculation

1. $X = c_v\sqrt{y}2\sqrt{H}$

   = -------------- m

2. $C_c = \frac{C_d}{C_v}$

   = ------------

Results:

1. Record the results on a copy of the result sheet for discharge characteristics.
2. For each result calculate the flowrate
3. Plot a graph of square root of the head against the flow rate for each orifice diameter, the results should lie on a straight line passing through the origin to confirm that:

$$Q \text{ vs } \sqrt{H}$$

4. Measure the slope of the line and hence calculate the coefficient of velocity from

$$Q = \frac{slope}{A\sqrt{2g}}$$

Table 1 Collecting tank Value

D (mm)				
H (cm)				
$\sqrt{H}$(m				
V (L)				
T (sec)				
Q (m^3/s)				

Table 2: Trajectory of horizontal jet

D (mm)				
H (cm)				
x (cm)	**Vertical distance below orifice center line y (cm)**			
Slope of graph				

Ex No : 5 **Date :**

DETERMINATION OF MEAN VELOCITY BY PITOT-TUBE

AIM

To determine co-efficient of discharge of the Pitot tube.

APPARATUS

1 Pitot tube
2 Pipe
3 Manometer
4 Stop watch
5 Collecting tank fitted with a valve

Theory

The pitot tube can be used to measure the velocity of water in an open channel as well as in a closed pipe. For an open channel, a simple pitot tube will serve the purpose. However for a closed pipe in which the water is flowing under pressure, it is necessary to measure the static pressure also. Then the velocity head will be equal to the total Pitot-tube reading minus the static pressure. The static pressure is measured by inserting another L-shaped tube with its end pointing towards the flow downstream. The water will be drawn in this tube by means of suction. If, now, the tubes are connected by an inverted U-tube manometer, the difference of water height 'h' will give the velocity head. Such an arrangement is known as ''Pitot-meter". The static pressure can also be measured by inserting the other end of inverted U-tube to the pipes.

A Pitot tube is fixed inside a pipe connected to a supply water tank. The Pitot tube is connected to an inverted water manometer. The flow rate in the pipe is measured from given collecting tank. The flow rate is varied by adjusting the delivery valve.

The following formulae are employed to find the theoretical velocity and Pitot tube coefficient

Theoretical Velocity $V_a = \sqrt{2gh}$

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

Where,

A = Internal plan area of collecting tank H

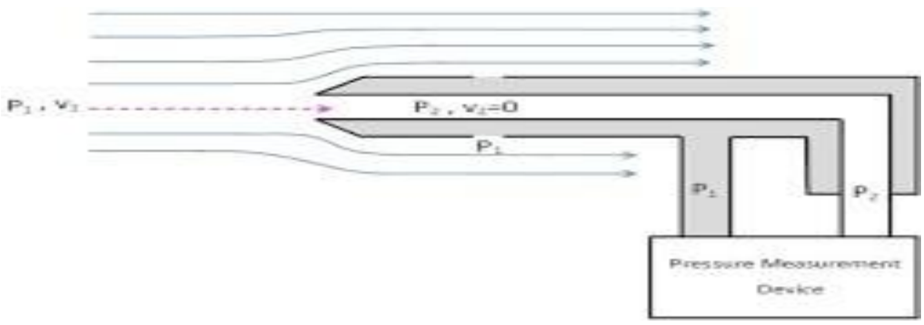
H = Rise of liquid in collecting tank

T = Time taken to collect liquid in the collecting tank

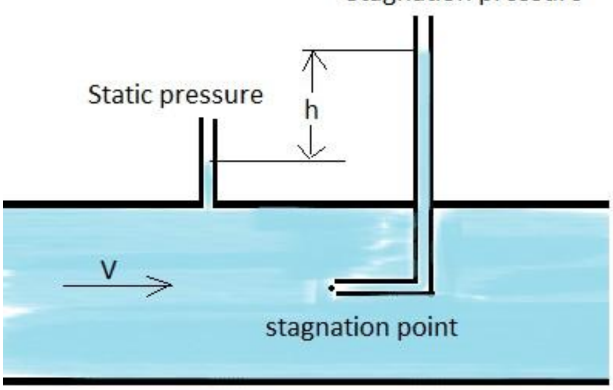
Actual velocity, $V_a = Q_a/a$

Error of the Pitot tube, $\Phi = V_a / V_{th}$

It is a device used for measuring the velocity of flow at any point in a pipe or a channel. It is based on the principle that if the velocity of flow at a point becomes zero, the pressure there is increased due to the conversion of the kinetic energy into pressure energy. In its simplest form, the Pitot-tube consists of a glass tube, bent at right angle as shown in figure below.

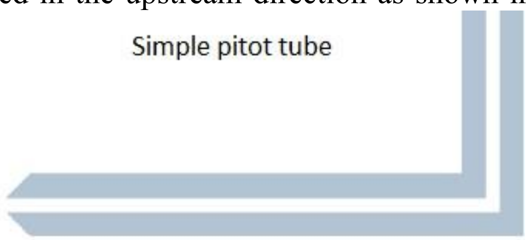


The lower end, which is bent through 90 is directed in the upstream direction as shown in



Simple pitot tube

Simple pitot tube



Pitot static tube

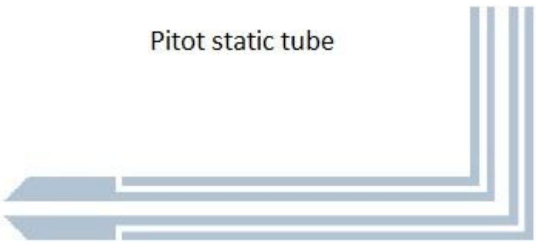


Figure. The liquid rises up in the tube to the conversion of kinetic energy in to pressure energy. The velocity is determined by measuring the raise of liquid in the tube.

Consider two points (1) and (2) at the same level in such a way that (2) is just at the inlet of the Pitot-tube and point (1) is far away from the tube.

Let

P_1 = intensity of pressure at point (1)

V_1 = velocity of flow at (1)

P_2 = pressure at section (2)

V_2 = velocity at point (1), which is zero

H = depth of tube in the liquid

h = rise of liquid in the tube above the free surface.

Applying Bernoulli's equations at point (1) and (2), we get

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

But $Z_1 = Z_2$ as points (1) and (2) are on the same line and $V_2 = 0$.

$\frac{P_1}{g}$ = pressure head at (1) = H

$\frac{P_2}{g}$ = pressure head at (2) = (h+H)

Substituting these values, we get

$$H + (V_1^2/2g) = (h+H)$$

This is theoretical velocity. Actual velocity is given by (V_1) act = $C_v \sqrt{2gh}$,

Where C_v = Co-efficient of Pitot-tube

Velocity of flow in a pipe by Pitot-tube

For finding the velocity at any point in a pipe by Pitot-tube, the following arrangements are adopted:

$$h = X\left(\frac{S_g}{S_o} - 1\right)$$

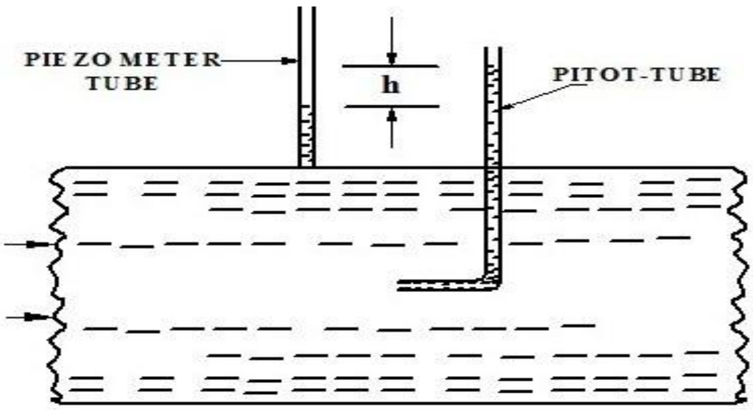


Fig. (b)

PROCEDURE

1. The diameter of the orifice and the internal plan dimensions of the collecting tank are measured.
2. The supply valve of the orifice tank is regulated and water is allowed to fill the orifice tank to a constant head (h)
3. The out let valve of the collecting tank is closed tightly and the time taken for "H" rise of water in the collecting tank is noted.
4. The above procedure is repeated for different heads and the readings are tabulated.

MODEL CALCULATIONS

1. Head calculation

$$h = X\left(\frac{S_g}{S_o} - 1\right)$$

= -----------------

$$X = h_1 - h_2$$

= -------

2. Velocity calculation

$$V_a = \sqrt{2gh}$$

= ------------

3. Discharge calculation

$$Q_a = \frac{A*h}{t} = ---------$$

4. Velocity Calculation

$$V_a = \frac{Q_a}{a} = \text{-----------}$$

5. Error in pitot tube

$$\Phi = \frac{V_a}{V} = \text{-----------}$$

GRAPHS

The following graph is drawn by taking V_a on y – axis and $\sqrt{h}$ in x- axis V_a vs $\sqrt{h}$.

RESULT

Error of the pitot tube, Φ = ----------------- (From experiment)

Error of the pitot tube, Φ = --------------------- (From Va vs graph)

OBSERVATIONS AND CALCULATIONS

Table 1. Results of flow through Prandtl Pitot tube

S.No.	Manometer reading, cm			$V = \sqrt{2gh}$	Time for 10 cm rise of water, T sec	$Q_a = \frac{AH}{T}$	$V_a = \frac{Q_a}{a}$	$\phi = \frac{V_a}{V}$
	h_1	h_2	$h = (h_1 \sim h_2)\left(\frac{S_m}{S} - 1\right)$					
1								
2								
3								
4								
5								

EX.NO: 6. DATE:………

FLOW THROUGH NOTCHES

AIM

To determine the coefficients of discharge of the rectangular, triangular and trapezoidal notches.

APPARATUS REQUIRED:

- Hydraulic bench Notches – Rectangular, triangular, trapezoidal shape.
- Hook and point gauge
- Calibrated collecting tank Stop watch

THEORY:

A notch is a sharp-edged device used for the measurement of discharge in free surface flows. A notch can be of different shapes – rectangular, triangular, trapezoidal etc. A triangular notch is particularly suited for measurement of small discharges. The discharge over a notch mainly depends on the head H, relative to the crest of the notch, measured upstream at a distance about 3 to 4 times H from the crest. General formula can be obtained for a symmetrical trapezoidal notch which is a combined shape of rectangular and triangular notches. By applying the Bernoulli Equation (conservation of energy equation) to a simplified flow model of a symmetric trapezoidal notch, theoretical discharge Q_{th} is obtained as:

$$Q_{th} = \frac{8}{15}\sqrt{2g}\ H^{5/2}\tan\frac{\theta}{2} + \frac{2}{3}\sqrt{2g}\ B\,H^{3/2} \qquad \text{-------------- (1)}$$

Where ‘H’ is the water head measured above the crest, ‘θ’ is the angle between the side edges and ‘B’ is the bottom width of the notch.

When θ=0, this equation is reduced and applicable for rectangular notch or when B=0 (no bottom width) it is applicable for triangular notch. Hence the same equation (1) can be also used for both rectangular and triangular notches by substituting corresponding values (ie θ=0 or B=0).

If Q_{act} actual discharge is known then coefficient of discharge Cd of the notch can be expressed as

$$Cd = Q_{act}/Q_{th.}$$

DESCRIPTION

In open channel hydraulics, weirs are commonly used to either regulate or to measure the volumetric flow rate. They are of particular use in large scale situations such as irrigation schemes, canals and rivers. For small scale applications, weirs are often referred to as notches and invariablyare sharp edged and manufactured from thin plate material. Water enters the stilling baffles which calms the flow. Then, the flow passes into the channel and flows over a sharp-edged notch set at the other end of the channel. Water comes of the channel in the form of a nappe is then directed into the calibrated collection tank. The volumetric flow rate is measured by recording the time taken to collect a known volume of water in the tank.

A vertical hook and point gauge, mounted over the channel is used to measure the head of the flow above the crest of the notch as shown in Fig. Hook gauge can be moved vertically to measure vertical movements.

FORMULA:

Co-efficient of Discharge = $\frac{Q_{act}}{Q_{th}}$

a) RECTANGULAR NOTCH

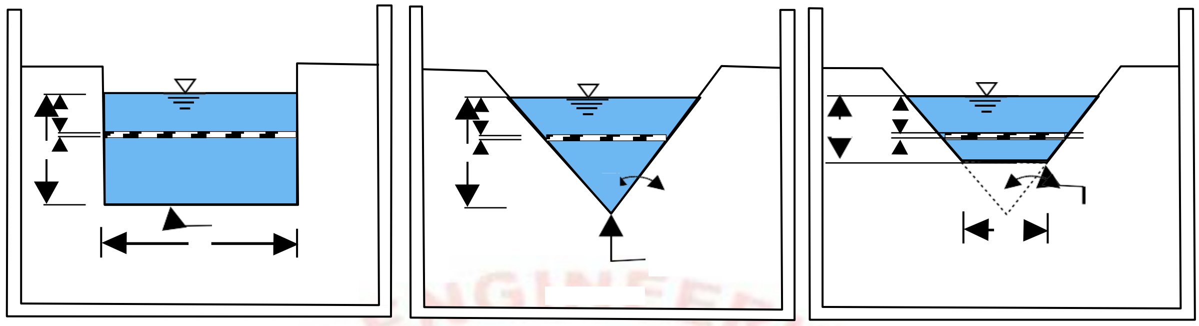
$$Q_{act} = \frac{Volume}{time}$$

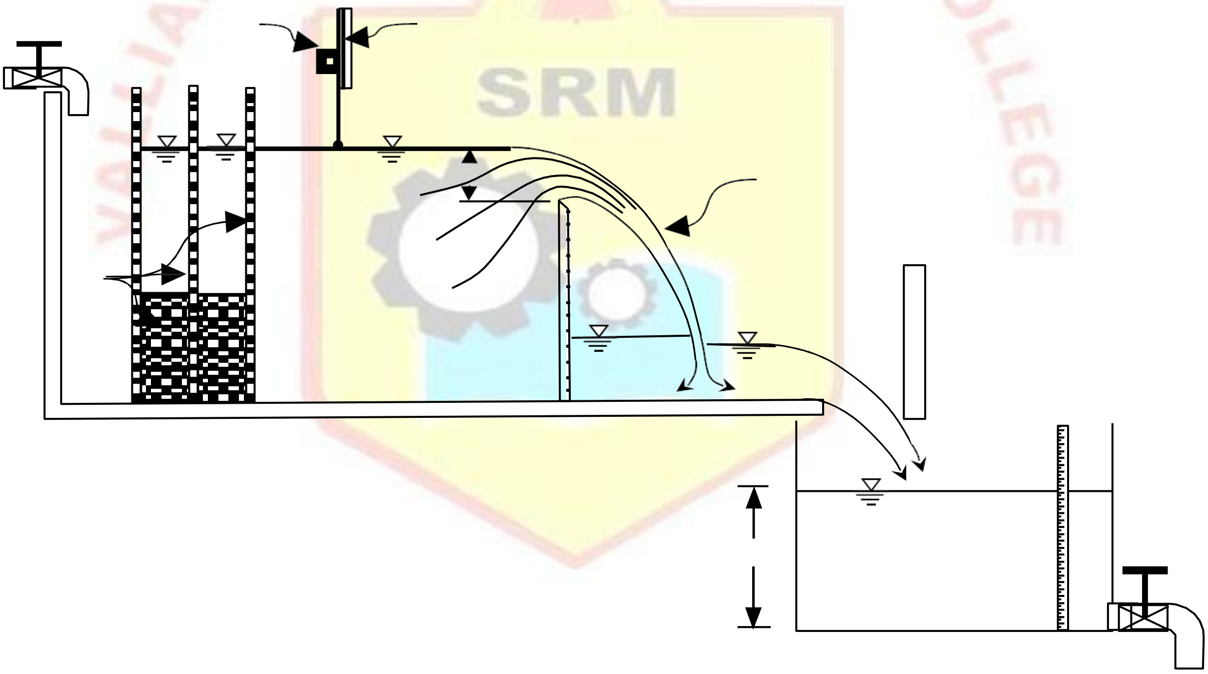
$$Q_{th} = \frac{2}{3}\sqrt{2g}\,B\,H^{3/2}$$

b) TRIANGULAR NOTCH

$$Q_{act} = \frac{Volume}{time}$$

$$Q_{th} = \frac{8}{15}\sqrt{2g}\,H^{5/2}\tan\frac{\theta}{2}$$





OBSERVATION AND COMPUTATIONS – I

A) For Rectangular notch Notch width 'B' = m

Initial reading of hook and point gauge h_0=

Area of the collecting Tank A_{ct} = -------- m^2

Tabulation -1: Determination of Cd of rectangular notch

No.	*Theoretical Discharge Measurement*			*Actual Discharge Measurement*				*Cd*
	h1 (m)	H (m)	Theoretical Discharge, $Q_{th} = \frac{2}{3}\sqrt{2g}\,B\,H^{3/2}$	Water Rise in Collecting Tank R (m)	Time Taken 'T' (sec)	Volume of water collected (m3)ct	Discharge, Qact	**Qact Qth**
1								
2								
3								
4								
5								

Rectangular notch: Average Value of Cd = ……………...….

B) For Triangular notch Notch angle 'θ' = 90º or 60º

Initial reading of hook and point gauge h_0 =

Area of collecting Tank A_{ct} = m2

Tabulation - 2: Determination of C_d of triangular notch.

No.	*Theoretical Discharge Measurement*			*Actual Discharge Measurement*				*Cd*
	h1 (m)	H (m)	Theoretical Discharge, $Q_{th} = \frac{8}{15}\sqrt{2g}\,H^{5/2}\tan\frac{\theta}{2}$	Water Rise in Collecting Tank R (m)	Time Taken 'T' (sec)	Volume of water collected (m3)ct	Discharge, Qact	**Qact Qth**
1								
2								
3								
4								
5								

PROCEDURE

Preparation for experiment:

1. Insert the given notch into the hydraulic bench and fit tightly by using bolts in order to prevent leakage.

2. Open the water supply and allow water till over flows over the notch. Stop water supply, let excess water drain through notch and note the initial reading of the water level 'h0'using the hook and point gauge. Let water drain from collecting tank and shut the valve of collecting tank after emptying the collecting tank.

Experiment steps:

3. After initial preparation, open regulating valve to increase the flow and maintain water level over notch. Wait until flow is steady.

4. Move hook and point gauge vertically and measure the current water level 'h1' to find the water head 'H' above the crest of the notch.

5. Note the piezometric reading 'z0' in the collecting tank while switch on the stopwatch.

6. Record the time taken 'T' and the piezometric reading 'z1' in the collecting tank after allowing sufficient water quantity of water in the collecting tank.

7. Repeat step 3 to step 6 by using different flow rate of water, which can be done by adjusting the water supply. Measure and record the H, the time and piezometric reading in the collecting tank until 5 sets of data have been taken. If collecting tank is full, just empty it before the step no 3.

8. To determine the coefficient of discharge for the other notch, repeat from step

After entering the readings in the Tabulation 1 and Tabulation 2, compute the necessary values.

RESULTS

1. The coefficient of discharge of rectangular notch = …………
2. The coefficient of discharge of triangular notch = …………
3. The coefficient of discharge of trapezoidal notch = ………….

VIVA VOCE QUESTIONS NOTCHES

1. What are the types of notches? Types Of Notches
- Rectangular notch.
- Triangular notch.
- Trapezoidal notch.
- Stepped notch.

2. How are notches classified?

A notch is usually made of metal plate whereas a weir is made of masonry or concrete. The bottom edge over which the water flows is called the sill or the crest of water the notch. ... They can be classified as rectangular, triangular and trapezoidal weirs based on the geometry of flow section

3. What is notch and Weir?

A notch is an opening in the side of a measuring tank or reservoir extending above the free surface. A weir is a notch on a large scale, used, for example, to measure the flow of a river, and may be sharp edged or have a substantial breadth in the direction of flow.

4. Which notch is more efficient?

In conclusion, V-notch has a higher discharge coefficient than rectangular notch. V-notch is moreefficient compared to rectangular notch.

5. What are the applications of notches?

There are many uses of notches, Mill ponds are created by notch impounding water then flows over the structure. Notches are commonly used to control the flow rates of the rivers during periods of high discharge. Sluice gates can be altered to increase or decrease the volume of water flowing downstream

6. Why V notch is used?

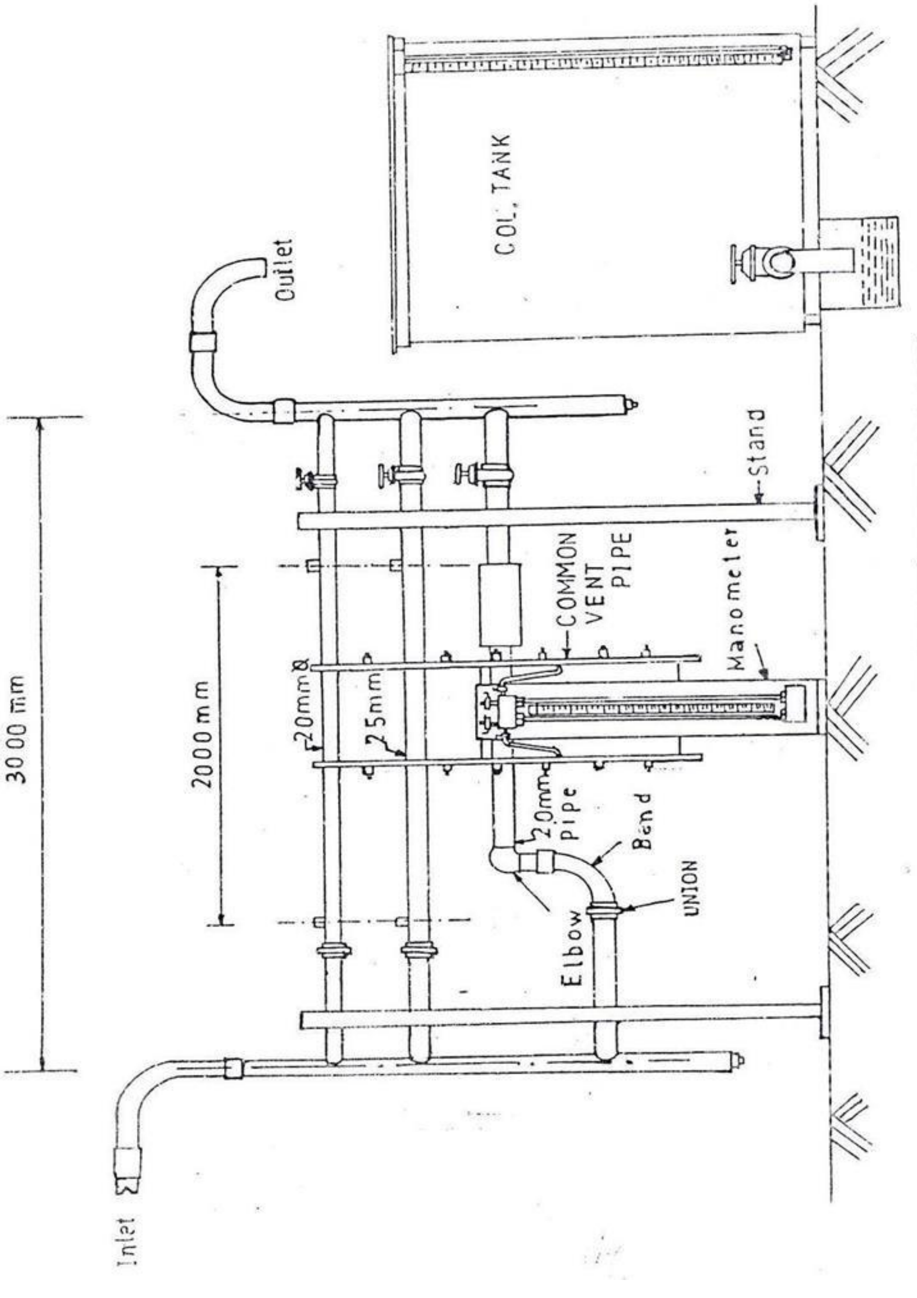
V-notch is generally used to measure flow rate in an open channel flow In real life applications it is used for seepage measurement of dam in foundation, inspection and top galleries and toe-drains in reservoirs. It has limited use in waste water and laboratories. It is a conventional device.

7. How do you cut pattern notches?

Simply cut outwards in a v shape. If the notch on your pattern points in, then just cut out from it. If you have a double sewing notch you can cut 2 separate v notches or cut across making it one piece. As long as you are consistent in the method you use, your pieces will match up

8. What is a notch radius?

For all notch types, a key parameter in governing stress concentration and failure in notched materials is the notch tip curvature or radius. This notch is also often referred to as C-notch, and is the most widely form of introduced notch, due to the repeatability of results obtained from notch specimens.



LOSSES IN PIPE LINES (MINOR & MAJOR)

Ex. no: 7 Date:

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. Meter scale

Theory

It is useful to characterize that roughness as the ratio of the roughness height k to the pipe diameter D, the "relative roughness". Three sub-domains pertain to turbulent flow:

In the smooth pipe domain, friction loss is relatively insensitive to roughness.

In the rough pipe domain, friction loss is dominated by the relative roughness and is insensitive to Reynolds number. In the transition domain, friction loss is sensitive to both.

The Darcy Equation is a theoretical equation that predicts the frictional energy loss in a pipe based on the velocity of the fluid and the resistance due to friction. It is used almost exclusively to calculate head loss due to friction in turbulent flow.

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

Where,

- h_f = Friction head loss,
- f = Darcy resistance factor,
- L = Length of the pipe,
- D = Pipe diameter,
- v = Mean velocity,
- g = acceleration due to gravity

PROCEDURE:

1. Gradually open the inlet valve of the set-up to let water into the pipes and connecting tubes. Disconnect the pressure tapping from the manometer, allow the water to flow freely thorough the flexible tubes connected to the pressure tapping to remove air bubbles if any. After ensuring that there are no air bubbles, connect the flexible tubes back to the manometer.

2. Record the size of the pipes, the distances of the pressure tapping which are to be used as lengths-of pipes and temperature of water flowing.

3. Allow the discharge to come to steady state and note the difference in pressure between the tappings.

4. For the same discharge, close the outlet valve of the collecting tank. Allow the water level in the collecting tank to rise by a certain amount. Note the time taken for this rise in water level and the area of the collecting tank. The discharge is equal to the volume of water collected divided by the time taken.

5. Repeat the procedure for different values of different discharges and different pipes. Maintain different tabular forms for different pipes.

Observation Table

Length of the pipe, or the distance between the pressure tappings, L=

Diameter of the pipe, D =

Temperature of water =

S. No	Manometer Reading			Time for H = 10cm rise of water (t) (sec)	Actual Discharge $Q_a = AH/t$ (m^3/sec)	Velocity = Q_a / a (m/sec)	V^2 $(m/sec)^2$	Coefficient of Friction $2gdh_f / 4LV^2$
	h_1	h_2	$h_t = h_1 - h_2$					

MODEL CALCULATION

1. Area of pipe,

$$a = \frac{\pi d^2}{4}$$

= --------- m^2

2. Internal plan area of collecting tank

= L X B

= ………… m^2

3. Actual discharge

Q = A*H / t

= ------------- m^3/sec

4. Velocity

$V = Q_a / a$

= ---------- m/sec

5. Cofficient of friction

$f = 2gdh_f / 4\ Lv^2$

= ------------

GRAPH

Draw graph h_f Vs V^2 taking V^2 on x-axis

RESULT

Coefficient of Friction of pipe (f)

Theoretically =

Graphically =

VIVA VOCE QUESTIONS

1. What is meant by energy loss in a pipe?

When the fluid flows through a pipe, it looses some energy or head due to frictional resistance and other reasons. It is called energy loss. The losses are classified as; Major losses and Minor losses

2. Explain the major losses in a pipe.

The major energy losses in a pipe is mainly due to the frictional resistancecaused by the shear force between the fluid particles and boundary walls of the pipe and also due to viscosity of the fluid.

3. Explain minor losses in a pipe.

The loss of energy or head due to change of velocity of the flowing fluid in magnitude or direction is called minor losses. It includes: sudden expansion of the pipe, sudden contraction of the pipe, bend in a pipe, pipe fittings and obstruction in the pipe, etc.

4. What are the factors influencing the frictional loss in pipe flow? Frictional resistance for the turbulent flow is,

- Proportional to v n where v varies from 1.5 to2.0.
- Proportional to the density of fluid.
- Proportional to the area of surface in contact.
- Independent of pressure.
- Depend on the nature of the surface in contact.

5. Write the expression for loss of head due to sudden enlargement of the pipe.

$$h_{exp} = (V_1 - V_2)^2 / 2g$$

Where, h_{exp} = Loss of head due to sudden enlargement of pipe.
V_1 = Velocity of flow at pipe 1; V_2 = Velocity of flow at pipe 2.

6. Write the expression for loss of head due to sudden contraction.

$$h_{con} = 0.5\, V^2/2g$$

h_{con} = Loss of head due to sudden contraction. V = Velocity at outlet of pipe.

7. What is compound pipe or pipes in series?

When the pipes of different length and different diameters are connected end to end, then the pipes are called as compound pipes or pipes in series.

8.What is mean by parallel pipe and write the governing equations.

When the pipe divides into two or more branches and again join together downstream to form a single pipe then it is called as pipes in parallel. The governing equations are:$Q = Q_1+Q_2$.

9.Define the terms a) Hydraulic gradient line [HGL] b) Total Energy line [TEL] Hydraulic gradient line:

It is defined as the line which gives the sum of pressure head and datum head of a flowing fluid in a pipe with respect the reference line. HGL = Sum of Pressure Head and Datum head Total energy line: Total energy line is defined as the line which gives the sum of pressure head, datum head and kinetic head of a flowing fluid in a pipe with respect to some reference line. TEL = Sum of Pressure Head, Datum head and Velocity head

10. What is meant by Moody"s chart and what are the uses of Moody"s chart?

The basic chart plotted against Darcy-Weisbach friction factor against Reynold"s Number (Re) for the variety of relative roughness and flow regimes. The relative roughness is the ratio of the mean height of roughness of the pipe and its diameter (ε/D). Moody"s diagram is accurate to about 15% for design calculations and used for a large number of applications. It can be used for non-circular conduits and also for open channels

Ex. no: 8 Date:

STUDY OF MINOR LOSSES IN PIPES

AIM:

To determine the co-efficient of minor loss of the given pipe.

APPARATUS REQUIRED:

1. Piping system
2. Measuring tank fitted with Piezometer
3. Differential U-tube manometer
4. Stop-watch

FORMULA:

Where there is any type of bend in pipe the velocity of flow changer, due to which the separation of the flow from the boundary and also formation of eddies takes place. Thus the energy is lost. The losses of head due to fittings in pipe.

i. Minor loss in bend $h_b = KV_1^2 / 2g$

ii. Minor loss in contraction $h_c = KV_2^2 / 2g$

iii. Minor loss in enlargement $h_e = K(V_1-V_2)^2 / 2g$

iv. Minor loss in elbow $h_d = KV^2 / 2g$

Where,

h_b = head loss due to bend

h_c = head loss due do contraction

h_e = head loss due to enlargement

h_d = head loss due to elbow

K = loss coefficient

V = velocity of fluid

V_1 = velocity of fluid in pipe of small diameter

V_2 = velocity of fluid in pipe of large diameter

Area of the collecting tank,

$$L \times B = \quad cm^2$$

L - Length of the collecting tank (cm)

B - Breadth of the collecting tank (cm)

3. Discharge,

Q = (A * y) / t cm^3 / s

A = Area of the collecting tank (cm^2)

y = Rise of water in the collecting tank (cm)

t = Time taken for 10 cm rise in the collecting tank (sec)

$a_1 = (\pi d_1^2) / 4$ (d1 – diameter of the pipe in cm)

$a_2 = (\pi d_2^2) / 4$ (d2 – diameter of the expanded pipe in cm)

4. Velocity, V1 = Q / a_1

V2 = Q / a_2

5. $h_e = (V_1 - V_2)2 / 2g$

h_e - head lost due to sudden enlargement

g - Acceleration due to gravity (981 cm / s^2)

PROCEDURE:

1. Close all the valves provided
2. Fill the sump tank 75% with clean water and ensure that there are no foreign particles
3. Fill the manometer with measurement of mercury up to half of its level by opening the pipe from the fitting connected to the bottom most point of the manometer and connect the pipe back to its position
4. Open bypass valve
5. Ensure that ON/OFF switch given on the panel is at OFF position
6. Switch on the main power supply and switch on the pump
7. Open floe channel control valve of pipe for bend, sudden enlargement, sudden contraction and elbow fitting on ball valve and gate valve fitting
8. Open the pressure taps of manometer of related test section, very slowly to avoid the blow of water on manometer fluids
9. Now open the air release valve provided on the manometer, slowly to

release the air in manometer

10. When there is no air in the manometer close the air release valves
11. Adjust water flow rate in desired section with the help of control valve for bypass valve
12. Record the manometer reading
13. Measure the flow of water, discharged through desired test section with using stop watch and measuring tank
14. Repeat the experiment for other fittings of selected pipe
15. When experiment is over for selected pipe open the control valve of other pipe
16. Repeat the experiment same procedure for different flow rate of water operating control valve and bypass valve

GRAPH:

A graph, h_{f} Vs V_2^2 is drawn taking V_2^2 on X-axis

RESULT

1.The co-efficient of expansion of the given pipe C_e =

i. Theoretically =

ii. Graphically =

2.The co-efficient of contraction of the given pipe C_c =

i. Theoretically =

ii. Graphically =

3.The co-efficient of bend of the given pipe C_b =

i. Theoretically =

ii. Graphically =

VIVA VOCE QUESTIONS

1. Where do major losses occur?

   Major losses occur due to friction within a pipe.

2. Where do minor losses occur?

   Minor losses occur at a change of section, valve, bend or other interruption.

3. What is the formula to calculate major losses?

   $hf = (f*L*V^2)/(D*2g)$

4. What contributes to significant pressure loss.

   A very sudden change to the flow path contributes to significant pressure loss.

5. Pressure loss is proportional to

   L/D ratio and Velocity head.

6. What is the role of minor losses in pipe flow.

   Minor losses are a major part in calculating the flow, pressure or energy reduction in piping systems.

7. What is the factor used to calculate configurational head loss.

   Kinetic energy factor.

8. What is Kinetic energy factor of return bend.

   1.5

9. What is the formula to calculate minor losses?

   $hf = (k*V^2/2g)$

10. What is the ev value of check valve (ball).

    70

EX.NO: 9 DATE: …..

HYDRAULIC JUMP (DEMONSRATION)

THEORY

The title type hydraulic flume may be used for uniform flow through open channels (i.e A phenomenon of flow through open channels, in which the rate of flow, depth of flow, area of flow and slope of bed remains constant). The change in any of the above condition causes the flow to be non- uniform.

The specific energy may be defined as energy per unit weight with respect to the datum passing through the bottom of the channel $E= h+ v^2 /\sqrt{2}g$ where h= depth of liquid flow and v= velocity of the liquid.

Critical depth: The depth of water in a channel corresponding to the minimum specific energy is known as critical depth = $h_c = q^2/g)^{1/3}$. the velocity of water at critical depth is known as critical velocity $V_c= q/h_c$

A hydraulic jump occurs in an open channel when the flow changes from the supercritical to subcritical. The water level abruptly rises at the hydraulic jump. A large number of rollers of turbulent eddies are formed at hydraulic jump, which cause dissipation of energy.

The hydraulic jump is analyzed by applying the impulse momentum equation to a control volume.

EXPERIMENT SET-UP

The set-up consists of a rectangular tilting flume having at the inlet and exit. The water is supplied to the flume by a centrifugal pump. A sluice gate is provided in the middle portion of the flume to create supercritical flow condition on its downstream so that a hydraulic jump can form.

A pointer gauge trolley can move on the rails at the top of the walls for the measurement of the water depths.

A venturimeter is provided on the supply pipe for the measurement of actual discharge.

THEORY

The depth y1 before hydraulic jump and the depth y2 after the hydraulic jump The loss energy in the hydraulic jump is given by

$d_E= E1-E2 = (Y_2-Y_1)^3/ 4Y_1Y_2$

PROCEDURE

- Measure the width of the flume. Take the pointer gauge at the bed of flume at suitable section upstream and downstream of the hydraulic of the hydraulic jump. H0
- Open the supply value and adjust the inlet and exit gates so that the flow becomes uniform and steady.
- Gradually lower the sluice gate and adjust the exit gate so that a stable hydraulic jump is formed on the downstream of the sluice gate.
- Note the deflection h of manometer liquid in the u- tube manometer attached to the venturimeter on the supply line for computation of actual discharge.

OBSERVATION AND CALCULATION

Width of flume L = 250 mm

Venturimeter dimension

D1 = 40mm ,

D2= 24 mm

Venturimeter coefficient, Cd = 0.95

s.no	VENTURIMETER		WATER DEPTH READING (cm)			Y1= H1‟- H0‟	Y2= H2‟- H0‟
	h1(cm)	h2(cm)	H1‟	H2‟	H0‟		

RESULT

The loss energy in the hydraulic jump=

EXP NO :10 DATE :

BERNOULLI'S EXPERIMENT

AIM:

To verify the Bernoulli"s theorem.

APPARATUS USED:

1) A supply tank of water a tapered inclined pipe fitted with no.of piezometer tubes point,
2) measuring tank,
3) scale,
4) stop watch.

THEORY

Bernoulli's theorem states that when there is a continues connection between the particle of flowing mass liquid, the total energy of any sector of flow will remain same provided there is no reduction or addition at any point.

FORMULA USED

$$H1= Z_1+ P_1/w+V_1^2/2g \quad H_2= Z_2+ P_2/w + V_2^2/2g$$

PROCEDURE

1. Open the inlet valve slowly and allow the water to flow from the supply tank. 2.Now adjust the flow to get a constant head in the supply tank to make flow in and out flow equal.

3.Under this condition the pressure head will become constant in the piezometer tubes.

4.Note down the quantity of water collected in the measuring tank for a given interval of time.

5.Compute the area of cross-section under the piezometer tube. 6.Compute the area of cross-section under the tube.

7.Change the inlet and outletsupply and note the reading.

Location	1	2	3	4	5	6	7	8	9	10	11
Discharge Of piezometer Tube from **inlet(cumec)**											
Area of Crosssection Under foot Of each point (m^2)											
Velocity Of water Under foot Of each point(m/sec)											
$V^2/2g$											
p/ρ											
$p/\rho+V^2/2g$											

RESULTS:

Hence, Bernoulli‟s theorem verified.

VIVA VOCE

1.What is Bernoulli's principal example?

An example of Bernoulli's principle is the wing of an airplane;

2.What is Bernoulli's Theorem and its application?

Bernoulli's theorem and its applications. According to Bernoulli's theorem, the sum of pressure energy, kinetic energy, and potential energy per unit mass of an incompressible, non-viscous fluid in a streamlined flow remains a constant.

3.How do you verify Bernoulli's Theorem?

Open the inlet valve and allow the water to flow from the supply tank to the receiving tank through a tapered inclined pipe. Adjust the flow using an outlet valve to make the head constant in the supply tank.

4.What is mean by Bernoulli's Theorem?

In Fluid dynamics, the Bernoulli's theorem or the Bernoulli's Principle is the law or statement or expression that gives relation between energies of a flowing fluid. It states that " The sum of Kinetic Energy, Potential Energy and Pressure Energy of a fluid per unit weight at any point is always constant"

5. What are the four applications of Bernoulli's principle?

List four applications of Bernoulli's principle. Airplane wings, atomizers, chimneys and flying discs

6. What is the V in Bernoulli's equation?

v: velocity of the fluid. ρ: Density of the fluid. h: height of the container or the pipe here the fluid is flowing

7. What is the aim of Bernoulli's Theorem?

Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy

8. Can Bernoulli's theorem apply on gases?

Yes, bernaullis theorem can be applied to incompressible fluids (liquids) and compressible fluids (gases) in the range of low mach number (less than 0.3)

9. How is Bernoulli's principle related to airplanes?

Bernoulli's principle helps explain that an aircraft can achieve lift because of the shape of its wings. They are shaped so that that air flows faster over the top of the wing and slower underneath. The high air pressure underneath the wings will therefore push the aircraft up through the lower air pressure.

10. What is steady flow?

A steady flow is the one in which the quantity of liquid flowing per second through any section, is constant. This is the definition for the ideal case. True steady flow is present only in Laminar flow