Terna Public Charitable Trust's

College of Engineering, Osmanabad

Dept. of Civil Engineering

Class:- S.Y.B Tech **Sub:-** Hydraulics-II

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Experiment No. : 01

Measurement of discharge

Aim: - To determine the co-efficient of discharge of a rectangular notch.

Theory:-

Notch: Notch is a device or arrangement made across the flow in open channel for measuring the discharge.

The discharge coefficient Cd of a rectangular notch must be determined by applying formula

$$Q = \frac{2}{3} L\, C_d \sqrt{2g}\, H^{3/2}$$

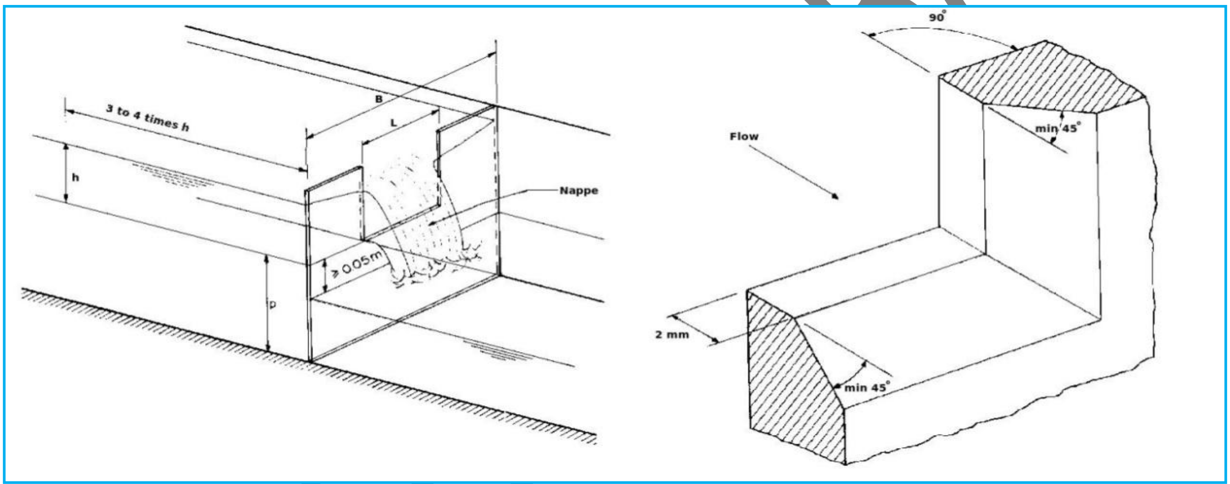


Fig.1 Rectangular Notch Apparatus Setup

Experimental Procedure:-

1. Check the experimental setup for leaks. Measure the dimensions of collecting tank and the notch.
2. Observe the initial reading of the hook gauge and make sure there is no discharge. Note down the sill level position of the hook gauge.
3. Open the inlet valve of the supply pipe for a slightly increased discharge. Wait for sometime till the flow become steady.
4. Adjust the hook gauge to touch the new water level and note down the reading. Difference of this hook gauge reading with initial still level reading is the head over the notch (h).
5. Collect the water in the collecting tank and observe the time t to collect R

Raise/Height of water.

6. Repeat the above procedure for different flow rates by adjusting the inlet valve opening and tabulate the readings.
7. Complete the tabulation and find the mean value of CD.
8. Draw the necessary graphs and calibrate the notch.

Observations:-

Initial Hook gauge reading = mm

Observation Table

Sl.No.	Sill level reading mm	Reading of head over the sill Mm	Head over the sill h cm	Rise cm	Time taken t sec.	Q_{th} m^3/s	Q_{act} m^3/s	Coefficient of discharge C_d

Specimen Calculations:-

$Q_a = A.R/t$

where $A = 6400\ cm^2$

$Q_a = C_d\ Q_{th}$

$Q_{th} = (2/3)\ L\ \sqrt{(2g)}\ h^{3/2}$

g = Acceleration due to gravity = $9.81\ m/sec^2$

$C_d = Q_a/Q_t$

Results:-

Coefficient of discharge of the given triangular notch from

1.Calculations

Conclusion:-

Average Cd ______________

Experiment No. : 02
Calibration of Ogee Weir

Aim : To calibrate the ogee weir and hence to determine the value of C_d

Apparatus :

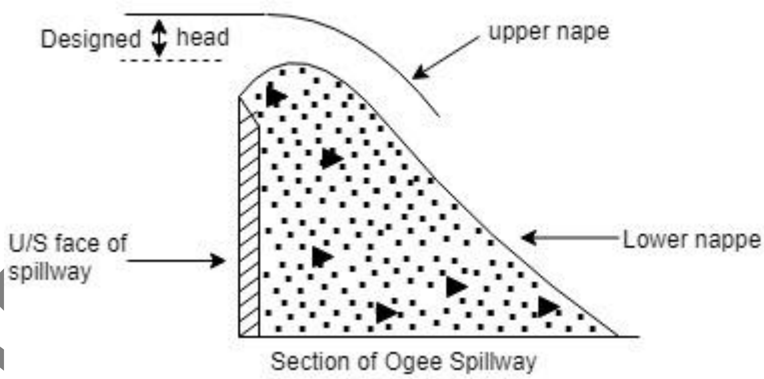
1. A constant steady water supply with a means of varying the flow
2. An approach channel (flume)
3. ogee weir (to be calibrated)
4. A flow rate measuring facility ((calibrated rectangular notch)
5. Hook gauge

Theory:

Generally ogee shaped weirs are provided for the spillway of a storage dam. The crest of the ogee weir is slightly rises and falls into parabolic form. Flow over ogee weir is also similar to flow over rectangular weir. The crest of the weir rises upto a maximum of 0.115H, where H is the head over the weir.

Formula governing the flow over a ogee weir is $Q = = (2/3)LC_d \sqrt{2g}H^{3/2}$ -----------1

Where L= length of weir (measured perpendicular to the direction of flow or the width of the channel in the laboratory)



Section of Ogee Spillway

Procedure:

1. Start the pump with the help of electrical 3phase DOL starter (Direct on line) and observe water flowing in the flume. Wait till the water level rises to the crest level of the weir fixed at the down stream end.
2. Adjust the vernier scale any whole number of main scale division and lock it.
3. Bring the hook gauge point exactly to the water level, note it as initial level h_1
4. measure the discharge flowing over the ogee weir note it as h_2
5. Procedure was repeated for different discharges.

Observation & calculation

		Head over weir			Length of weir		
Sr No	**Rotameter Reading LPM**	**Crest Level h_1m**	**Water Level h_2m**	**Head over weir H = h_1- h_2**	**Q act m^3/sec**	**Q th m^3/sec**	**Cd**

Calculations:(any one trial)

Qth =(2/3) $\sqrt{2g}$ LH$^{3/2}$

Qact = Rotameter reading in m^3 / sec

Cd= Qact / Qth

Graphically,

A log Qa vs log H suggests a straight line relation as shown in fig. This equation is of the form

Qa=(2/3) $\sqrt{2g}$Cd L x H$^{3/2}$ =KH^n

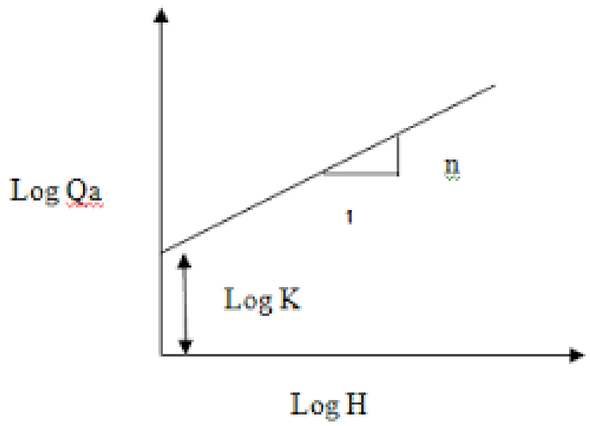
Taking log on both sides

log Qa =logK+n logH

Where logK is the intercept on the log Q axis n is the slope of the straight line. n

Knowing the valve of logK, K can be determined and then the value of Cd is determined as follows. 1

Cd = (1/K) X (1/Slope)



Experiment no 3 (a)

Study of hydraulic jump

Aim: To determine Hydraulic jump .

Experimental Setup:

For conducting this experiment long hollow rectangular channel is used with bed slope adjustments. Inlet pipe is provided with flow regulating arrangement. Outlet of channel is directly taken to the measuring tank which is provided with piezometer tube arrangement outlet is provided with measuring tank

Theory

The rise of water level, which takes place due to transformation, the unstable shooting flow (super critical) to the stable streaming flow (sub critical flow).

The height of water of the section 1-1 is small. As we move towards downstream, the height or depth of water increases rapidly over a short length of the channel. This is because of the section 1-1, the flow is a shooting flow as the depth of water at section 1-1 is less than critical depth. Shooting flow is an unstable type of flow & does not continue on the downstream side then this shooting flow will convert itself into a streaming flow & hence depth of water will increase.

Hydraulic jumps are very efficient in dissipating the energy of the flow to make it more controllable & les erosive. In engineering practice, the hydraulic jump frequently appears downstream from overflow structures (spillways), or under flow structures (slvice gates), where velocities are height.

A hydraulic jump is formed when liquid at high velocity discharges into a zone of lower velocity only if the 3 independent velocities (y1, y2, fr1) of the hydraulic jump equation conform to the following equation:

$$Y2 = y_1/2\ [-1+\sqrt{1+8Fr^2}\ ]$$

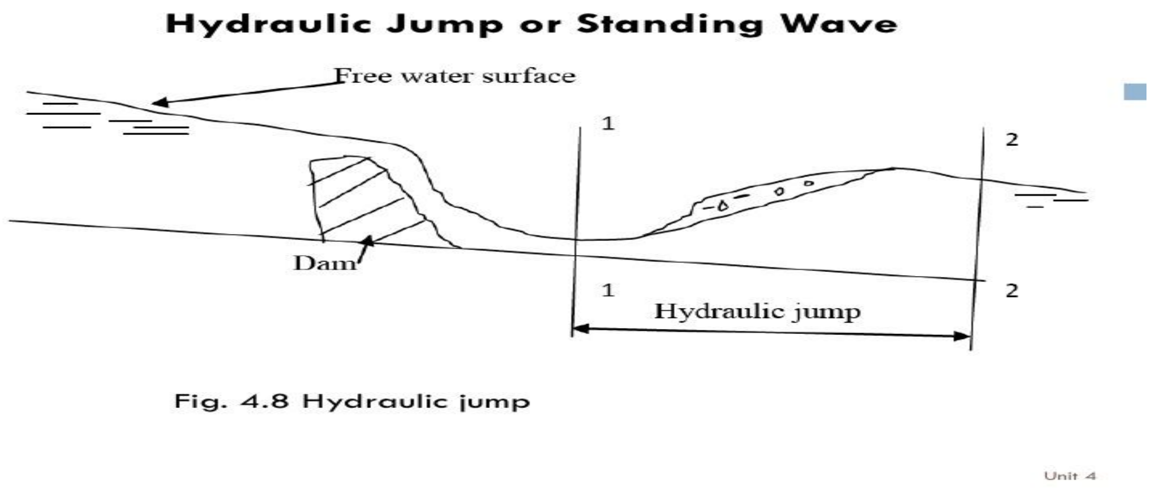


Fig. 4.8 Hydraulic jump

Use of Hydraulic jump:

- Hydraulic jump is used to dissipate or destroy the energy of water where it is not needed otherwise it may cause damage to hydraulic structures.
- It may be used for mixing of certain chemicals like in case of water treatment plants.
- It may also be used as a discharge measuring device.

Procedure:

1. start the pump to supply water to the flume.
2. Then close the tail gate to allow water to accumulate and to develop hydraulic jump.
3. adjusted the position of the hydraulic jump by adjusting the amount of closure of slvice gate.
4. then measured the depth of the bed of flume by using a point gauge.
5. Measure depth of water befor jump.
6. Measure depth of water after jump
7. Find length of jump and specific energy loss.

Observations:

1. Width of channel “ B ”= cm
2. Length of channel= m

Experiment no 3 (b)

Aim:_

To determine sequent depth & energy loss due to hydraulic jump.

Apparatus:-

Hydraulic lifting flume with spillway model point gauge mounted on trolley a shutter to control flow discharge measurement tank with piezometer, scale, stopwatch.

Theory:-

i) Hydraulic Jump:- If the sub critical flow changes its state of flow into super vertical flow in a short length is called as hydraulic jump

ii)How expressions for hydraulic jump.

iii) Types of hydraulic jump.

v) length or height of hydraulic jump.

Procedure:- i) Measure the length of channel dimensions of measuring tank.

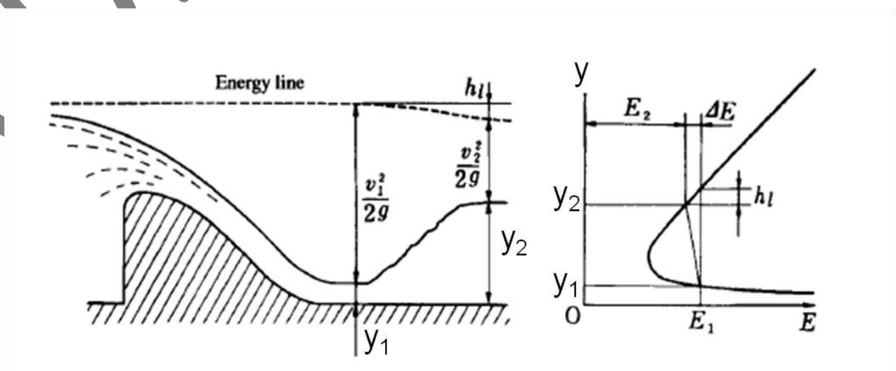
ii) Keep upstream take open & open inlet valve.

iii)Allow the water to flow through flume control upstream sluice gate so as to createsuper critical flow.

iv)Control the down-stream sluice gate to createahydraulic jump.at the top of weir.

v)When the jump becomes stationary measure the initial depth &sequent depth or length o fhydraulic jump.

vi) At the same time measure the discharge with the help of measuring tank & pyrometer i.e. ΔH&Δt



Observations :

1. Width of channel = m
2. Area of tank = m^2

Observation table

Sr no	Initial depth before jump			Discharge after jump			Discharge Qact= Δ <u>H xA</u> Δt			V_1= <u>Qact/</u> (b x y_1) (m/s)	V_2 = <u>Qact/</u> (b x y_2) (m/s)	Fr = $V_1/\sqrt{gy}$	$y_2 = Y_1/2\ (\sqrt{1+8Fr2}-1)$	(Y_2-y_1) Height Of Hydraulic Jump	Length of Hydraulic Jump is $(Y_2- Y_1)$	Loss of energy due to hydraulic Jump = $(y2\ y_1)3 / (4 \times Y_1 \times Y_2)$
	IR	FR	Y_1	IR	FR	Y_2	ΔH (m)	ΔT (Sec)	Qact m^3/Sec)							
1																
2																
3																
4																
5																

Sample Calculations:-

i)Qact = (ΔH x A)/ Δt = (0.1 x 0.64)/25 = $2.56 \times 10^{-3}\ m^3$/sec

ii) v_1 = <u>Qact/</u>A = 2.568×10^{-3}/(0.25 x 0.018) =1.024 m/s

ii)V_2 = Qact/A = 2.56×10^{-3}/ (0.25 x 0.03) = 0.341 m/

iii)Froude no. Fr = $V_1/\sqrt{gY1}$= <u>1.024/(</u>$\sqrt{9.81 \times 0.01}$

Fr= 3.26

iv) Y_2= Y_1/2 ($\sqrt{1+8\,Fr2}$) – 1)

=0.01/2$\sqrt{1+8 \times 3.26 \times 3.26}$) – 1)

Y_2 = 0.041

v) Height of hydraulic Jump = $Y_2 – Y_1$

= 0.03- 0.0 1

= 0.02m

Vi) length of hydraulic Jump = 5.5.(Y_2 - Y_1)

= 5.5 (0.03- 0.0 1)

L J = 0.11m

7) Loss of energy due to hydraulic jump

$$\Delta L = (Y_2 - Y_1)^3 / (4 \times Y_1 \times Y_2)$$

$$= (0.03 - 0.01)^3 / (4 \times 0.03 \times 0.01)$$

$$\Delta E = 6.66 \times 10^{-3} \text{ Kg-m/kg.}$$

Results

Sequent depth = Y2 – Y1 = m

The loss of energy clue to hydraulic jump =ΔF= kg.m/kg.

Experiment No 04

SLUICE GATE EXPERIMENT

Open Channel Flow

Pressure at water surface is atmospheric or zero gage pressure
Water surface = piezometric head level
i.e., level registered by manometer with a piezometric tap
Open channel flow, in general, has two possible flow depths for each energy level Subcritical and supercritical. Sluice gate changes flow from subcritical to supercritical

Flow under sluice gate

Minimum cross-sectional area (vena contracta) is slightly downstream from the gate
Ideal Flow Theory (No Energy Losses)

Q = V1*A1 = V2*A2
Experimental Studies

Discharge coefficient

Flow is never really “ideal” Coefficient is related to relative size of gate opening

Brater & King summarize some of these
General form Q = C*A*(2g*dH)0.5

Specific Energy
Energy in an open channel measured relative to the channel bottom E = y + V2/2g

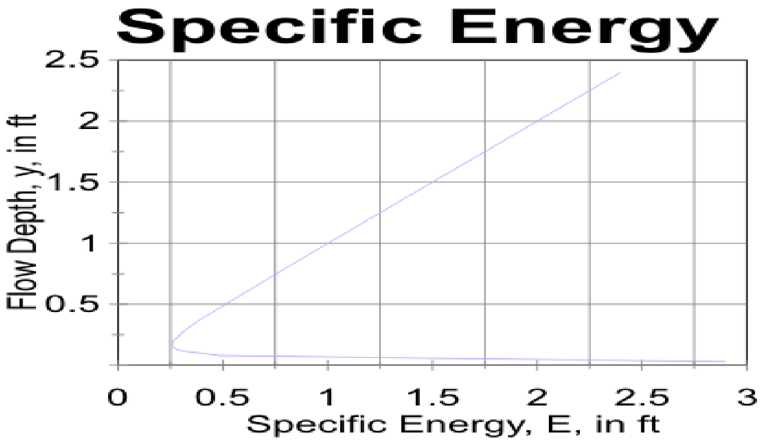
For two values of y with the same value of E

E = y1 + V12 /2g = y2 + V22 /2g

Combine this with the continuity equation,
V1*b*y1 = V2*b*y2
Now we can eliminate one of the velocities and compute the other velocity without using Q. This gives some experimental data for a two-dimensional plot of specific energy to compare with the theoretical equation. To use the specific energy plot, we measure y2 at the vena contracta.

As an aside, the specific energy function,
E = y + Q2 /2g*b2 y2
is actually cubic in y
i.e., -y3 + E*y2 = Q2 /2g b2

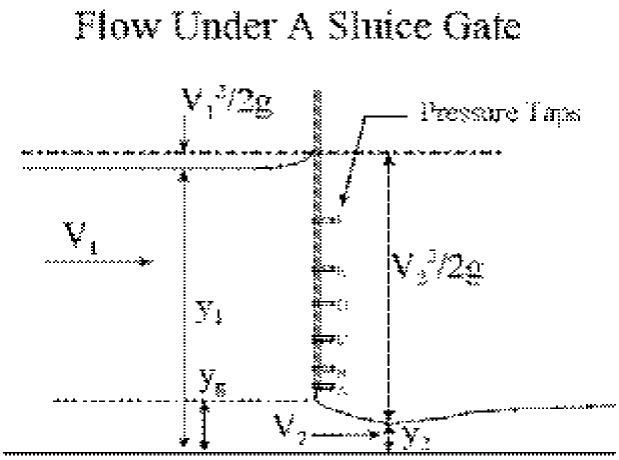
The subcritical and supercritical flows are two of the three areas for the solution. The third area of the solution has a negative value of y, which is meaningless for open channel flow



Sluice Gate Experiment

Study the application of one-dimensional flow analysis involving continuity, energy and momentum equations to a sluice gate in a rectangular channel

Flow Under A Sluice Gate
As stated earlier, there are two flow depths, subcritical and supercritical, for each energy level.The easiest approach is to compare the measured values of y2 with values computed for observed y1.



Force By Momentum Equation

$F_x = \gamma * V_x * Q$ becomes

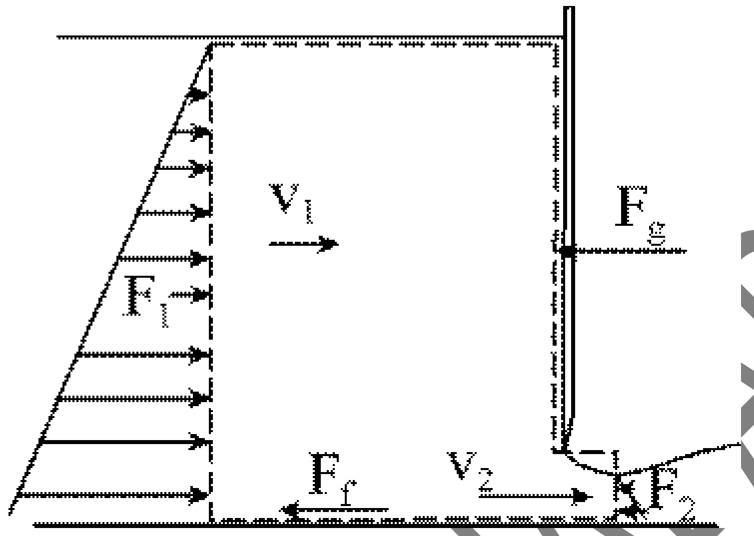
$F_g = \gamma*[Q*(V_1 - V_2) + 0.5*b*(y_1^2 - y_2^2)]$

where γ = density of water

g (in the drawing) = gravity constant

Q = flow rate

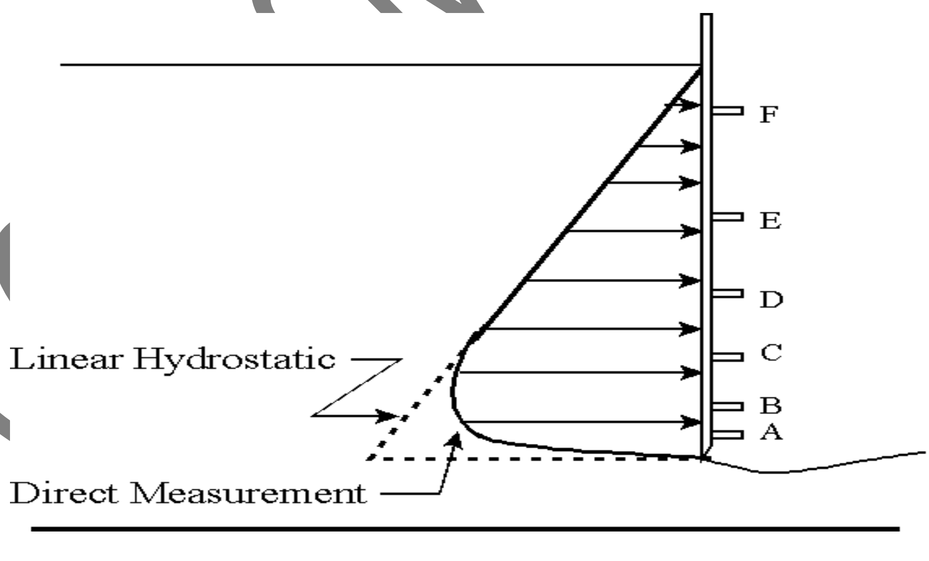
v_1, y_1 = upstream velocity and depth
v_2, y_2 = downstream velocity and depth
b = width of rectangular channel



Force By Hydrostatic Model & By Direct Measurement

Linear hydrostatic pressure uses the simple triangular pattern of pressure, with the average pressure at the center point times the area. (In our experiment, the top pressure is atmospheric, which we use as H1 of zero.)

Direct measurement uses pressure measured at several points along the gate. The key is to select the area you associate with each pressure value.



Sluice Gate Experiment: Preparation

Objectives (Presented above)

Apparatus (Same flume & measurement taps as for Weir Experiment, except tap on the sluice gate)

Set up experiment:

Open surge tank valve. Open both the head and the tail (sluice) gates of the half-meter open channel unit

Determine the longitudinal profile along the centerline of the floor of the flume to get point gage zeros. (If not clear from a prior experiment.)

Remove air from all manometric tubing. Locate the pressure taps in the gate and on the floor of the flume and match them to the manometer columns.

Close the drain valve, start the large pump, and open the intake valve.

Experimental data collection

Measure the profile and the sluice gate variables.

Establish a steady flow in the flume

Lower the upstream sluice gate until it impinges on the flow.

Slowly lower the gate until the flume is nearly full.
Wait for the flow to reach the steady state.
[Note: remove air from the manometer tubes A-F.]

Record the flow depths of the water surfaces both upstream and downstream of the gate. For the supercritical section, you are trying to measure at the vena contracta.

Repeat step d until you have at least 6 measurements of depth

Measure the water surface profile & taps A-F

Close the sluice gate enough to raise level above taps A-F

Measure the depth of the water to about half-way down the channel

Also record the levels at taps A-F

Shut off the flow. Turn off the pump, close the intake valve, & open the drain valve on the head tank.

Sluice gate experiment: Results

Attach your data sheet and sketch of the experimental set-up

Flow Through Sluice Gate

Using the continuity equation between the upstream and downstream flows (latter at the vena contracta) compute the velocities on both sides of the gate for each pair of flow depths.

From $Q = V_iA_i$
$V_1 = Q/(b*y_1)$ and $V_2 = Q/(b*y_2)$

Compare the specific energy ($E_i = y_i + V_i^2/2g$) plot for the observed depths and computed velocities with the theoretical plot at the same flow rate, Q

Compare the measured contraction coefficient with any hydraulic literature reference.

Flow Rate Calculation

Using your depth measurements upstream of the gate and at the vena contracta, along with the continuity and energy equations, compute the flow rate and compare it with the rate given by the flow meter

$Q = V_1*A_1 = V_2*A_2$
$E_i = y_i + V_i^2/2g$
or $y_1 + V_1^2/2g = y_2 + V_2^2/2g$

Combining these: $Q = 2g*b*y_1*y_2/(y_1 + y_2)^{0.5}$

Force On Gate

Compute the force on the gate using (a) the measured pressures, (b) hydrostatic assumption, and (c) the momentum equation.

Compare the three values in terms of accuracy and convenience.

Plot the pressure distributions on the upstream side of the sluice gate from the measured pressures and from the hydrostatic assumption on the same chart and compare the two patterns.

Experiment no 05

Velocity distribution in open channel

Aim-

To study Velocity distribution in open channel in traverse direction of flow.

Theory :-

The presence of corners & boundaries in an open channel causes the velocity vectors of the flow to hare components not only in the longitudinal & lateral direction but also in normal direction to the flow in a micro analysis, one is concerned only with the major component viz, the longitudinal component ‘ Vx’ The other two components being small ore ignored &‘Vx ‘ is designed as ‘V’ The distribution of ‘ V ‘ in a channel is dependent on the geometry of the channel .

Fig:- a Shows isolves (contours of equal Velocity) of ‘ V ’ for a natural & rectangular channel resp. The influence of the channel geometry is apparent. The velocity ‘V’ is zero at the solid boundaries&gradually increases with distance from the boundary. The maximumvelocity of the cross section occurs at a certain distance below the free surface. This dip of the maximum velocity point, giving surface velocities which. Are less than the maximumvelocity , is due to secondary currents & is a function of the aspect ratio (ratio of depth to with) of the channel. Thus for a deep narrow channel the location of a maximumvelocity point will he much lower from the water surface than for a wider channel of the same depth This characteristic location of the maximum velocity point below the surface has nothing to do with the wind shear on the free surface.

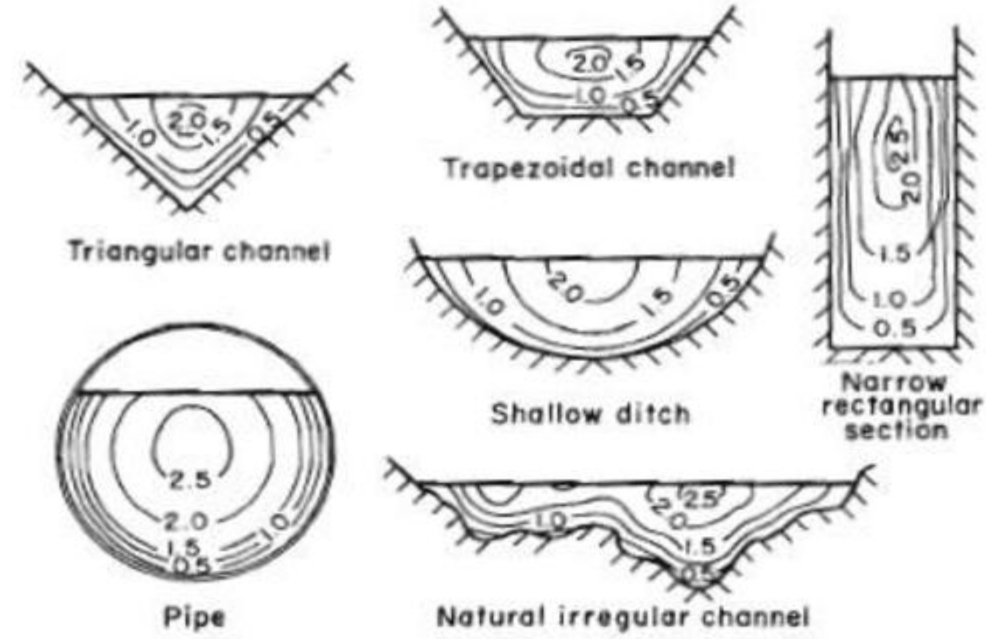


Fig a.

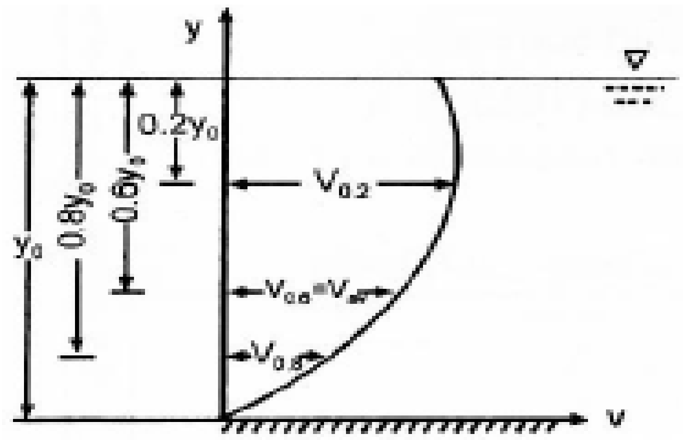


Fig. b

A typical velocity profile at a section in a plane normal to the direction of flow is presented in fig . The profile can be roughly described by a logarithmic distribution up to the maximum velocity point.

Field observations in rivers & canals have shown that the average velocity at any vertical Vav, occurs at a levelof 0.6Yo from the free surface where

Yo = depth of flow.

Further it is found that Vqv = $(V_{0.2} + V_{o.8}) / 2$

In which $V_{0.2}$ = velocity at a depth of 0.2Yo from surface. & $V_{0.8}$ = velocity at a depth of 0.8Yo from the free surface. This property of the velocity distribution is commonly used in stream gauging practice to determine the discharge using the area velocity method.

The surface velocity Vs is related to the average velocity v_{av} as

Vqv = KV8

Where,

K = a coefficient with a valve between 0.8 to 085

The proper value of k depends on the channel section & has to be determined by field calibrations. Knowing K, One can estimate the average velocity in a open channel by using floats & other surface velocity measuring devices.

EXPERIMENT NO 6
IMPACT OF JET ON VANES

AIM: To determine the Co-efficient of impact jet – vanes combination by the force for stationary vanes of different shapes VIZ: Hemispherical, Flat plate, inclined plate.

Theory:

When jet of water is directed to hit the vane of particular shape, the force is exerted on it by fluid in the opposite direction. The amount of force exerted depends on the diameter of jet, shape of vane, fluid density, and flow rate of water. More importantly, it also depends on whether the vane is moving or stationary. In our case, we are concern about the force exerted on stationary vanes. The following are the figures and formulae for different shapes of vane, based on flow rate.

HEMISPHERICAL $F_t = 2\ \rho\ A\ V^2/g$

FLAT PLATE $F_t = \rho\ A\ V^2/g$

INCLINED PLATE $F_t = (\rho\ A\ V^2/g)\ \sin^2\theta$

Where,

$g = 9.81 m/sec^2$

A = Area of jet in m^2

ρ = Density of water = 1000 Kg/m^3

V = Velocity of jet in m/sec=Q/A

θ = Angle of deflected vanes makes with the axis of striking jet, 45 degree.

F_t = theoretical force acting parallel to the direction of jet

F_a = Actual force acting parallel to the direction of jet

Description:

It is a closed circuit water re-circulating system consisting of sump tank, mono block pump set, and jet / vane chamber. The water is drawn from sump to mono block pump and delivers it vertically to the nozzle. The flow control valve is also provided for controlling the water into the nozzle. The water issued out of nozzle as jet. The jet is made to strike the vane, the force of which is transferred directly to the vane. A collecting tank with piezo meter to measure discharge. The provision is made to change the size of nozzle/jet and vane of different shapes.

Specifications:

Vane shapes : Flat, Hemispherical, Inclined (standard) & any other optional shapes at extra cost.

Jets diameter : 6mm.

Measurements: Pressure of jet by pressure gauges and discharge by collecting tank with the help of stop watch

Pump : 1 hp, single phase, 230volt with starter

Type : Recirculating with sump & jet chamber made of stainless steel.

Jet chamber : Fixed with toughened glass windows with leak proof rubber gaskets.

OPERATION:

1. Fix the required diameter jet and the vane of required shape in position.
2. Keep the delivery valve closed & switch ON the pump.

3. Close the front transparent cover tightly.
4. Open the delivery valve and adjust the flow rate of water by gate wall provided.
5. Note down the diameter of jet, shape of vane, flow rate & force and tabulate the results.
6. This way take readings for 1) different flow rates
2) Different vanes

observation table :-

Sr no	**Type of Vane used**	**Time taken for 10 cm rise of water in sec**	**Qact M^3/sec**	**Velocity Of jet m/s Va**	**Actual force Fa**	**Theoretical Force Ft**	**Coefficient Of impact**

Calculation :
1. Area of the vane A=……………..m^2
2. Volume of water collected U =…………m^3
3. Actual discharge Qa= U/t =……………… m^3/sec
4. Velocity of water jet = Va = Qa/A =……… m/s
5. Theoretical force = Ft ………..m/sec
6. Actual force Fa = ……..
7. Co-efficient of impact = k = Fa/Ft =………..

Results: Coefficient of Impact for flat vane:
Coefficient of Impact for Inclined vane:
Coefficient of Impact for curved vane:

EXPERIMENT NO 07
Study of turbines

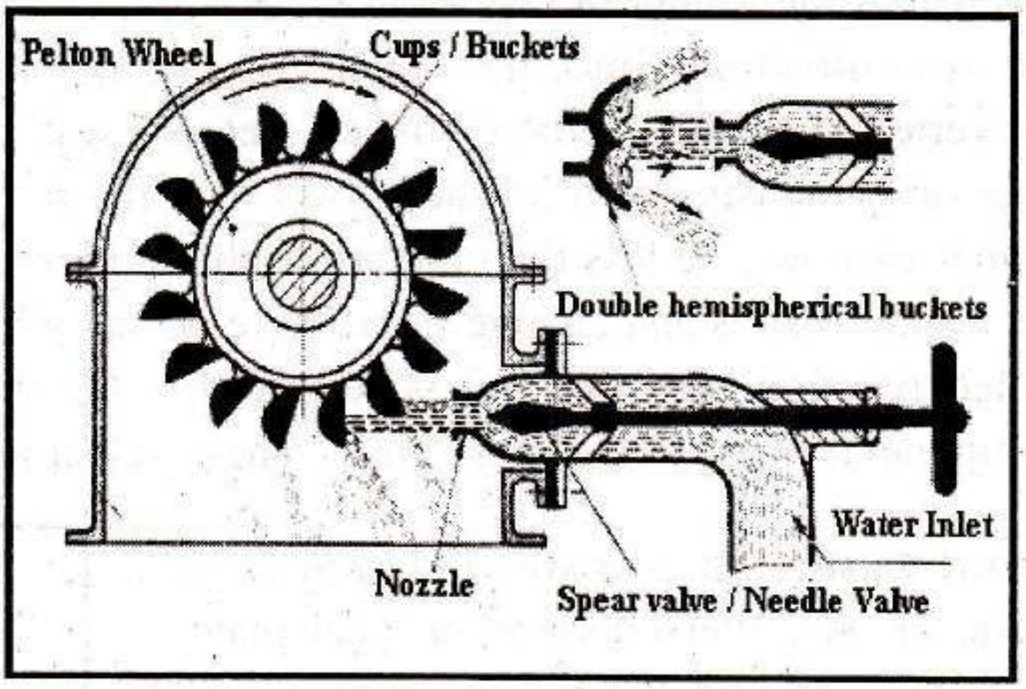
Aim :- Trial On Pelton Wheel turbine.
Appratus : -
1. Pelton Wheel Turbine 2. Nozzle & Spear Arrangement
3. Pressure Gauges (03 Nos. – Range = 00 – 07 kg/cm2)

THEORY :-

Hydraulic Energy is now widely used in the world as it is one of cheap sources of power. To convert this power into mechanical energy, turbines are used,which drive the generators coupled to them.There are many types of turbines,i.e. Francis, Kaplan, Pelton wheel… etc. Among these turbines Elton wheel turbin is only type being mostly used these days. It is also called as free jet turbine and operates under a high head of water and therefore requires a comparatively less quantity of water. It is named after A. Pelton, The American engineer who contributed much to its development about 1880.

The water is conveyed from a reservoir in the mountains to the turbine in the power station through penstocks. The penstrok is joined a branch pipe or lower end with a bend fitted with nozzle assembly. Water comes out of the nozzle in the form of a free and compact jet. All the pressure energy of water is converted into velocity head. The water having a high velocity is made to impinge, in air, on buckets fixed round the circumference of a wheel, the latter being mountedon a shaft. The impact of water on the surface of the bucket produces a force which causes the wheel to rotate thus, supplying a torque or mechanical power on the shaft. The jet of water strikes the double hemispherical cup shaped buckets at the centre and is deviated on both the sides, thus eliminating an entrust. The water after impinging on the buckets is deflected through an angle of about 165 Deg. Instead of 180 Deg. So that it may not strike the back of the incoming bucket and retard the motion of the wheel. After performing the work on the buckets water is then dischared into the tail race.

In order to control the quantity of water striking the runner, the nozzle is provided with a spear having a streamlined head which is fixed to the end of a rod. The spear may be operated either by a hand wheel in case of very small units or automatically by a governor in case of almost all the higher capacity units. A causing of fabricated steel plates is usually plates is usually provided for a Pelton Wheel. It has no hydraluic function to perform, it is provided only to prevent splashing of water to lead water to the tail race and also to act as s safe guard against accidents.



Larger Pelton wheels are usually equipped with a small break nozzle which when operated/opened directs a jet of water on the back of the buckets, thereby bringing the wheel quickly to rest after it is shut down as otherwise it would go on revolving by inertia for a considerable time.

SPECIFICATIONS:

1. PELTON WHEEL (RUNNER):

A) Pitch circle diameter – 190mm B) outer diameter of wheel – 250 mm

C) No of buckets – 12 Nos. D) Bucket width Height – 50*50 mm

E) effective radius 280mm F) Material of bucket – Gun metal with powder coating for higher life.

2. Wheel casing Casing size : Height – 500mm Width – 520mm

3.Sump tank Size: 1.2 m X0.6mX 0.6 m (lit) provided with pump and turbine mounting facility.

Material : N.S. sheet 16 gauge thick with fibre lining from inside for corrosion resistance.

4. Centrifugal Pump Capacity : 15 HP motor, 3 phse, 440 VAC induction, 50Hz ,8Amp. RPM: 2880 Flow: 10L.P.S. Pipe sizes suction side – 3’ Delivery side 2.1/2’(Diameter)

5.Venturimeter : (Material – C.I.) Inlet Diameter – 50mm Throat Diameter – 25mm

6. Manometer Type: U type ,acralyc manometer – 2, with brass valves

7. Nozzle Material : gun metaln Size : 15 mm

8.Power supply requirements : 3Ø, 440VAC , 50Hz supply..

PRECAUTIONS TO BE TAKEN IN USING THE TEST RIG.

1. Close the Isolator valve of the Pressure Gauge before starting the pump in order to avoid damage to the Pressure gauge.

2. Close the brass valves of the Venturi before start of the pump.

3. Never run the pump dry i.e. without water in the tank.

4. Check that the Brake Drum is free to rotate before starting the pump.

5. Fill the sump tank always with clean and dirt free water.

6. The tank should be sufficiently filled with water in order to get positive head at the suction side.

7. During the flow measurement test, operate the two brass valve in the same proportion so as to avoid the siphoning of mercury from the ‘ U’ tube manometer,to the water tank. The manometer is to be operated only during flow measurement.

8.Load the Break Drum gradually by the use of hand wheel &screw mechanis.

9. Fill in the grease in the bearing caps of the shaft periodically.

10. As far as possible the Test Rig is to be operated by a Trained- Technical person only.

11. Tighten the nuts and bolts of the bearing block and other moving /rotating parts periodically.

12. Use cooling system for the brake Drum when under load to avoid overheating and burning of the rope.

13. Drain off the water from the tank when the Test Rig is not in use, Keep the equipment free of water and dirt when not in use.

TEST PROCEDURE

1.Take all the necessary precautions as given in the earlier page before the actual starting of the Test Rig.

2. Start the pump by pressing the push button of the Starter.

3.Keep the nozzle adjustment handle in full open position.

4. The runner will start rotating, allow it achive a constant speed.

5. Gradually open the Isolater valve of the Pressure Gauge & check the pressure. Set to required valves by the use of the flow control valve.

6. By keeping the head constant take the reading as per the observation table given on the next page.

7. For next test keep the RPM constant and take the readings of m/c as per the observation table.Here the load is to be adjusted and also the flow is to be adjusted.

8. Also readings can be taken for discharge constant and variable RPM& Load valves.

9. Reading also can be taken for the nozzle open position to 50% and the calculation done accordingly.

10. Unload the drum and shut – off the motor switch. Release the pressure on the gauge by loosening the isolator volve knob.

OBSERVATION TABLE:

Sr. No.	Speed RPM	Spring Balance Readings (Kg)		Actual Load in Kg.	Manometer Reading in cm of Hg.	Head 'H'	
		S_1	S_2	$S_2 – S_1$		Kg/cm^2	Met of water

The above observation table is to be used for nozzle position fully opened. However, the same observation table can be used for nozzle position at 50% open.

SPECIMEN CALCULATIONS:

1. SHAFT HORSE POWER (S.H.P.) OR BRAKE HORSE POWER (B.H.P.) Break Drum Radius = 122.5 mm thickness of brake 5 mm

Effective Brake Radius = 250 mm

S.H.P. or B.H.P. =2 πN T/4500 (H.P) = 2 π N T/4500 *0.746 (KW)

Where.. N= speed of Pelton Wheel T= Torque in Kg.M.

2. POWER SUPPLY OF THE TURBINE

Power supply = WQH / 75 (HP) = WQH/75*0.746 (KW)

Where.. H= Head at the nozzle in meters of water.

Q = Discharge in M^3/Sec $= \frac{a1.a2.\sqrt{2gh}}{\sqrt{a1^{2-}a2^{2}}}$ x 0.7 (Where… A_1 = area at inlet of venturimeter in m^2

A_2 = area at throat of venturimeter in m^2 H = Venturi head in M of water = Manometer reading difference in M x 12.6, inlet dia of venture = 50mm=0.050M Throat dia of venture = 25mm=0.025 M) W = specific weight of water = 1000Kg/m^3

B) …Mechanical Efficiency is the ratio of power obtained at the shaft (S.H.P.) to the power developed by the turbine.

η M = S.H.P. (or B.H.P.)/W.H.P.

C) Overall efficiency is the ratio of power obtained at the shaft to the power actually supplied to the turbine.

η O = S.H.P./(WQH)/75

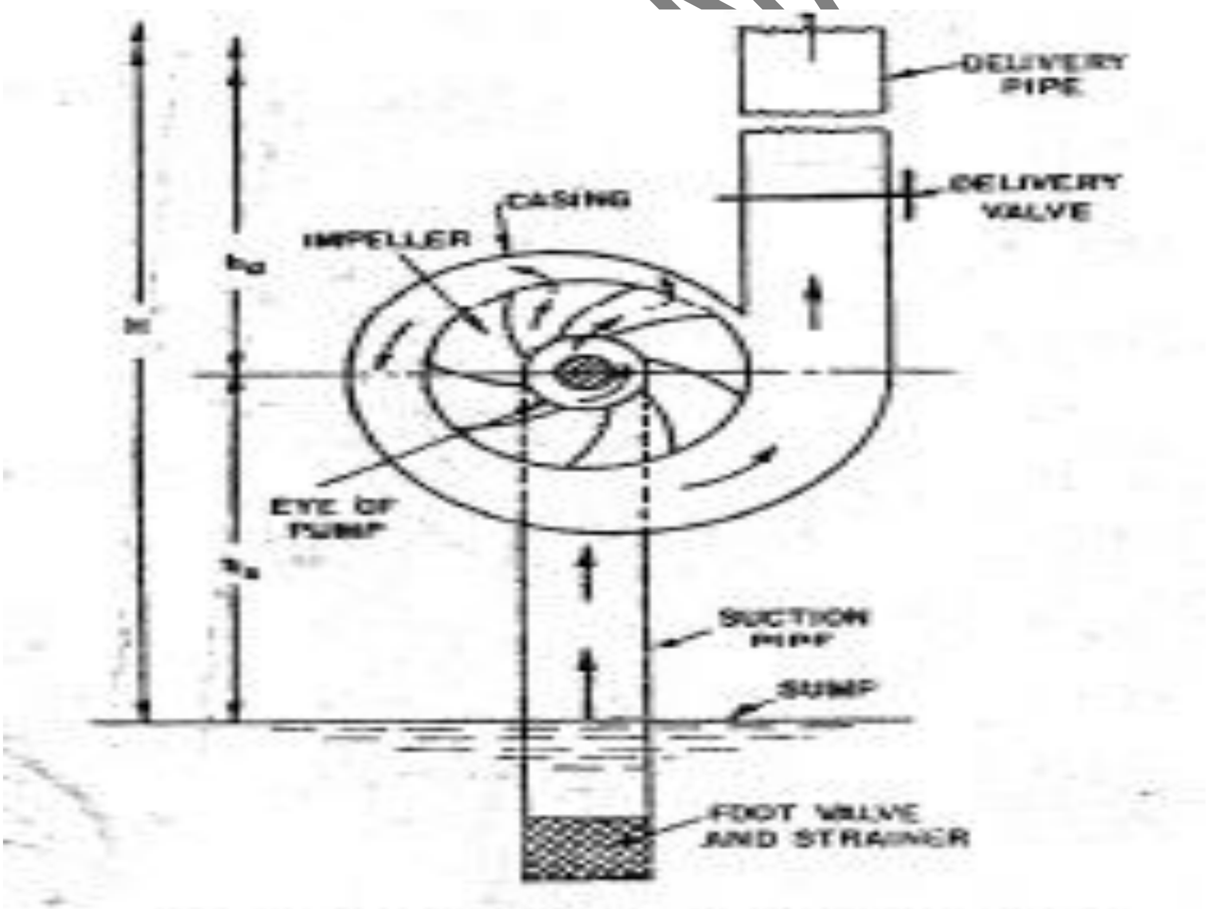
RESULT: Avg. Efficiency of the Pelton Wheel Turbine = ……………………..%

EXPERIMENT NO:8
CENTRIFUGAL PUMP

AIM-: To determine the overall efficiency of a Centrifugal Pump.

APPARATUS-: Centrifugal Pump Set

THEORY-: The hydraulic machine which converts mechanical energy into hydraulic energy is called as the pump. The hydraulic energy is in the form of Pressure Energy. If Mechanical Energy is converted into Pressure Energy by means of hydraulic machine is called as a Centrifugal Pump. A Centrifugal Pump consists of an impeller which is rotating inside a spiral / volute casing. Liquid is admitted to the impeller in an axial direction through a central opening in it side called the Eye. It then flows radially outward & is discharged around the entire circumference into a casing. As the liquid flows through the rotating
impeller, energy is imparted to the fluid, which results in increase I and the Kinetic Energy. The name of pump of liquid from the rotating impeller is due to the centrifugal head created in it when a liquid mass is rotated in a vessel. This results in a pressure rise throughout the mass, the rise at any point being proportional to the square of the Angular Velocity & the distance of the point from the axis of rotation.



Principal parts of a centrifugal pump

Working

To Start the pump firstly priming is done.

In priming water is filled in suction pipe, casing & into portion of delivery pipe up to delivery valve.

This is done for removal of air so that centrifugal head gets developed to lift the water

During priming the D.V. is kept closed so that when motor is started it will reduce starting torque.

When pump attains constant speed delivering valve is gradually opened & thus water is allowed to flow in radially outward direction through impeller vanes towards outlet of pump, due to this a partial vacuum is exerted at the eye of the impeller

Due to this water from sump at atm pressure is raised in suction pipe. The water leaves impeller with high velocity & high pressure through a delivery pipe int desired height.

This in this way water reaches & leaves the impeller the continuously

When pump is to be stopped the delivery valve should first closed to avid back flow from reservoir

PROCEDURE-:

1) Switch on the motor and check the direction of rotation of pump in proper direction.
2) Keep the discharge valve full open and allow the water to fall in main tank.
3) No doubt the speed of the motor is controlled by the hand tachometer.
4) The readings of suction and discharges are noted.
5) Note the power consumed by pump from energy meter.
6) Measure the discharge of the pump in the measuring tank by diverting the flow.
7) Take few readings by varying the discharge.

PRECAUTIONS-:

1) Priming is necessary if pump doesn't give discharge.
2) Leakage should be avoided at joints.
3) Foot valve should be checked periodically.
4) Lubricate the swiveled joints & moving parts periodically.

SPECIFICATIONS-:

Pump type -: Centrifugal Pump Type
Motor Power -: 05 HP
Energy Meter -: Electrical
Vacuum Gauge -: 0 to 760 mm of Hg (0 to -30 PSi)   - 500 mm
Pressure Gauge -: 0 to 2.1 kg / cm2   -0.2kg/ cm2

Observations:

1. Area of measuring tank = 40*40 cm2
2. X = ……..cm
3. N'= …..rpm
4. Suction head = 0.5*13.6=6.8
5. Guage Presser =0.2*10(no of turns)=2mt.
6. Total Head = 6.8+2=8.8 mt.

Observation table

Sr No.	IR. (cm)	FR (cm)	R (mt)	Time (tsec)	Qact = A*R/t	Speed (N)	Output =wQH/1000	Input	N%

Calculations -:

Graph:

Result -:
From Observations:
1. Maximum Efficiency = ή = ……………………..%
2. I.H.P = ………
3. Total Head = …….
4. B.H.P. (output) = ………….

From Observations:
1. Maximum Efficiency = ή = ……………………..%
2. I.H.P = ………
3. Total Head = …….
4. B.H.P. (output) = ………….

Experiment no 09

Characteristics curves of centrifugal pump

Characteristics curves of centrifugal pumps are defined those curves which are plotted from the results of a no of tests on the centrifugal pump these curves are necessary

To predict the behaviour & performance of the pump when the pump is working under different flow rate, head & speed the following are the important **characteristic** curves for pumps.

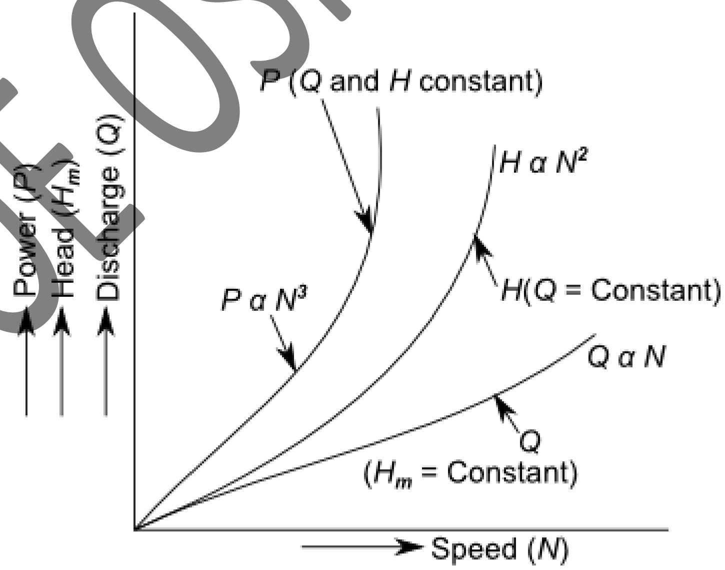
i)Main characteristics curves

ii) Operating characteristics curves

ii) Constant efficiency or mischel curves

Main Characteristics Curves .

The main characteristics curves of a centrifugal pump consist of variation of head (man metric head) power &discharge w.r.t. to speed for plotting curves of mano metric head versus speed. Discharge is kept constant for plotting curves of power versus speed the manometric head &discharge kept constant for plotting curves of power versus speed the Manometric head discharge kept constant



Main characteristics curves of a pump.

For plotting the graph Hm V/s speed (N) the discharge is kept constant from eq^n it is clear that $\sqrt{HM}/DN$ is constant HM $\propto N^2$ is a constant or HM* N^2 This mean that head developed by a pump is proportional to N^2. Hence the curve of HM. V/s N is a parabolic curve as shown in fig. from eq^1 it is dear that P/D^5N^3 is a constant Hence $P \propto N^3$ This means that the curve P V/S N is cubic curve.

The eqns show that $\underline{Q/D^3N}$= constant

This means Q $\propto$N for a given pump. Hence the curve Q V/S N is a straight line

Operating Characteristics curers:-

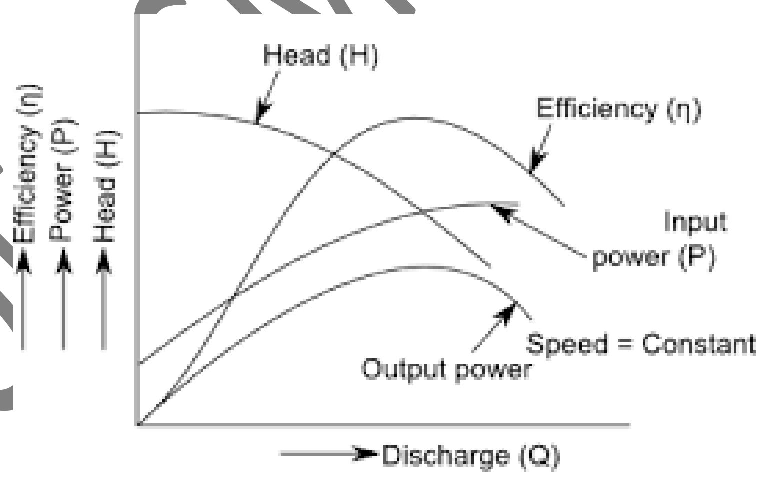
It the speed is kept constant the variation of man metric head, power & efficiency w.r.f. discharge given the operating characteristics of the thump.

The input power curve for pumps shall not pass through the origin. It will be slightly away from the origin or the y- axis as even of zero discharge some power is needed to overcome mechanical losses.

The head curve will hare max value of head when discharge is zero.

The efficiency curve will start from origin as at Q = 0, n=0

N = output/input



Operating characteristic surves of a pump.

Constant efficiency curve:-

For obtaining efficiency curves for a pump, the head V/S discharge curves for diff speed are used fig (a) shows the head V/S discharge curves for diff speed as shown in fig (b) by combining these curves.

H v Q curves & n $\sim Q$ CURVES) constant efficiency curves are obtainedas shown in fig (a)

For plotting the constant efficiency curves (also known as is O- efficiency curves) Horizontal lines representing constant.

Efficiencies are drawn on the n∼ Q cumes. The points at which these lines cut the efficiency curves at various speeds are transferred to the corresponding H∼ Q curves. The points having the same efficiency are then joined by smooth curves. These smooth curves represents the iso. Efficiency curves.