FLUID MECHANICS AND HYDRAULIC MACHINERYLAB MANUAL

Department of Mechanical Engineering

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

FLUID MECHANICS AND HYDRAULIC MACHINERY LAB MANUAL

Name:____

H.T.No:____

Year/Semester:__________________________________

Department of Mechanical Engineering

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

SYLLUBUS

FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY (20A01302P)

OBJECTIVE: *The object of the course to make the students understand the fluid flow concepts and get familiarity with flow measuring devices.*

SYLLABUS :

1. Impact of jet on vane.
2. Calibration of venture meter.
3. Calibration of orifice meter.
4. Determination of coefficient of discharge for a small orifice by constant head method.
5. Determination of coefficient of discharge for external mouth piece by constant head method.
6. Determination of coefficient of discharge for external mouth piece by variable head method.
7. Calibration of contracted rectangle notch.
8. Calibration of contracted rectangle notch. Determination of friction factor.
9. Determination of loss of head due to Sudden contraction.
10. Determination of Loss of head due to Sudden Expansion.
11. Performance test on Impulse Turbine (Pelton wheel).
12. Performance test on Reaction Turbine (Francis Turbine).
13. Verification of Bernoullis Equation.
14. Performance test on Centrifugal Pump, determination of operation point and efficiency (Multistage).
15. Determination of coefficient of discharge for a small orifice by variable head method.

CONTENTS

FLUID MECHANICS AND HYDRAULIC MACHINERYLAB

COURSE OUT COMES

1	Students will be able to know the principles of discharge measuring devices.
2	Students will be able to distinguish and calibrate different flow measuring devices.
3	Students will be able to know the head loss due to sudden contraction and expansion in pipes.
4	Students will be able to visualize the flow around the objects using flow visualisation techniques.
5	Students will be able to know the working principles of various pumps and motors.

INSTRUCTIONS TO STUDENTS

DO‘S

1. Learn objective & significance of the practical.
2. Keep silence in the lab.
3. Always perform the experiment or work presicisely as directed by teacher
4. Don’t forget to bring calculator, graph sheet and other accessories when you come to lab.
5. Before performing practical’s read instrument manual carefully.
6. Count all accessories before receiving equipments in lab.
7. Before performing practical’s read instrument manual carefully.

DONT‘S

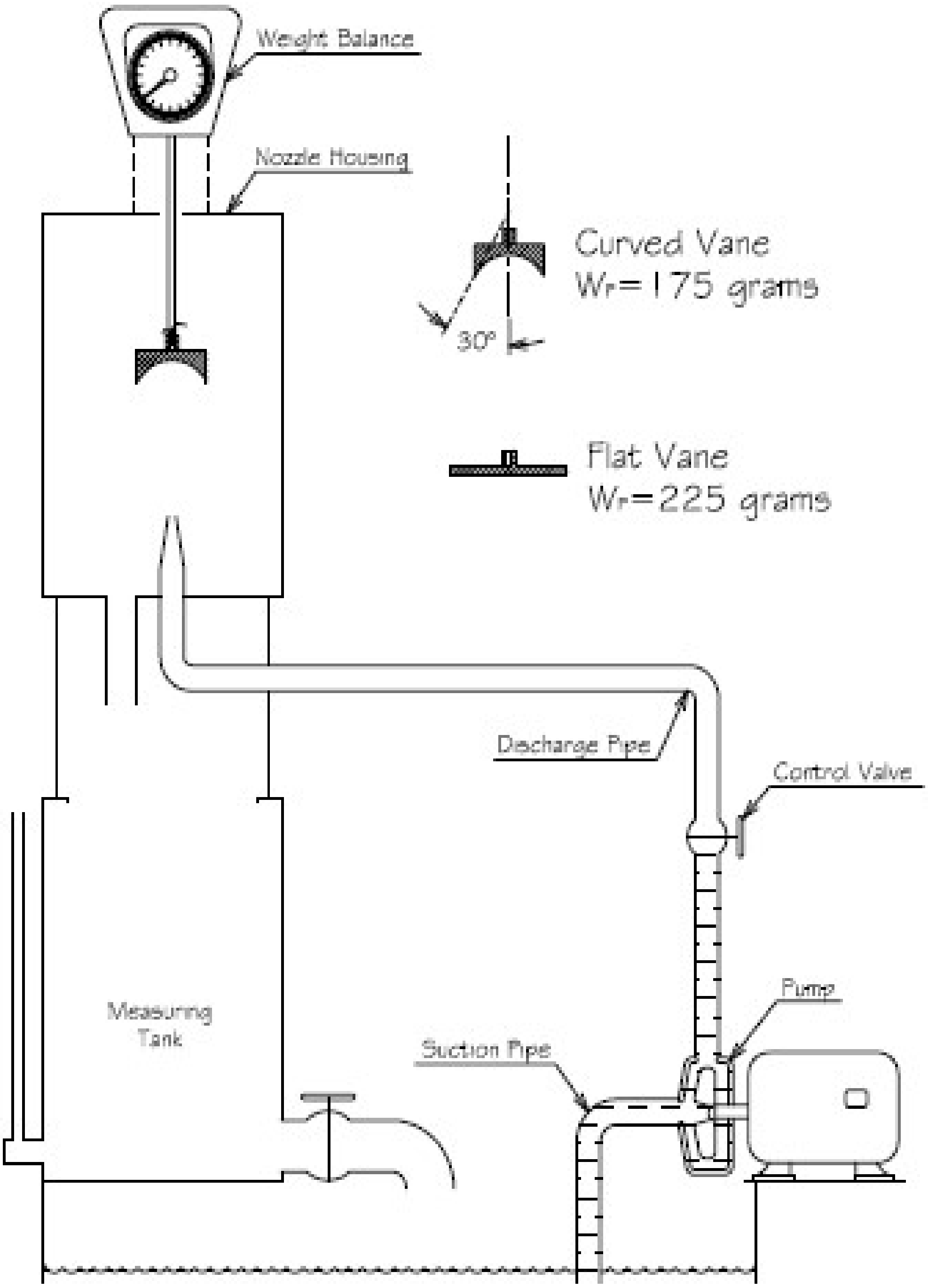
1. Don’t use mobile phones during lab hours.
2. Don’t try to repair any faulty instrument.
3. Don’t run machine without permission.

SCHEME OF EVALUATION

S.No	Experiment	Date	Marks Awarded				Total 30(M)
			Record (10M)	Observation (10M)	VivaVoce (5M)	Attendance (5M)	
1.	Impact of jet on vane.						
2.	Calibration of venture meter.						
3.	Calibration of orifice meter.						
4.	Determination of coefficient of discharge for a small orifice by constant head method.						
5.	Determination of coefficient of discharge for external mouth piece by constant head method.						
6.	Determination of coefficient of discharge for external mouth piece by variable head method.						
7.	Calibration of contracted rectangle notch.						
8.	Calibration of contracted rectangle notch. Determination of friction factor.						
9.	Determination of loss of head due to Sudden contraction.						
10.	Determination of Loss of head due to Sudden Expansion.						
11.	Performance test on Impulse Turbine (Pelton wheel).						
12.	Performance test on Reaction Turbine (Francis Turbine).						
13.	Verification of Bernoullis Equation.						
14.	Performance test on Centrifugal Pump, determination of operation point and efficiency (Multistage).						
15.	Determination of coefficient of discharge for a small orifice by variable head method.						

Signature of Lab In-charge

IMPACT OF JET ON VANES



IMPACT OF JET ON VANES

IMPACT OF JET ON VANES

Ex. No:- **Date:**

AIM: - To determine the coefficient of impact of jet for a given vanes.

APPARATUS:-

Vane, hanger, water jet, inlet valve, collecting tank fitted with piezometer and control valve, stop watch

THEORY:-

When the jet of water is directed to hit the vane of any particular shape, the force is exerted on it by the fluid. This force is large in magnitude, acts for a short duration and is termed as Impact Force. The magnitude of the force exerted on the Plate/Vane depends on the velocity of jet, shape of Vane, Fluid Density and Area of cross section of the jet. More importantly, it also depends on whether the vane is moving or stationary. In our present case, we are concerned about the force exerted on the Stationary Plates/Vanes. The following are the theoretical formulae for different shapes of vane, based on flow rate.

1. Flat Plate $(F_t) = \rho A V^2$
2. Flat Plate inclined at θ angle from horizontal $(F_t) = \rho A V^2 \cos\theta$
3. Hemi – Spherical $(F_t) = 2 \rho A V^2$
4. Curved Plate with angle of deflection 180-θ, $(F_t) = \rho A V^2 (1 + \cos\theta)$

Where,

'A' – Area of jet in m^2

'ρ' – Density of water = 1000 kg/m^3

'V' – Velocity of jet in m/sec

'F_t' – The theoretical force acting in the direction of jet.

PROCEDURE:-

1. Fix the vane to be tested inside the testing chamber by opening the transparent door provided, close the door
2. Note the initial reading on scale.

3. Open the inlet valve then the water from the nozzle strikes on vane; gets deflected then the water back to the collecting tank.
4. Note the final reading of spring gives the actual force.
5. Close the collecting tank drain valve and note the time taken for 10 cm rise of water in collecting tank.
6. Repeat the experiment for different flow rates by adjusting the position of inlet valve for different vanes.

PRECAUTIONS:-

1. Do not start the pump if the voltage is less than 180 V.
2. Ensure the electrical neutral & earth connections are given correctly.
3. Frequently (at least once in three months) grease / oil the rotating parts.
4. Ensure that the moving parts are oiled regularly and that they are operated at least some time every week to avoid clogging.
5. Ensure there are no leakages in the piping and nozzle housing.

CONCLUSION:-

The actual Force is observed to be slightly differed than theoretical because of frictional losses and reduction of velocity due to gravity.

APPLICATIONS:-

The force of impact calculated in this experiment is useful in determining the work done and torque exerted by the jet of water on moving vanes in turbines

FORMULAE:-

1. $\boldsymbol{F_{act} = (initialreading - finalreading) inkgs}$

$$F_{act} = ----kgx9.81\ N$$

2. $DischargeQ = \frac{AH}{t} m^3/sec$

Where

A=area of collecting tank=0.25m2

H= rise of water in collecting tank=0.1 m

t= time taken for `h` rise of water

3. $Velocityofflow(v) = \frac{Q}{a} m/sec$

Where

Q= discharge

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

d= diameter of nozzle=0.01 m

4.$TheoroticalforceF_{th} = 2\rho a v^2\ N$

Where

ρ=density of water=1000kg/m^3

a=area of nozzle

v=velocity of flow

5.$CoefficientofimpactofjetC_d = \frac{F_{act}}{F_{th}}$

OBSERVATION TABLE:-

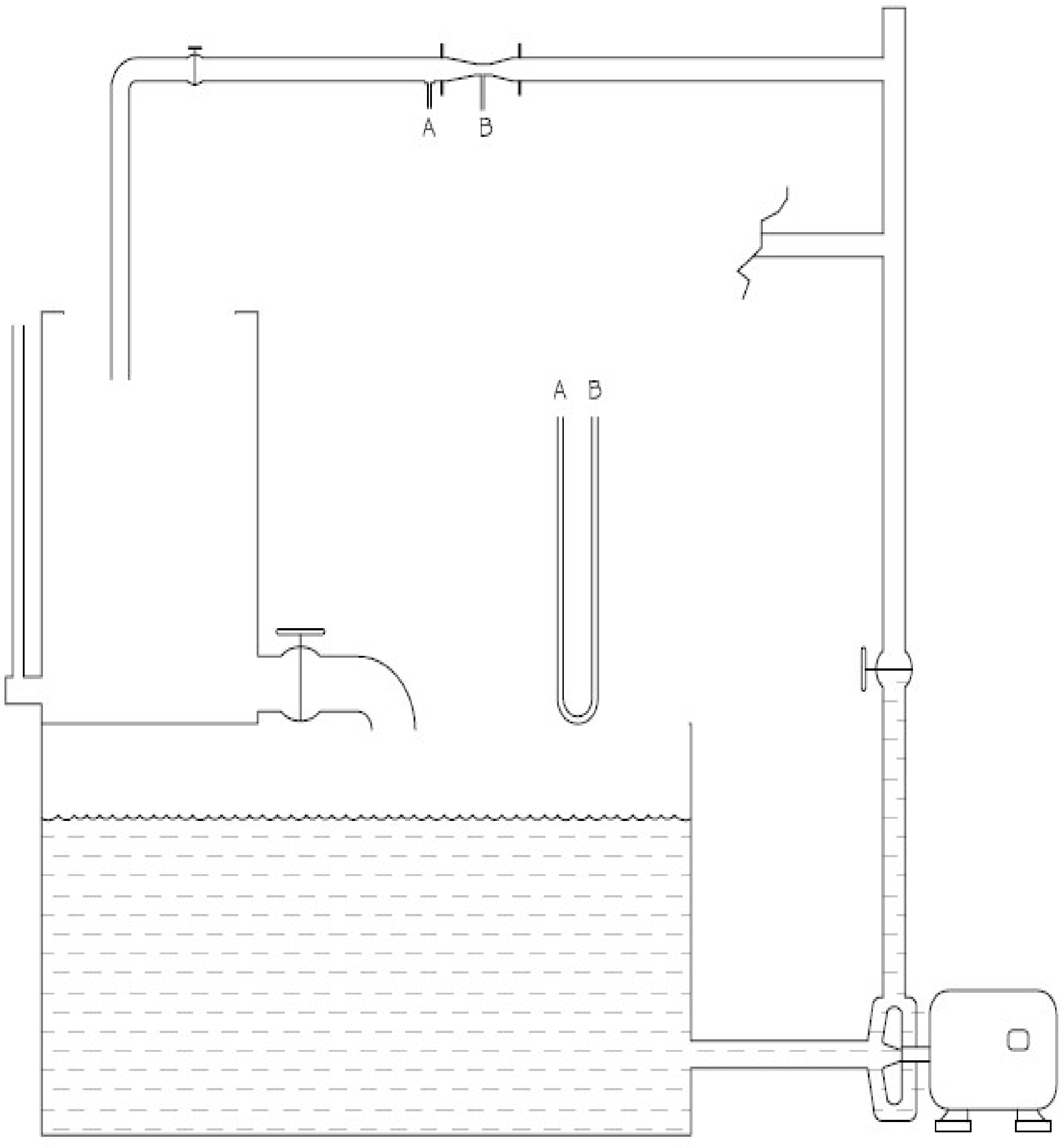
S.No	Actual force(F_a)		$F_{act} = initial - final$			Time taken for 10 cm rise in collecting tank
	Initial reading	Final reading	Gram	kg	kg×9.81	

CALCULATION TABLE:-

S.No	Discharge Q m^3/sec	Velocity vm^2/sec	Theoretical force=F_{th}	$Cd = \frac{F_a}{F_{TH}}$

RESULT:- Thus the experiment was conducted on impact of jet on vanes and calculated the coefficient of impact of jet on vane C_d=_____________________________

CALIBRATION OF VENTURIMETER



Venturimeter

CALIBRATION OF VENTURIMETER

Ex. No:-2 **Date:-**

AIM: - To Determine the co-efficient of discharge of the venturimeter.

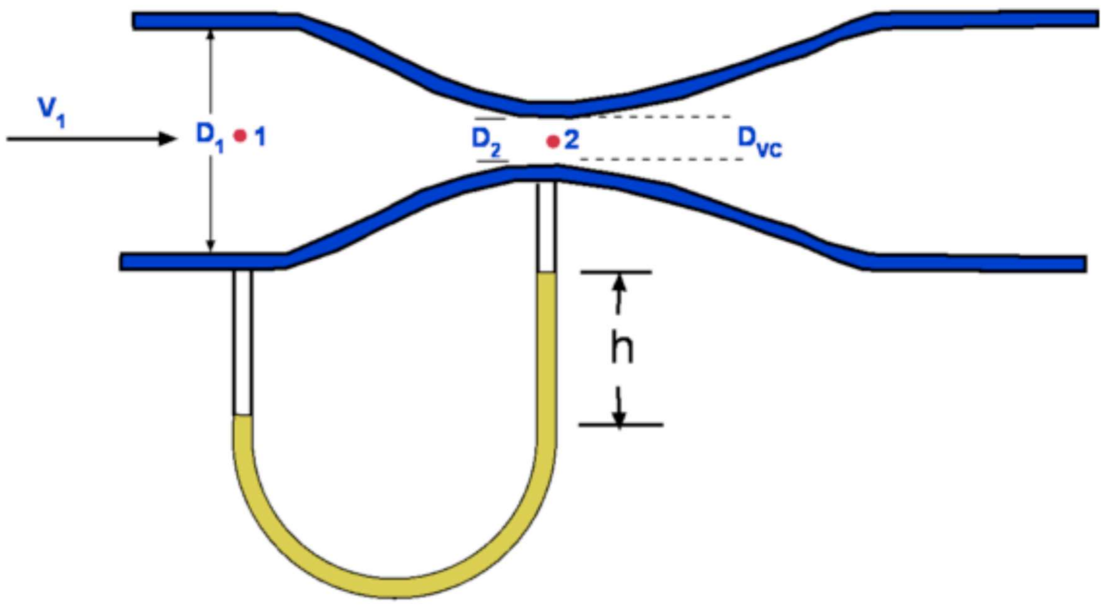
APPARATUS:- venturimeter, differential u-tube mercury manometer, collecting tank fitted with peizometer,control value, stop watch ,meter scale

THEORY:-

A Venturimeteris a device which is used for measuring the rate of flow of fluid through pipe line. The pressure difference due to reduced cross-sectional area is proportional to Water Discharge. So, if we know the coefficient of Discharge we can determine the Water Discharge just by measuring the pressure difference in the throat and inlet.

A Venturimeter consists of,

1. An inlet section followed by a Convergent Cone,
2. A Cylindrical Throat and
3. A gradually Divergent Cone.



PROCEDURE: -

All the necessary instrumentations along with its accessories are readily connected. It is just enough to follow the instructions below:

1. Make sure the water in sump Tank is free of any oil content.
2. Open all the outlet valves and start the pump.
3. Open the outlet valve of the Venturimeter and close the valve of orifice meter.
4. Remove all the air bubbles from manometer and connecting pipes.
5. Adjust the flow at suitable rate.
6. Note down the manometric readings.
7. Close the gate valve of measuring tank & determine the time‘t’ for height ‘h cm’ of water collection in measuring tank.
8. Change the flow rate and take similar readings

APPLICATIONS:-

- They are found in many applications where the discharge and velocity of the fluid are important, and form the basis of devices like a carburetor.
- Venturimeter is also used to measure the velocity of a fluid, by measuring pressure changes from one point to another along the Venturimeter.
- Placing a liquid in a U-shaped tube and connecting the ends of the tubes to both ends of a Venturimeter is all that is needed.
- When the fluid flows though the Venturimeter the pressure in the two ends of the tube will differ, forcing the liquid to the "low pressure" side.
- The amount of that move can be calibrated to the speed of the fluid flow.

FORMULAES:-

1. $X = h_1 - h_2$

   Where h1 and h2 are height of mercury levels in two limbs of differential manometer

   $h_f = x \frac{(s_m - s_l)}{s_l}$

   Where

   S_m=specific gravity of mercury=13.6

   S_l= specific gravity of liquid=1

2. $Q_a = \frac{AH}{t} m^3/sec$

   Where

   A=Area of collecting tank=0.25 m^2

   H= 10 cm rise of water

   t= time taken for 10 cm rise of water

3. $Q_{th} = \frac{a1\ a2\sqrt{2gh}}{\sqrt{{a_1}^2 - {a_2}^2}}$

   Where

   $$a_1 = area of inlet = \frac{\pi}{4} {d_1}^2$$

   d_1 = 0.025 m

   $a_2 = area of throat = \frac{\pi}{4} {d_2}^2$

   d_2=0.015 m

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

OBSERVATION TABLE:-

S. No	Manometer readings				$h = x(\frac{s_m - s_l}{s_l})$	Time for 10 cm rise of water
	h_1	h_2	$X=(h_1-h_2)$			
			cm	M		

CALCULATION TABLE:-

S. No	$Q_a(m^3/sec)$	$Q_{th}(m^3/sec)$	C_d

GRAPH:-

1.Q_a vs h

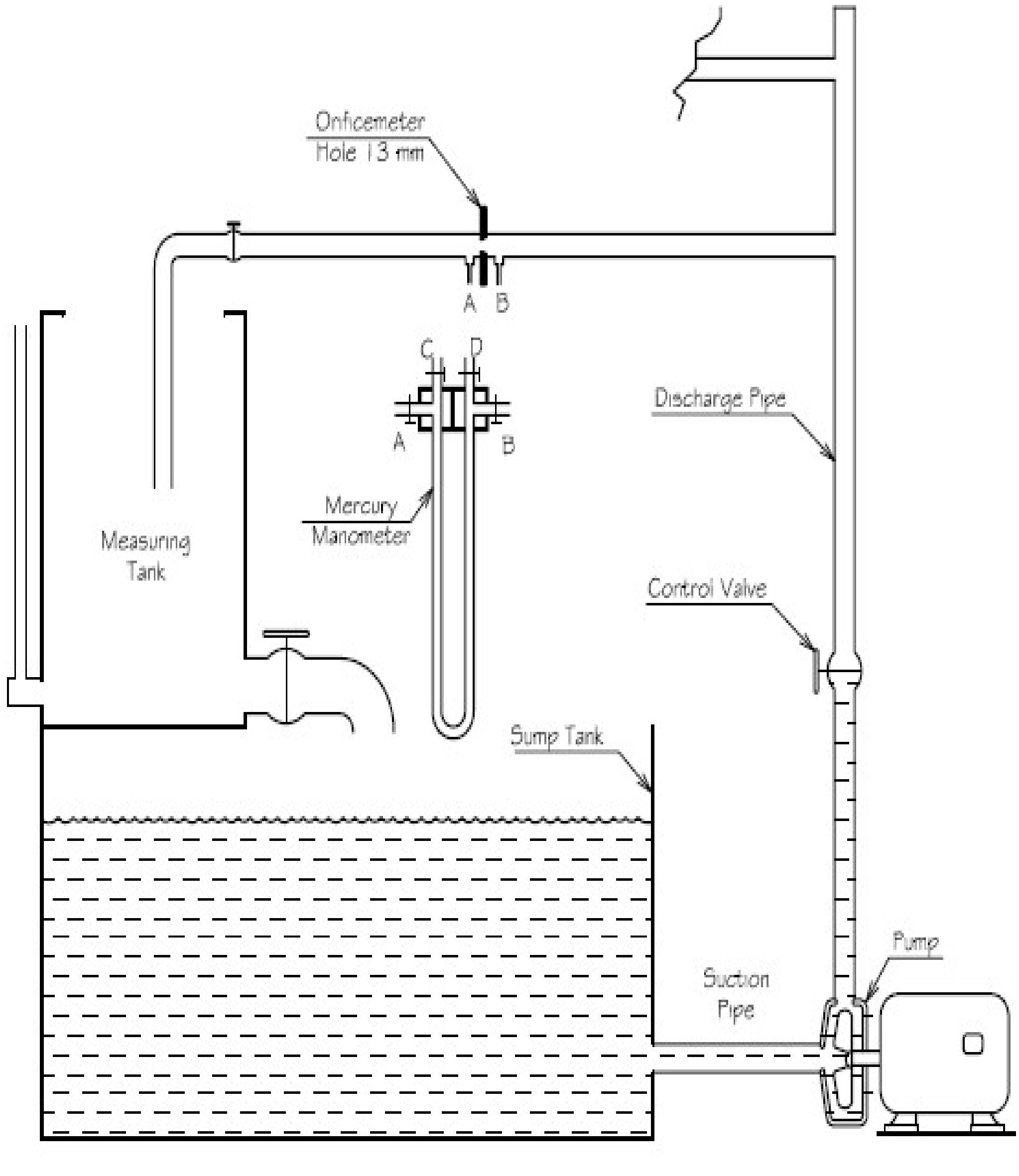
2.Q_a vs √h

3.log Q_a vs logh

Taking h&√h on x axis

RESULT:- Coefficient of venturimeter is C_d=-----------------

CALIBRATION OF ORIFICEMETER



ORIFICE METER

CALIBRATION OF ORIFICE METER

Ex.No:- **Date:-**

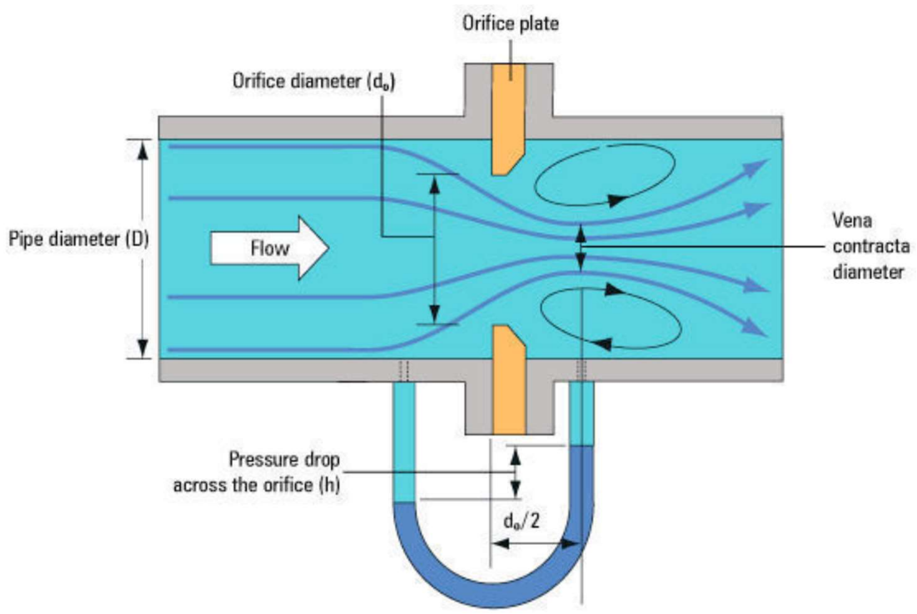
AIM: - To Determine the co-efficient of discharge of the Orifice meter.

APPARATUS: - orifice meter, differential u-tube mercury manometer, collecting tank fitted with piezometer, control value, stop watch, meter scale

THEORY:-An ORIFICE METER is another simple device used for measuring the discharge through pipes. Orifice meter also works on the same principle as that of Venturimeter i.e., by reducing the cross-sectional area of the flow passage, a pressure difference between the two sections before and after orifice is obtained and the measurement of the pressure difference enables the determination of the discharge through the pipe. However, an orifice meter is a cheaper arrangement for discharge measurement through pipes and its installation requires a smaller length as compared with Venturimeter. As such where the space is limited, the orifice meter may be used for the measurement of discharge through pipes.

An Orifice meter consists of,

1. An inlet section followed by a sudden Contraction,
2. A sudden enlargement to the same diameter as inlet.



PROCEDURE: -

All the necessary instrumentations along with its accessories are readily connected. It is just enough to follow the instructions below:

1. Make sure the water in sump Tank is free of any oil content.
2. Open all the outlet valves and start the pump.
3. Open the outlet valve of the Orifice meter and close the valve of venture meter.
4. Remove all the air bubbles from manometer and connecting pipes.
5. Adjust the flow at suitable rate.
6. Note down the manometric readings.
7. Close the gate valve of measuring tank & determine the time ‘t’ for height ‘h cm’ of water collection in measuring tank.
8. Change the flow rate and take similar readings

APPLICATIONS:-

- They are found in many applications where the discharge and velocity of the fluid are important.
- Orifice meter is also used to measure the velocity of a fluid, by measuring pressure changes from one point to another along the orifice meter.
- Placing a liquid in a U-shaped tube and connecting the ends of the tubes to both ends of an orifice meter is all that is needed.
- When the fluid flows though the orifice meter the pressure in the two ends of the tube will differ, forcing the liquid to the "low pressure" side.
- The amount of that move can be calibrated to the speed of the fluid flow.

FORMULAE:-

1. $X = h_1 - h_2$

Where h1 and h2 are height of mercury levels in two limbs of differential manometer

$$h_f = x \frac{(s_m - s_l)}{s_l}$$

Where,

S_m=specific gravity of mercury=13.6

S_l= specific gravity of liquid=1

2. $Q_a = \frac{AH}{t} m^3/sec$

Where,

A=Area of collecting tank=0.25 m^2

H= 10 cm rise of water

t= time taken for 10 cm rise of water

3. $Q_{th} = \frac{a1\ a2\sqrt{2gh}}{\sqrt{{a_1}^2 - {a_2}^2}}$

Where,

$a_1 = area of inlet = \frac{\pi}{4} {d_1}^2$

d_1 = 0.025 m

$a_2 = area of orifice = \frac{\pi}{4} {d_2}^2$

d_2=0.015 m

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

OBSERVATION TABLE:-

S. No	Manometer reading				$h = x(\frac{s_m - s_l}{s_l})$	Time for 10 cm rise of water
	h_1	h_2	$X=(h_1-h_2)$			
			cm	M		

Calculation table:-

S. No	$Q_a(m^3/sec)$	$Q_{th}(m^3/sec)$	C_d

GRAPH:-

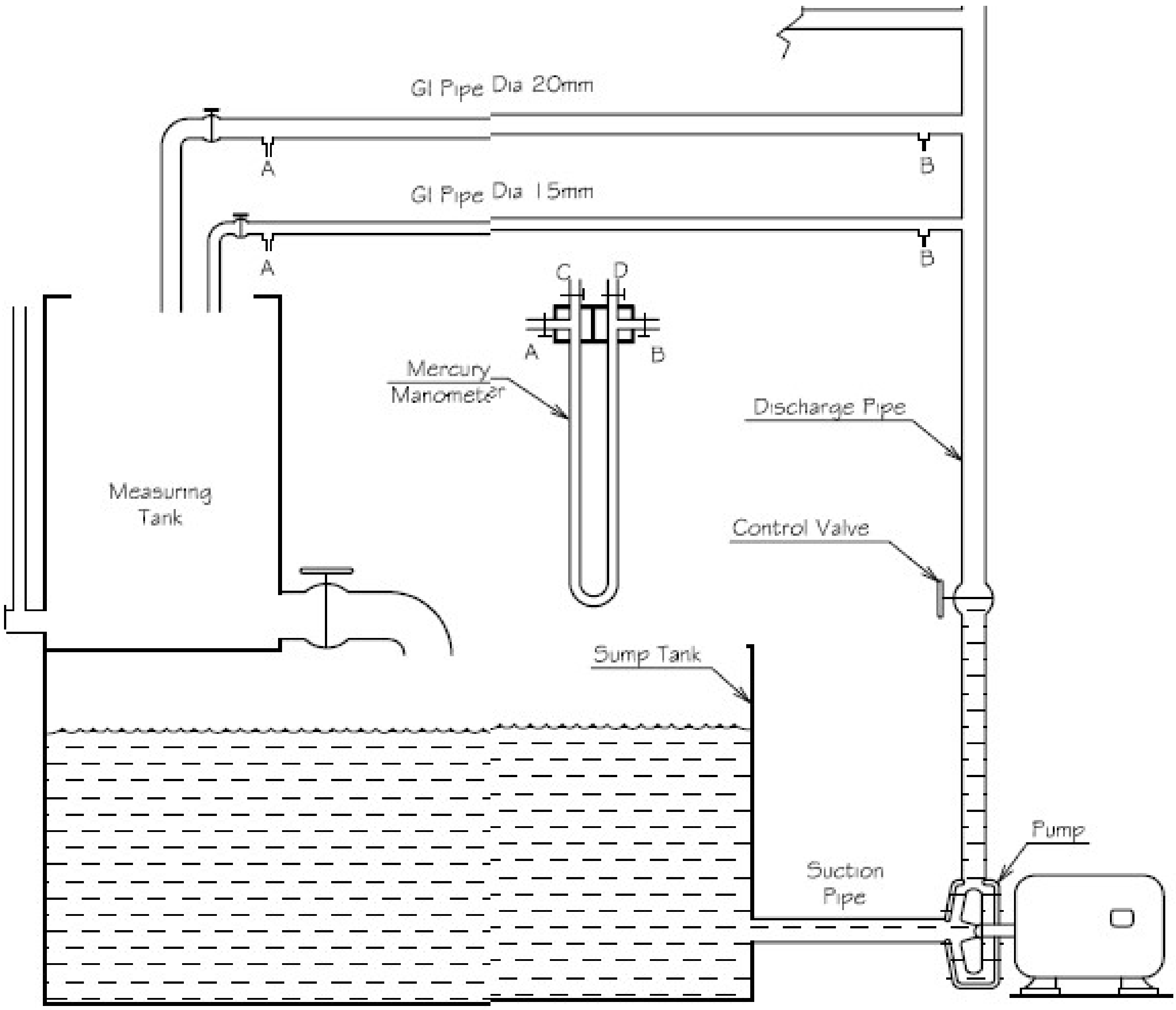
1. Q_a vs h
2. Qa vs √h
3. log Q_a vs logh

Taking h&√h on x axis

RESULT:-

Coefficient of orifice meter is C_d=------------------

DETERMINATION OF FRICTION FACTOR IN FLOW THROUGH PIPES



FRICTION LOSSES IN PIPE

DETERMINATION OF FRICTION FACTOR IN FLOW THROUGH PIPES

Ex.No:- **Date:-**

Aim:

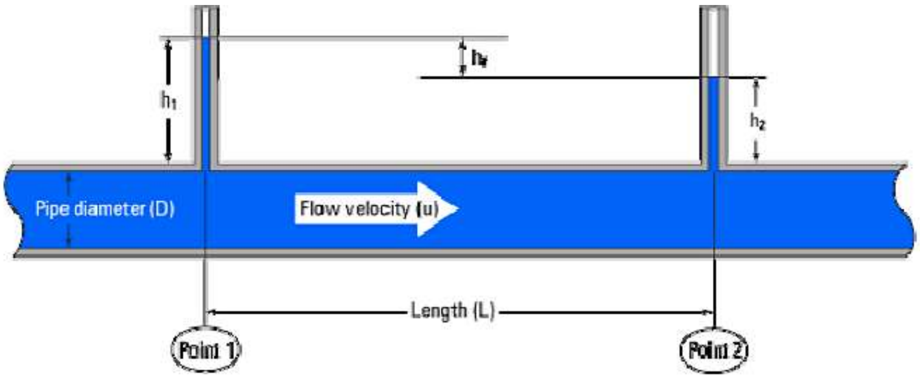
To determine the friction factor of the given pipe.

APPARATUS:-

A pipe provided with inlet, outlet valves and pressure taping locks, differential u-tube manometer, collecting tank fitted with piezometer and control valve, stop watch, meter scale

THEORY:

Any Fluid flowing through a pipe experiences resistance from the walls of the pipe due to shear forces or in simple terms - Viscosity. The amount of loss depends on the Velocity of flow and area of contact between the pipe and fluid particles. It also depends upon the type of flow, i.e. Laminar or Turbulent. This frictional resistance causes loss of pressure in the direction of flow.



The Drop of head can be calculated by using the Darcy-Weisbach Formula:

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

From the above formula coefficient of friction of friction will be

$$f = \frac{h_f 2gd}{4lv^2}$$

Where,

'hf' – Drop of head *(got from the manometer difference)*.
'f' – Coefficient of Friction
'L' – Length of pipe (2 meter)
'V' – Velocity of flow,
'g' – Acceleration due to gravity, 9.8m/s

PROCEDURE:-

1. Measure the length and breadth of the collecting tank and find area A m2
2. Open the respective valves in a pipe line where head loss to be measured. close other valves & pressure locks, adjust the flowing rate suitably.
3. Note the left limb reading (h1) cm and right limb reading (h2) cm of the manometer.
4. Close the drain valve of the collecting tank,
5. Find the time taken for 0.1 m rise of water in collecting tank.
6. Repeat the experiment for different flow rates and flow through different pipe fittings.

FORMULAE:-

1. $crosssectionalareaofpipe(a_1) = \frac{\pi}{4}d^2$

   Where

   D= diameter of pipe=0.02 m

2. $AreaofcollectingtankA = lxbm^2$

   Where

   L= length of collecting tank=0.5 m

   B= breadth of collecting tank=0.5 m

3. $Lossofhead(h) = xX(\frac{s_m}{s_l} - 1)$

   Where

   x= difference of manometer reading=h1-h2 m

   sm= specific gravity of mercury=13.6

   sl= specific gravity of liquid=1

4. $DischargeQ = \frac{AH}{t}m^3/sec$

   Where

   A=area of collecting tank=0.25m2

   H= rise of water in collecting tank=0.1 m

   t= time taken for `h` rise of water

5. $Velocity\,offlow(v) = \frac{Q}{a}m/sec$

Where

Q= discharge

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

d= diameter of pipe=0.02 m

6. $fictionfactor(f) = \frac{h_f 2gd}{4lv^2}$

Where,

'hf' – Drop of head *(got from the manometer difference)*.

'f' – Coefficient of Friction

'L' – Length of pipe (2 meter)

'V' – Velocity of flow,

'g' – Acceleration due to gravity, 9.8m/s2

'd' – Diameter of the pipe=20 mm

Observation table:-

S.no	**Manometer readings**				$\boldsymbol{h = x(\frac{S_m - S_l}{S_l})}$	**Time for 10 cm rise of water**
	h_1	**h_2**	**$X=(h_1-h_2)$**			
			cm	**M**		

CALCULATION TABLE:-

S.no	**Discharge Q m^3/sec**	**Velocity v m2/sec**	**V^2**	$(f) = \frac{h_f 2gd}{4lv^2}$

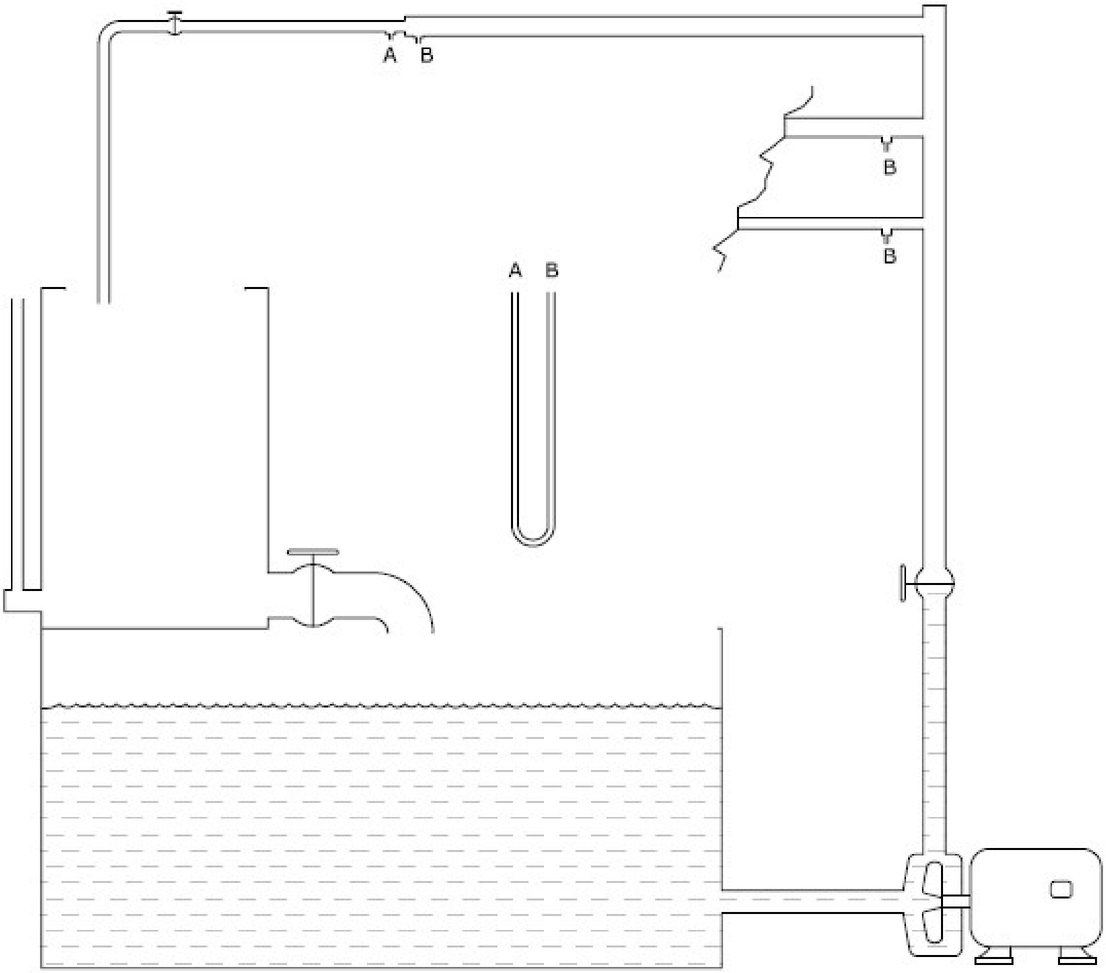
GRAPH:-

1. V vs hf
2. Log v vs log hf

RESULT:-

The experiment was conducted and friction factor of given pipe line is ----------------

DETERMINATION OF LOSS OF HEAD DUE TO SUDDEN CONTRACTION



Losses in Sudden Contraction

DETERMINATION OF LOSS OF HEAD DUE TO SUDDEN CONTRACTION

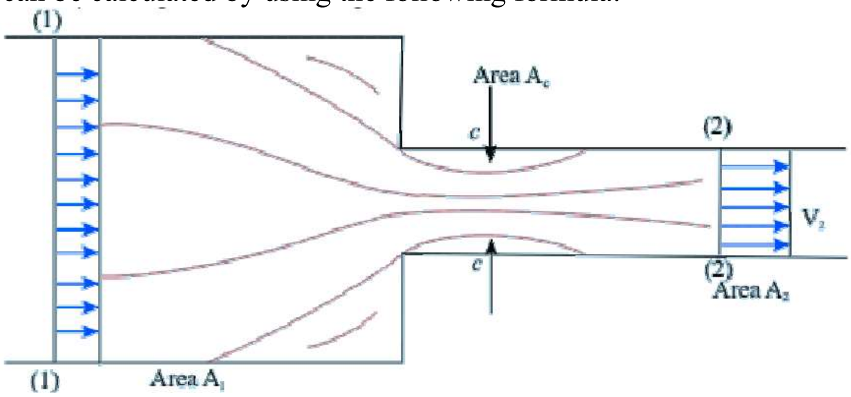
Date:-

Ex.No:-

AIM: - To determine the loss of head due to sudden contraction

APPARATUS: - collecting tank fitted with piezometer and control valve, Stop watch and differential 'U' tube manometer.

THEORY: - Whenever there is a sudden contraction in a pipe there is a loss of pressure head. This Drop of head can be calculated by using the following formula:



$$h_C = \frac{V^2}{2g}\left[\frac{1}{C_c} - 1\right]^2$$

It is possible to measure the head loss directly using manometer. However it is difficult to attach orifice meters wherever this loss needs to be calculated. But we can calculate it with the above formula in case we know the Coefficient of contraction which is constant for a given fluid.

PROCEDURE:-

1. Measure thelength and breadth of the collecting tank and find area A m2
2. Open the respective valves in a pipe line where head loss to be measured. close other valves & pressure locks, adjust the flowing rate suitably.
3. Note the left limb reading (h1)cm and right limb reading (h2) cm of the manometer.
4. Close the drain valve of the collecting tank,
5. Find the time taken for 0.1 m rise of water in collecting tank.
6. Repeat the experiment for different flow rates and flow through different pipe fittings.

FORMULAE: -

1. $crosssectionalareaofpipe(a_1) = \frac{\pi}{4}d^2$

   Where

   D= diameter of pipe=0.02 m

2. $AreaofcollectingtankA = lxbm^2$

   Where

   L= length of collecting tank=0.5 m

   B= breadth of collecting tank=0.5 m

3. $Lossofhead(h) = xX(\frac{S_m}{S_l} - 1)$

   Where

   x= difference of manometer reading=h1-h2 m

   S_m= specific gravity of mercury=13.6

   S_l = specific gravity of liquid=1

4. $DischargeQ = \frac{AH}{t}m^3/sec$

   Where

   A=area of collecting tank=0.25m2

   H= rise of water in collecting tank=0.1 m

   t= time taken for `h` rise of water

5. $Velocityofflow(v) = \frac{Q}{a}m/sec$

   Where

   Q= discharge

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

   d= diameter of pipe=0.02 m

6. $h_C = \frac{V^2}{2g}\left[\frac{1}{C_c} - 1\right]^2$

   Where,

   V = Velocity of flow.

C_c = Coefficient of contraction (0.62)

OBSERVATION TABLE:-

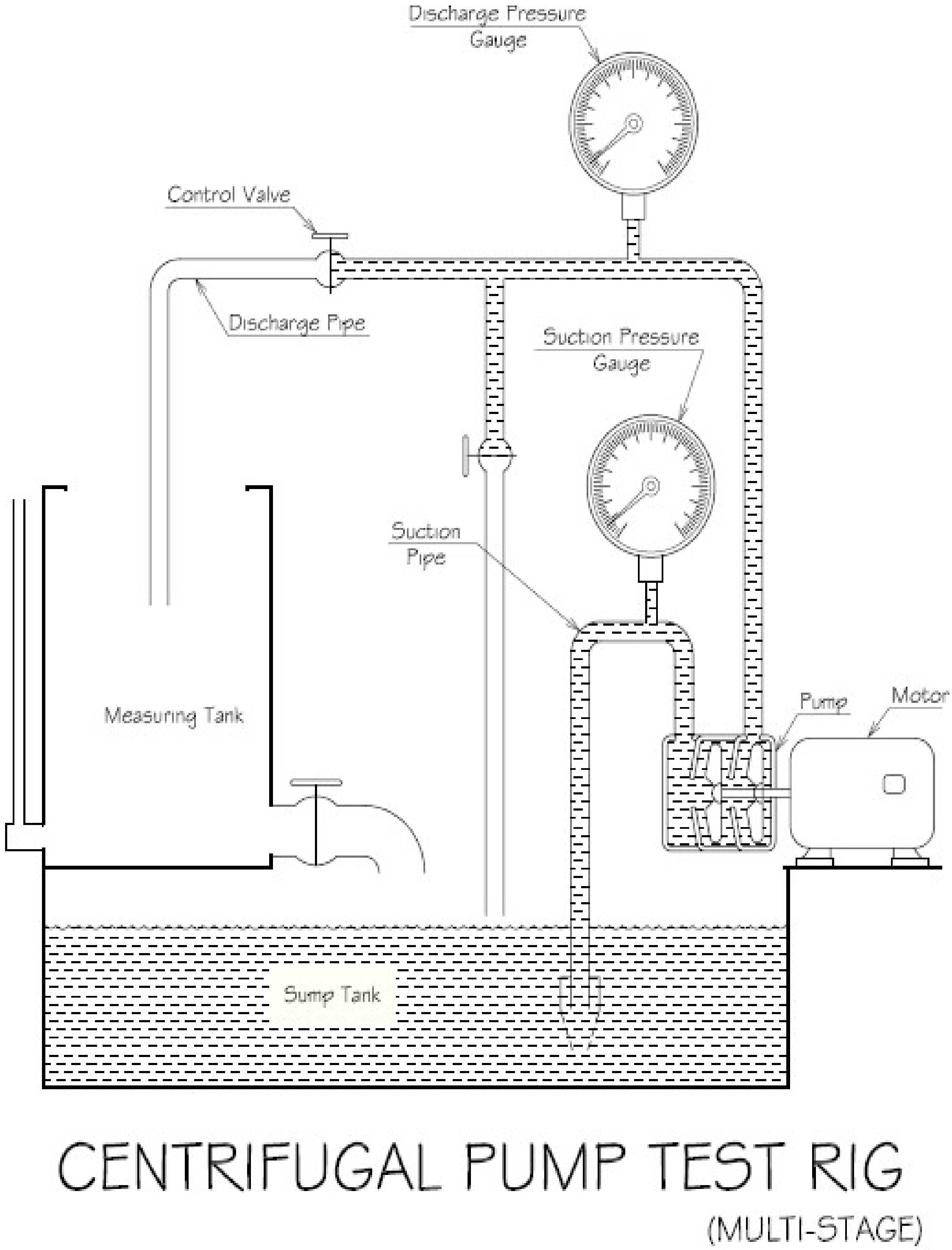
S. No	**Manometer reading**				$h = x(\frac{s_m - s_l}{s_l})$	**Time for 10 cm rise of water**
	h_1	h_2	$X=(h_1-h_2)$			
			Cm	**m**		

CALCULATION TABLE:

S. No	Discharge Q m^3/sec	Velocity v m^2/sec	V^2	$h_C = \frac{V^2}{2g}\left[\frac{1}{C_c} - 1\right]^2$

RESULT: - thus the loss of head due to sudden contraction-----------------

TEST ON MULTI STAGE CENTRIFUGAL PUMP



PERFORMANCETESTONMULTISTAGECENTRIFUGALPUMP

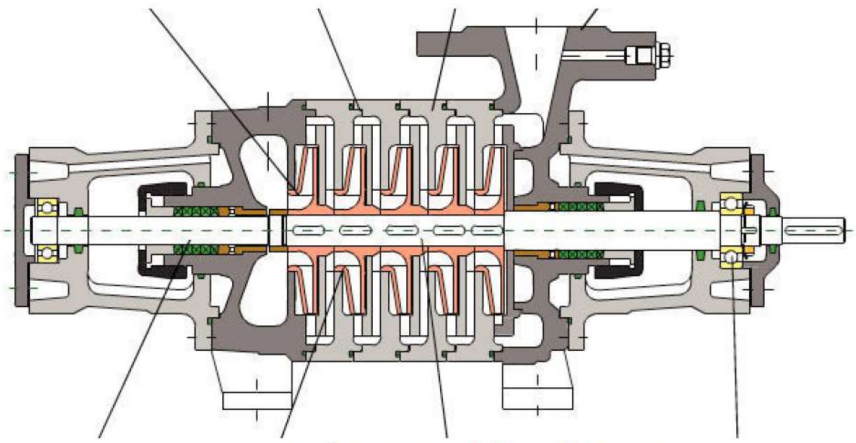
Date:-

Ex.No:-

AIM: - To study the performance of multistage centrifugal pump and draw the characteristic curves.

APPARATUS: - multistage centrifugal pump with electric motor, pipe system with all necessary valves, vaccumgauge on suction pipe, pressure gauge on delivery pipe, energy meter, tachometer, stop watch, collecting tank.

THEORY:-Centrifugal pumps are basically Roto-Dynamic Pumps, which develop Dynamic Pressures for Liquids. In Centrifugal pumps, liquid in Impeller is made to rotate by external force, so that it is thrown away from the Center of Rotation. As constant supply of fluid is needed at the center of rotation, its supply can be taken from higher level. Normally, head produced by a single impeller depends upon the peripheral speed of the impeller. In order to produce higher heads, either rotational speed or diameter of the impeller has to be increased, which increases stresses in the material of impellers. Hence, two pumps in series can be used to produce higher heads. Now, this method is replaced by multistage pumps. In multistage pumps, two or more impellers are arranged on a single shaft so that liquid discharged by first stage impeller at certain head passes to the next stage impeller, where the head is increased till the liquid finally enters into delivery pipe. The unit consists of a two stage centrifugal pump driven by a 3-phase induction motor. An energy meter provided measures electrical input to the motor and a measuring tank provided enables to measure the discharge of the pump.



A 5 Stage Centrifugal Pump

PROCEDURE:-

1. The pump was primed and motor was started by keeping the delivery valve closed.
2. Note down the pressure gauge and vacuum gauge reading by adjusting the delivery valve to require head say 0 meters. Now calculate the total head (H).

Pressure Head (or) Suction head H_s= _______Kg/cm² x 10 meters.

$$\text{Vaccum Head}= \frac{\text{mm of hg x 13.6}}{1000} \text{ meters}$$

Datum head (z) = Distance between pressure and vacuum gauge in meters (0.3m)

$$Totalhead\ (H) = PressureHead\ (H_s) + VacuumHead\ (or)\ Deliveryhead\ (H_d) + DatumHead\ (z)$$

3. Note down the time required for the rise of 10cm (i.e. 0.1m) water in the collecting tank by using stop watch. Calculate discharge using below formula.

Discharge:- The time taken to collect some 'h' cm of water in the collecting tank in m³/sec.

$Q=AH/T m^3/sec$

Where:

A = area of the collecting tank in m² (0.5m X 0.5m)

h = rise of water level taken in meters (say 0.1m or 10cm)

t = time taken for rise of water level to height 'h' in seconds.

Note down the time taken for 'n' revolutions of energy meter disk and calculate the Input power

Input power to the pump, $p_i = n \times 3600 \times \eta_m / T \times N_e$ KW

ηm = Efficiency of motor (0.8).

n = No. of revolutions of energy meter disc (say 10 Rev.)

T = Time for Energy meter revolutions disc. In seconds

Ne = Energy meter constant 750 rev/KWH

4. Now calculate the output power

$$\text{Output power} = \frac{W \times Q \times H}{1000} \text{ Kw}$$

W = Sp. Wt. of water (9810 N/m^3)

Q = Discharge

H = Total Head

5. Efficiency(η)=$p_o/p_i \times 100$

6. Repeat the steps from 2 to 5 for various heads by regulating the delivery valve.

Table:-1

Observations:-

S. No.	Pressure gauge reading (kg/cm^2)	Vacuum gauge reading(mm of hg)	Time taken for 5rev of energy	Time taken for collecting 10 cm rise of water In collecting tank

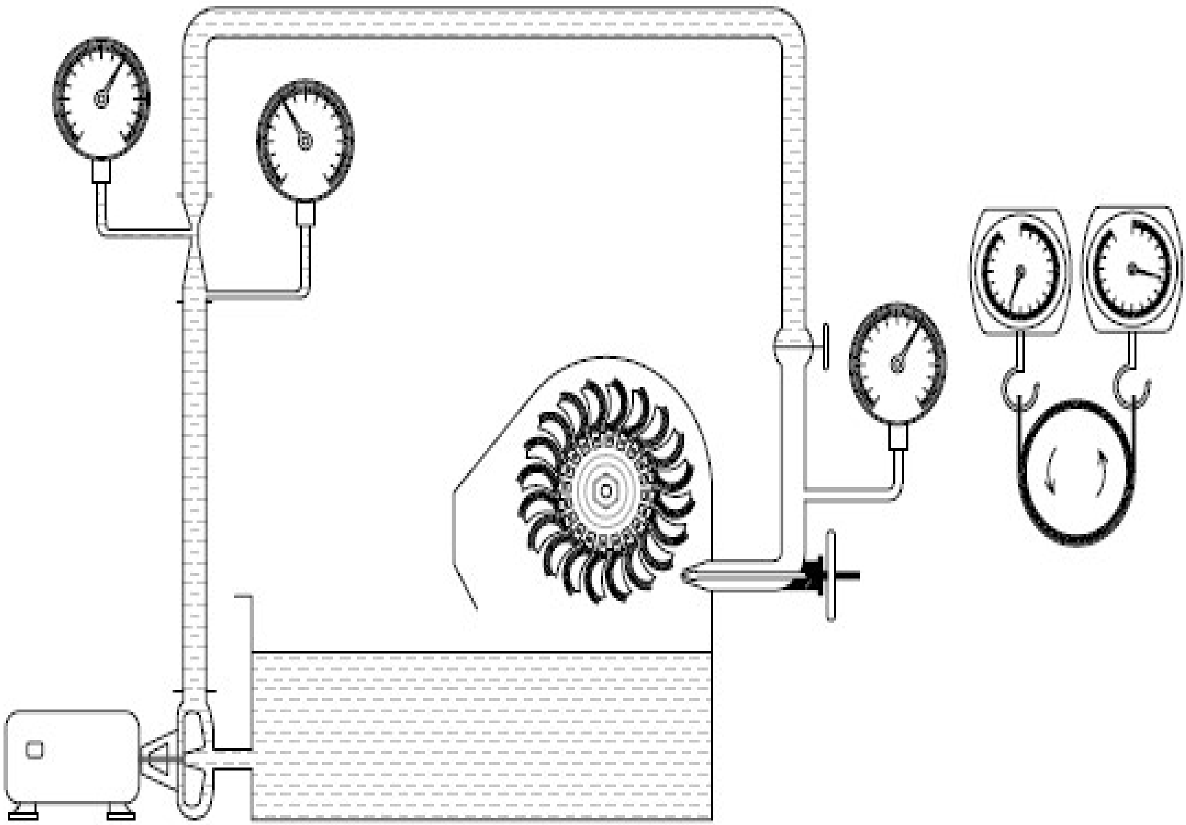
Graphs for :-

1. Discharge Vs Head
   Discharge Vs Input power
2. Discharge Vs Efficiency

Result table:

S. No.	Suction head Hs=p×0.0136 (mts of water)	Delivery head H_d =p×10 (m of water)	Total head H=hd+Hs+z (mts of water)	Actual discharge Q_a (m3/sec)	Input power Pi(w)	Out power Po(w)	% of Efficiency (ŋ)

RESULTS ANDCONCLUSIONS:-



PELTON WHEEL TEST RIG

TEST ON PELTON WHEEL TURBINE

Date:-

Ex.No:-

AIM:- To study the performance of pelton wheel turbine and to draw the characteristics curves at compact head.

APPARATUS:- Pelton wheel turbine with all necessary pipe network, centrifugal pump, manometer, spring balance , orificemeter,tachometer,pressure gauge, pipe system with all necessary control valves, rope brake dynamometer.

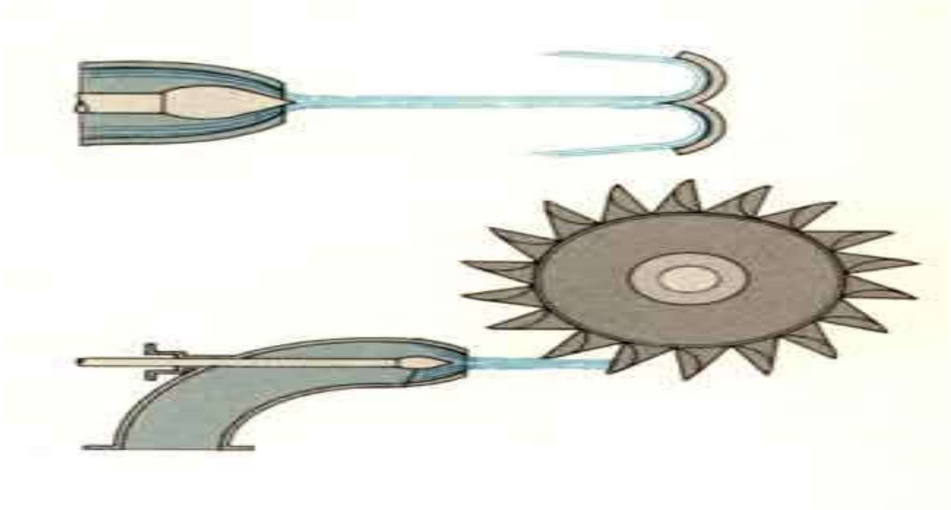
THEORY:-

Hydro-Power is one of major cheap source of power available on earth, and hence it is widely used for generation of electric power world wide. Water stored in the Dam contains potential energy. This is utilized to run turbine, which then drives a generator. The output from the generator can be transmitted to the areas of electric power requirement.

Turbines are basically of two types, viz. Impulse turbines and Reaction turbines. In impulse turbines, water coming from high head acquires high velocity. The high velocity water jet

strikes the buckets of the turbine runner and makes it to rotate by impact force. In reaction turbine, total head of water is partly converted into velocity head as it approaches turbine runner and it fills the runner and pressure of water gradually changes as it flows through runner. In impulse turbine, the only turbine used now-a-days is Pelton Wheel Turbine. In reaction turbines, Francis Turbine and Kaplan Turbine are the examples.

The Pelton wheel turbine consists of a runner mounted over the main shaft. Runner consists of buckets fitted to the disc. The buckets have a shape of double ellipsoidal cups. The runner is encased in a casing provided with a Perspex window for viewing the turbine. A nozzle fitted in the side of casing directs the water jet over the 'Splitter' or center ridge of the buckets. A spear operates inside the nozzle to control the water flow. On the other side of the shaft, a rope brake is mounted for loading the turbine. Impulse turbines convert all the energy of Water into Kinetic Energy at the nozzle. The jet impinges on the turbine's curved blades and gets diverted (by about 160o). The resulting change in momentum (impulse) causes a force on the turbine blades. All the Pressure/Potential Energy is converted to kinetic energy by the nozzle and focused on the turbine. No pressure change occurs at the turbine blades, and the turbine doesn't require a housing for operation. Newton's second law lets us calculate transfer of energy for impulse turbines. Impulse turbines are most often used in very high head applications, but the discharge used is less.



PROCEDURE:-

1. Centrifugal pump is switched on to supply the required head of water.
2. The discharge at no load condition is measured.
3. The pressure guage and vaccum guage readings are noted.
4. The speed of the turbine is recorded by means of Tachometer.
5. The speed of the turbine is loaded by means of rope breaking dynamometer.
6. The turbine is supply head is maintained constant and load on rope breaking dynamometer is increased in stages.
7. The experiment is repeated on different speeds.
8. The following readings are noted down in each case
   I. Pressure guage reading
   II. Vaccum guage reading
   III. Difference in mercury level of manometer
   IV. Speed of turbine
   V. Load on rope head.

FORMULAES:-

1.$Delivery head H_d = P \times 10\ m$

2. $h = x\left(\frac{S_m}{S_l} - 1\right) m$

3. $Torque = (W - S) \times R \times 9.81 \quad N - m$

Where

W= Weight over hanger in Kg

S= Spring balance reading in Kg

R= Radius of braek drum = 0.1 m

4. $Discharge(Q) = \frac{C_d \times a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$

Where

$$C_d = coefficientofdischarge = 0.6$$

$$a_1 = areaofpipe = \frac{\pi}{4} d_1^2$$

d_1=diameter of inlet pipe=0.05 m

$$a_2 = areaoforifice = \frac{\pi}{4} d_2^2$$

d_2=diameter of orifice=0.03 m

5. $InputpowerP_i = WQHwatts$

Where,

W= weight density of water=9.81×1000 $\frac{N}{m^3}$

Q= Discharge m^3/sec

H=Pressure head

6. $OutputpowerP_o = \frac{2\pi NT}{60} watts$

Where

N=speed of the shaft

T= torque

7. $Efficiency = \frac{P_o}{P_i} \times 100$

8. $UnitspeedN_u = \frac{N}{\sqrt{H}}$

9.$SpecificspeedN_s = \frac{N\sqrt{P_O}}{H^{5/4}}$

10. $Unit dishargeQ_u = \frac{Q}{\sqrt{H}}$

11.$Unit power P_u = \frac{p_o}{H^{3/2}}$

GRAPH:

Constant head characteristics

1. Unit discharge (Qu) vs. Unit speed (Nu).
2. Unit power (Pu) vs. Unit speed (Nu).
3. Percentage efficiency (%η) vs. Unit speed (Nu).

PRECAUTIONS:-

1. Do not start pump set if the supply voltage is less than 300 V (phase to phase voltage).
2. Do not forget to give electrical earth and neutral connections correctly. Otherwise, the RPM indicator gets burnt if connections are wrong.
3. Frequently, at least once in three months, grease all visual moving parts.
4. Initially, fill-in the tank with clean water free from foreign material. Change the water every six months.
5. At least every week, operate the unit for five minutes to prevent any clogging of the moving parts.
6. To start and stop the supply pump, always keep gate valve closed.
7. It is recommended to keep spear rod setting at close position before starting the turbine. This is to prevent racing of the propeller shaft without load.
8. In case of any major faults, please write to manufacturer, and do not attempt to repair.

RESULT:-

Thus the experiment was conducted that the performance of the PELTON WHEEL turbine calculated & characteristic curves are plotted.

The average efficiency of pelt on wheel turbine =______________%

TEST ON FRANCIS TURBINE

Date:-

Ex.No:-

AIM:- To study the performance of FRANCIS turbine and to draw the characteristics curves at compact head.

APPARATUS:-FRANCIS turbine with all necessary pipe network, centrifugal pump, manometer, spring balance , orifice meter, tacho meter, pressure gauge, pipe system with all necessary control valves, rope brake dynamometer.

THEORY:-

Reaction Turbine: - In this type of turbine there is a gradual pressure drop and takes place continuously over the fixed and moving blades or over guide vanes and moving vanes. The function of the guides' vanes is that they alter the direction of water as well as increases its velocity. As the water passes over the moving vanes its kinetic energy is absorbed by them.

Francis Turbine: - The inward flow reaction turbine having radial discharge at outlet is known as Francis turbine, after the name of J.B Francis an American engineer who in beginning designed inward radial flow reaction turbine. In the modern Francis turbine, the water enters the runner of the turbine in the radial direction and leaves in the axial direction at the outlet of the runner. Thus the modern Francis turbine is a mixed flow type turbine.

Constructional details:-

The main parts of the Francis turbine are: -

1. Penstock
2. Casing
3. Guide mechanism
4. Runner
5. Draft tube

1. Penstock: - It is a long pipe at the outlet of which a nozzle is fitted. The water from reservoir flows through the penstock. The nozzle increases the kinetic energy of water flowing through the penstock.

2. Casing: - In case of reaction turbine, casing and runner are always full of water. The water from the penstocks enters the casing which is of spiral shape in which area of cross-section of the casing goes on decreasing gradually. The casing completely surrounds the runner of the turbine. The casing is made of spiral shape, so that the water may enter the runner at constant velocity through the out of the circumference of the runner. The casing is made of concrete or cast steel.

3. Guide Mechanism: - It consists of a stationary circular wheel all round the runner of the turbine. The stationary guide vanes are fixed on the guide
mechanism. The guide vanes allow the water to strike the vanes fixed on
the runner without shake at inlet. Also by a suitable arrangement, the width between two adjacent vanes of a guide's mechanism can be altered so that the amount of water striking the runner can vary.

4. Runner: - It is a circular wheel on which a series of radial curved vanes are fixed. The surface of the vanes is made very smooth. The radial curved vanes are so shaped that the water enters and leaves the runner without shock. The runners are made of cast steel, cast iron or stainless steel. They are keyed to the shaft.

5. Draft tube: - The pressure at the exit of the runner of a reaction turbine is generally less than atmosphere pressure. The water at exit cannot be directly discharged to the tail race. A tube or pipe of gradually increasing area is used for discharging water from the exit of the turbine to the tailrace. This tube of

increasing area is called draft tube. The draft tube, in addition to serve a passage for water discharge, has the following two purposes also.
1. The turbine may be placed above the tail race and hence turbine may
be inspected properly.
2. The kinetic energy rejected at the outlet of the turbine is converted
into useful pressure energy.
Specifications:-
1. Type –Reaction Turbine
2. Type of flow – Mixed (Redial & Axial)
3. Head –Medium 45 to 250m
4. Specific speed – Medium 50 to 250
5. Shaft position – Mainly vertical (it may be horizontal also)
6. Discharge – Medium

Governing Mechanism:-
The governing mechanism changes the position of guide blades to affect a variation in the water flow rate in the wake of changing load condition of the turbine. When the load changes, the governing mechanism rotates all guide blades about their axis through the same angle so that the water flow rate to the runner and its direction essentially remain the same at the all passages between any two consecutive guide vans. The penstock pipe feeding the turbine is often fitted with a relief valve, also known as the pressure regulator. When guide vanes are suddenly closed, the relief valve opens and diverts the water direct to tail race. The simultaneous operation of guide vanes and relief valve is termed as double regulation

PROCEDURE:-

1. Centrifugal pump is switched on to supply the required head of water.
2. The gate opening is adjusted to 50%and the discharge is measured by a orifice meter.
3. The pressure guage and vaccum guage readings are noted.
4. The speed of the turbine is recorded by means of Tachometer.
5. The speed of the turbine is loaded by means of rope breaking dynamometer.
6. The turbine is supply head is maintained constant and load on rope breaking dynamometer is increased in stages.
7. The experiment is repeated on different weights.
8. The following readings are noted down in each case
   VI. Pressure guage reading
   VII. Vaccum guage reading
   VIII. Difference in mercury level of manometer
   IX. Speed of turbine
   X. Load on rope break

FORMULAES:-

1.$Delivery head H_d = P \times 10\ m$

2.$suction head = G \times 0.0136\ m$

Where

G= vaccum head

3. $Total head H = H_d + H_s + Z$

Z=0.1 m

4. $h = x\left(\frac{S_m}{S_l} - 1\right) m$

5. $Torque = (W - S) \times R \times 9.81 \quad N - m$

Where

W= Weight over hanger in Kg

S= Spring balance reading in Kg

R= Radius of braek drum = 0.1 m

6. $Discharge(Q) = \frac{C_d \times a_1 a_2 \sqrt{2gh}}{\sqrt{{a_1}^2 - {a_2}^2}}$

Where

$$C_d = coefficient of discharge = 0.6$$

$$a_1 = area of pipe = \frac{\pi}{4}{d_1}^2$$

d_1=diameter of inlet pipe=0.1 m

$$a_2 = area of orifice = \frac{\pi}{4}{d_2}^2$$

d_2=diameter of orifice=0.06 m

7. $Input power P_i = WQH watts$

Where,

W= weight density of water=9.81×1000 $\frac{N}{m^3}$

Q= Discharge m^3/sec

H=Pressure head

8. $Output power P_o = \frac{2\pi NT}{60} watts$

Where

N=speed of the shaft

T= torque

9. $Efficiency = \frac{P_o}{P_i} \times 100$

10. $Unit speed N_u = \frac{N}{\sqrt{H}}$

11. $Specific speed N_s = \frac{N\sqrt{P_O}}{H^{5/4}}$

12. $Unit disharge Q_u = \frac{Q}{\sqrt{H}}$

13. $Unit power P_u = \frac{p_o}{H^{3/2}}$

GRAPH:-

Constant speed characteristics

1. Unit discharge (Qu) vs. Unit speed (Nu).
2. Unit power (Pu) vs. Unit speed (Nu).
3. Percentage efficiency (%η) vs. Unit speed (Nu).

N_u--------- x-axis

PRECAUTIONS:-

1. Do not start pump set if the supply voltage is less than 300 V (phase to phase voltage).
2. Do not forget to give electrical earth and neutral connections correctly. Otherwise, the RPM indicator gets burnt if connections are wrong.
3. Frequently, at least once in three months, grease all visual moving parts.
4. Initially, fill-in the tank with clean water free from foreign material. Change the water every six months.
5. At least every week, operate the unit for five minutes to prevent any clogging of the moving parts.
6. To start and stop the supply pump, always keep gate valve closed.
7. It is recommended to keep spear rod setting at close position before starting the turbine. This is to prevent racing of the propeller shaft without load.
8. In case of any major faults, please write to manufacturer, and do not attempt to repair.

RESULT:-

Thus the experiment was conducted that the performance of the FRANCIS turbine calculated & characteristic curves are plotted.

The average efficiency of francis turbine =

VERIFICATION OF BERNOULLI'S EQUATION

Experiment No : **Date:**

Apparatus: Bernoulli's Apparatus Controlling valve at inlet and outlet, Discharge Measuring Tank, Scale, Stopwatch etc.

Formula: Total Energy = $\frac{P}{\rho g} + \frac{v^2}{2g} + z = Const$

Where $\frac{P}{\rho g}$ = Pressure Energy, $\frac{V^2}{2g}$ = Kinetic Energy, Z = Potential Energy

Theory: The Bernoulli's theorem states that the total energy of in viscid, incompressible fluid in a steady state of flow, remains constant along a stream line. Daniel Bernoulli's enunciated in 1738 that is "In any stream flowing steadily without friction, the total energy contained in a given mass is some at energy contained in a given mass is some at energy point in its path of flow."

Procedure:

1. Open the measuring tank valve fully, to keep the tank empty. Close the outlet valve.

2. Open the inlet valve and let water rise to some height 'h1' in the inlet tank. Measure this height on the piezometer.

3. Now open the outlet valve slightly and maintain height h2 < h1 to maintain the flow rate.

4. Thus adjust the outlet valve fill the water level remains constant at 'h', and also readings on each of the piezometer.

5. Check if reading is correctly written. Close the measuring tank valve. Measure the discharge, i.e. note rise in water level in 5 or 10 sec., write these and also measure and note length and breath of the tank. This completes on run. Take at least three runs by changing the discharge.

6. Note down the area of the conduit at various gauge points.

7. Open the supply valve and adjust the flow so that the water level in the inlet tanks remains constant.

8. Measure the height of water level (above an arbitrarily selected suitable plane) in different remains constant.

9. Measure the discharge of the conduit with the help of measuring tank.

10. Repeat steps 2 to 4 for two more discharges.

11. Plot graph between total energy and distance of gauge points starting from u/s side of conduit.

Observation :

Area of collecting tank=A=LxB=_____________x_________=__________cm^2 Difference in water level in collecting tank =Δh =__________________cm

Time required for rise of water level by 10 cm =Δt=____________sec.

$$\text{Discharge} = Q_{act} = \frac{\text{Volume of water}}{Time} = \frac{A\Delta H}{\Delta t} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \frac{m^3}{s}$$

S No	Piezometric Head $\frac{P}{w}+z$	Duct Area $a\ cm^2$	Velocity $V=\frac{Q}{a}\frac{cm}{s}$	Velocity Head $\frac{V^2}{2g}$	Total Energy $\frac{P}{\rho g}+\frac{v^2}{2g}+z=Const$

Result:

Calibration of rectangular notch

Experiment No: **Date:**

Aim of the Experiment

To Determine the Co-efficient of discharge of a flow through rectangular notch

Theory

A notch is a device used for measuring the rate of flow of liquid through a small channel (or) a tank. It is used to estimate discharge and velocity of flowing water. Notches are those over flow structure whose length of crest in the direction of low is accurately shaped. There may be rectangular, trapezoidal,V-notch etc. a rectangular notch, symmetrically located in a vertical thin plate, which is placed perpendicular to the side and bottom of a straight channel, is defined as a rectangular sharp-crested notch. The discharge coefficient Cd of a rectangular notch given by

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

In which Q_{act}=the actual discharge flowing in the pipe and Q_{th}=theoretical discharge of rectangularnotch is given by

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

Where Q=discharge over a rectangular notch, B=width of notch and H=head over the crest of the notch.

Apparatus used

Approach channel with baffle plate fitted with notch, A Surface level gauge to measure head over notch, a measuring tank to measure flow rate and a constant steady supply of water with using pump.

Procedure

i) The notch under test is positioned at the end of the tank, in a vertical plane and with the sharp edge on the upstream side.

ii) Thetankisfilledwithwateruptocrestlevelandsubsequentlynotedownthecrestlevelofthenotch by the help of a point gauge.

iii) Theflowregulatingvalveisadjustedtogivethemaximumpossibledischargewithoutfloodingth enotch.

iv) Conditions are allowed to steady before the rate of discharge and head H were recorded.

v) The flow rate is reduced in stages and the reading of discharge and H were taken.

vi) The procedure is repeated for other type of notch.

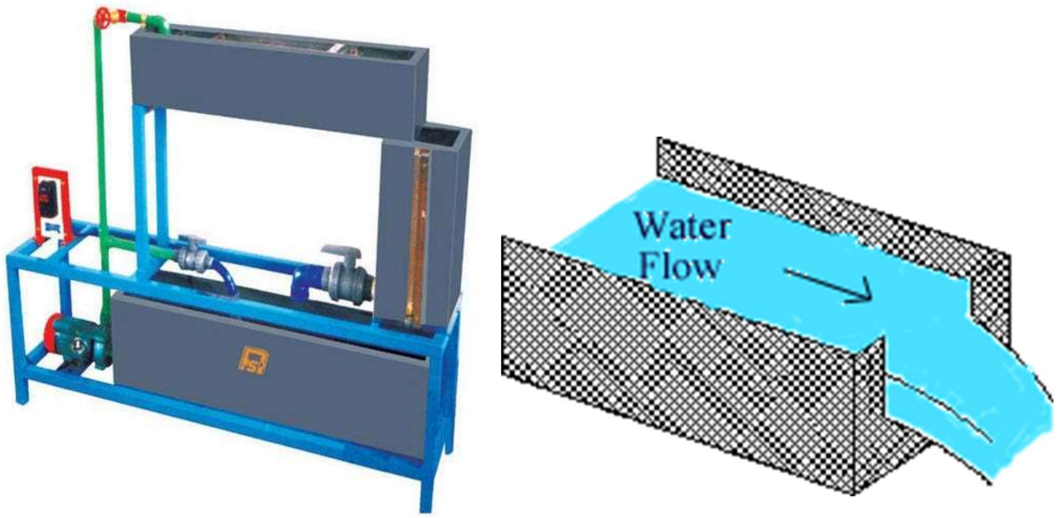


Fig. Experimental setup of rectangular notch apparatus.

Observation

Area of collecting tank (A) =

Width of notch (B)=

Crest Level of trapezoidal notch (H0)=

Sl. No.	Rise of water level in collecting tank(h)	Δt	Discharge ($Q_{act}=\frac{Ah}{\Delta t}$)	Final Water level abovenotch(H1)	Water head(H= H1-H0)	$Q_{th}=\frac{2}{3}\sqrt{2g}\,BH^{3/2}$	$C_d=\frac{Q_{act}}{Q_{th}}$

Sample calculation

$$Q_{act} = \frac{Ah}{\Delta t} =$$

$$Q_{th} = \frac{2}{3}\sqrt{2g}BH^{3/2} =$$

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

Result: The average co-efficient of discharge of the rectangular notch is found to be____.

Loss of Head Due to Sudden Expansion

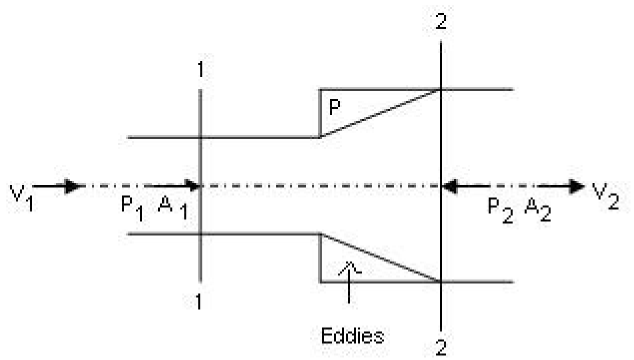
Experiment No: Date:

AIM:

To find the loss of head due to sudden expansion during flow through a pipe.

APPARATUS:

An arrangement for uniform supply of water, pipe fittings consisting of sudden enlargement, sudden contraction, elbow and bend, measuring tank with a piezometer and a scale, manometer.



THEORY:

(a) Loss of head due to sudden enlargement is given by

$$h_e = \frac{K_e \times (V_1 - V_2)^2}{2g}$$

where

V_1 = Velocity at inlet.

V2 = Velocity at outlet.

K_e = Coefficient of enlargement.

g = Acceleration due to gravity.

PROCEDURE:

Uniform water flow through a pipe fitting is made. The outlet through the pipe fitting is collected in a measuring tank. The amount water collected during a definite period of time (t = 60 s)is noted. Manometer readings in the two limbs connected on either side of the pipefitting is noted. Calculate the velocity of flow and head loss due to various fittings, calculate the different coefficients of various fittings. The above procedure is repeated for different flow rates and for different diameter of the pipe for different pipe fittings.

OBSERVATIONSUDDENEXPANSION:

Length of the measuring tank, l= ....mm

Breadth of the tank, b= .... mm

Pipe diameter, d_1=...............mm,

Pipe diameter, d_2=....................mm,

area, a_1= .... m^2

area, a_2= ....m^2

TABULARCOLUMNFORSUDDENENLARGEMENT

Sl. No	Hg manometer Reading(mm)			h_{fe}m H_2O	Measuring tank Reading in cms			Q m^3/s	V_1 m/s	V_2 m/s
	h_1	h_2	$h=h_1+h_2$(mts)		IR	FR	H=FR-IR (mts)			
1										
2										
3										

(a) SPECIMENCALCULATIONSFORSUDDENENLARGEMENT

1. Manometer head(h_f) in m of water

   h_{fe}=(12.6)×h= .... m

   $h = h_1 + h_2$

Where

2. Discharge, Q= l×b×H/60= .... m^3/s

3. Velocity at inlet of sudden enlargement pipe=V_1

   $=Q/a_1$ =.......................m/s

4. Velocity at exit of sudden enlargement pipe=V_2

   $=Q/a_2$= .... m/s

5. Coefficient of enlargement (K_e)

$$K_e = \frac{h_{fe} 2g}{(V_1 - V_2)^2}$$

OBSERVATIONSUDDENCONTRACTION:

Length of the measuring tank, L=.......................mm

Breadth of the tank, B=................mm

Pipe diameter, d_1=................mm,

Pipe diameter, d_2=.....................mm,

area, a_1= .... m^2

area, a_2= .... m^2

TABULARCOLUMNFORSUDDENCONTRACTION

		Hg manometer Reading(mm)			**h_{fc}m H_2O**	**Measuring tank Reading in cms**			**Q m^3/s**	**V_2 m/s**
		h_1	**h_2**	**$h=h_1+h_2$(cms)**		**IR**	**FR**	**H=FR-IR (cms)**		

Result:

COEFFICIENT OF DISCHARGE FOR A SMALL ORIFICE BY CONSTANT HEAD METHOD

Experiment No: **Date:**

AIM: To determine the coefficient of discharge for a small orifice by constant head method

APPARATUS:

1. Orifice

2. Stop clock

3. Collecting Tank

PROCEDURE:

1. Open the valve and let the water in to the balancing tank

2. Adjust the inlet valve such that the water remains constant at particular head.

3. Record the head orifice (H cm) i.e. the height of water surface from the center of orifice 4. At a particular head collect water flowing through the orifice in a collecting tank and note the time taken for collection of water.

5. Repeat the experiment for six different heads.

CALCULATIONS:

Theoretical discharge through an orifice

$$Qth = a\sqrt{2gH}$$

$$Qth = K\sqrt{H}$$

Where a= Area of cross section of orifice

H= Head of the orifice

g= acceleration due to gravity

Actual discharge through orifice is given by Ca=Cd ×Qth

Determination of coefficient of discharge by constant head method for an orifice

Diameter of an orifice= 3.0 cm

C/s area of an orifice=……………….

Size of collecting tank 50*50 cm2

OBSERVATIONS:

S.NO.	Head (H cm)	Rise of water in collecting Tank (R cm)	Volume of collecting Tank(cm3)	Actual discharge Qa =V/T	Theoretical discharge Qth = $K\sqrt{H}$	Coefficient of discharge K= Qa/Qth

RESULTS:

CALIBRATION OF CONTRACTED TRIANGULAR NOTCH

Experiment No: **Date:**

AIM:

To calibrate notches, and thereby establish the relationship between the head over weir and discharge.

APPARATUS:

1. Approach channel fitted with the notch or weir
2. A point gauge to measure head over the weir
3. A constant steady supply of water with a means of varying discharge
4. Measuring tank and stop watch to measure the actual discharge

THEORY:

A notch or sharp crested weir is a device used to measure the discharge flowing through the open channel. The general types of notches according to their geometric shapes are rectangular, triangular and trapezoidal.

End contraction: Due to the constriction of flow as it flows through the weir, the actual flow decreases. In case of rectangular weir, the flow through the weir including end contraction is given by

$$Q = \frac{2}{3} C_d \sqrt{2g}(L - 0.2h)h^{\frac{3}{2}} = \frac{2}{3} C_d \sqrt{2g}\, Lh^{\frac{3}{2}} - \frac{2}{15} C_d \sqrt{2g}\, h^{\frac{5}{2}}$$

As can be seen reduction in flow is triangular portion

$$\frac{8}{15} \times \frac{1}{4} C_d \sqrt{2g}\, h^{\frac{5}{2}} = \frac{8}{15} C_d \sqrt{2g} \tan\theta\ h^{\frac{5}{2}}$$

C_d = Coefficient of discharge

L= Crest length of rectangular notch=………………………….

θ = Half-angle of the triangular portion=………………………….

h= difference between crest reading to gauge reading (head of water over the notch)

g= 9.81 m/s^2

$\tan\theta$ = ¼

Triangular Notch

S. No.	Head over Notch	Time for____mm rise in tank	$Q_a = \frac{A \times r}{t}$	Q_t	$C_d = \frac{Q_a}{Q_t}$
	M	S	m^3/s	m^3/s	
1					
2					
3					
4					
5					

SPECIMEN CALCULATION:

Crest reading = ... m

$Q_a = \frac{A \times r}{t}$=................. *A*=....................... ....X...= .... m^2

$Q_t = \frac{2}{3}\sqrt{2g}\, Lh^{\frac{5}{2}}$ m^3/s

L=.................... m

g=9.81 m/s^2

$C_d = \frac{Q_a}{Q_t}$ =…………………………

Hence the triangular portion by the side of rectangular weir with crest width L is having slopes as 1H:4V. then the additional flow in the triangular portion of trapezoidal weir will be compensating for the end contraction and the flow through Cippoletti weir will be same as rectangular weir.

Coefficient if discharge is the ratio of actual discharge to the corresponding theoretical discharge to the weir crest is the point about which the flow is just about to begin.

Procedure:

1) Select the given notch set-up.
2) Note down the type of notch by using point gauge.
3) Note down the crest reading of the notch by using pint gauge.
4) Allow the water by opening the gate valves.
5) Note down the final reading by using point gauge.
6) Note down the time required to fill the particular height of water in the collecting tank
7) Repeat steps 5to 6 for various discharge by varying the gate valve for four more trails.

Precautions:

1) The weir / notch should be fixed exactly in the vertical plane perpendicular to the flow axis.
2) The weir should be fixed in a position such that it is symmetrical over vertical axis.
3) Sufficient time should be given foe the flow to become steady-uniform.
4) Gauge readings should be measured only in peizometre attached to the channel and not on the free surface.

Possible Errors:

1. Head should be constant in the head tank and the point gauge measurements before and after taking the readings of volumetric measurements (actual discharge) should be the same. If the measurements are not the same, take the average of the two readings.
2. Reading error may occur at gauge and volumetric peizometre scale by not recording the readings at the eye level.
3. Synchronize the stop watch operations for volumetric measurement

Triangular weir

$$Q_t = \frac{8}{15} C_d \sqrt{2g} \tan\theta \ h^{\frac{5}{2}} = K h^n$$

$$K = \frac{8}{15} C_d \tan\theta \sqrt{2g}$$

Where,

$log\ Q_a = log\ K + n\ log\ h$ at h =1; $Q_a = K$

hence,

$$C_d = \frac{k}{\frac{8}{15}\tan\theta\sqrt{2g}}$$ and n is the slope of the line

General values of the C_d varies in between 0.60 to 0.62 depending on the type of notch

Result

DETERMINATION OF COEFFICIENT OF DISCHARGE FOR AN EXTERNAL MOUTH PIECE BY VARIABLE HEAD METHOD

Experiment No: **Date:**

AIM: To observe the variation in the coefficient of discharge of a mouth piece with that in the head above the mouth piece using a mouth piece apparatus by falling head method.

APPARATUS: 1) Mouth piece apparatus, 2) Stop watch, 3) Scale

DESCRIPTION: The apparatus consists of a mouthpiece fitted to one side of a vertical tank, main water tank and a collecting tank. Water in the main tank can be driven by means of a motor so that it flows in the mouthpiece fitted tank and there by into the collecting tank through the mouth piece. A valve is provided at the site of motor so that flow in the mouth piece fitted tank can be adjusted. The vertical tank is provided with some scale to measure the head of water above the mouth piece. The collecting tank is provided with some scale to read the water level in it and there by volume of water collected can be computed.

THEORY: Mouth piece is a short length pipe which is two or three times its diameter in length, fitted in a tank or vessel containing fluid. It is used to measure the rate of flow of fluid.

Mouth piece fitted external to the tank is called external mouthpiece (this is the present use with our experiment). The jet of liquid entering the mouth piece constructs to form a vena – contracta. Beyond this section jet again expands and fill the mouth piece completely.

Measurement of coefficient of discharge by falling head method

$$\text{Coefficient of discharge} = C_d = \frac{2A(\sqrt{H_1} - \sqrt{H_2})}{(a \times t \times \sqrt{2g})}$$

Where A = area of the over head
tank H = head of water above the mouth piece
a = area of mouth piece
t = time for water level to fall by 5 cm

PROCEDURE:

1) The mouthpiece fitted tank is completely filled with water.

2) Starting from say40 cm above the mouthpiece (i.e head) time taken for water level to drop by say 5cm is noted.
3) Now time for water level to drop from 35 to 40cm is noted
4) Similarly 5 to 6 readings are noted.
5) The readings are tabulated.

PRECAUTIONS:

1) Head above the mouthpiece should be noted carefully.
2) Time for rise in water level in collecting tank and that for fall in water level in mouth piece fitted tank should be correctly noted.

OBSERVATIONS:

S.No	Water head above the mouth piece		Time taken for 5 cm fall of water level	C_d
	Initial H_1	Final H_2		

MODEL CALCULATIONS:

$$\text{Coefficient of discharge} = C_d = \frac{2A(\sqrt{H_1} - \sqrt{H_2})}{(a \times t \times \sqrt{2g})}$$

Where A = area of the over head tank = 0.34 X 0.35 = 0.119 m^2 H_1 = Initial head of water above the mouth piece =
H_2 = Final head of water above the mouth piece = a = area of mouth piece ($\pi/4\ d^2$)
d = Diameter of the mouth piece = 0.01 m t = time for water level to fall by 5 cm

GRAPHS: t Vs $\sqrt{H_1}$ $\sqrt{H_2}$

RESULT: Mean value of C_d of mouth piece =

DETERMINATION OF COEFFICIENT OF DISCHARGE FOR AN EXTERNAL MOUTH PIECE BY CONSTATNT HEAD MOUTH

Experiment No: **Date:**

AIM: To observe the variation in the coefficient of discharge of a mouth piece with that in the head above the mouth piece using a mouth piece apparatus by constant head method.

APPARATUS: 1) Mouth piece apparatus, 2) Stop watch, 3) Scale

DESCRIPTION: The apparatus consists of a mouthpiece fitted to one side of a vertical tank, main water tank and a collecting tank. Water in the main tank can be driven by means of a motor so that it flows in the mouthpiece fitted tank and there by into the collecting tank through the mouth piece. A valve is provided at the site of motor so that flow in the mouth piece fitted tank can be adjusted. The vertical tank is provided with some scale to measure the head of water above the mouth piece. The collecting tank is provided with some scale to read the water level in it and there by volume of water collected can be computed.

THEORY: Mouth piece is a short length pipe which is two or three times its diameter in length, fitted in a tank or vessel containing fluid. It is used to measure the rate of flow of fluid.

Mouth piece fitted external to the tank is called external mouthpiece (this is the present use with our experiment). The jet of liquid entering the mouth piece constructs to form a vena – contracta. Beyond this section jet again expands and fill the mouth piece completely.

Measurement of coefficient of discharge by Constant head

method Theoretical discharge = $Q_{th} = a\sqrt{2gH}$

Where a – area of mouth piece
H – head of water above the mouth

piece Actual discharge = $Q_{act} = (A \times h) / t$

Where A – area of the collecting
tank h – rise in water level
And t – time for water level to rise by h

Coefficient of discharge is defined as the ratio of actual discharge to theoretical discharge

$$C_d = Q_{act} / Q_{th}$$

PROCEDURE:

6) The main tank is filled with water and the motor is switched on
7) Valve at the motor site is closed to transfer in to the vertical mouth piece fitted tank
8) Time is allowed for the water level to settle at some height above the mouth piece

The head of water above the mouthpiece is measured by means of the scale provided at the side of the tank

9) The head of water above the mouthpiece is measured by means of the scale provided at the side of the tank.
10) Time for 5am rise in water level in the collecting tank is noted.
11) The valve at motor site is further closed to achieve another flow rate and the above procedure is adopted.
12) In this manner for 2 more times the similar procedure is repeated and the readings are noted.
13) Readings at 4 different heads are noted in a tabular form.

PRECAUTIONS:

1) Head above the mouth piece should be noted carefully.
2) Time for rise in water level in collecting tank and that for fall in water level in mouth piece fitted tank should be correctly noted.

Observations:

S.No	Time taken for 5 cm rise of water level	Head above mouth piece H cm	Q_{act}	Q_{th}	C_d

MODEL CALCULATIONS:

Theoritical discharge = $Q_{th} = a\sqrt{2gH}$

Where a – area of mouth piece = $\pi d^2/4$

d = dia of mouth piece = 0.01 m

H – head of water above the mouth piece in meters

Actual discharge = $Q_{act} = (A X h) / t$

Where A – area of the collecting tank = .45x 0.55 = 0.2475 m^2 h
– rise in water level (in meters)
t – time for water level to rise by h

$C_d = Q_{act} / Q_{th}$

GRAPHS: 1) Q_{act} Vs H 2) Q_{act} Vs Q_{th} Take Q_{act} on Y-axis

RESULT:

Mean value of Cd of mouth piece = Cd of mouth piece by Graph =