MAHATMA GANDHI MISSION'S

JAWAHARLAL NEHRU ENGINEERING COLLEGE,

AURANGABAD. (M.S.)

DEPARTMENT OF CIVIL ENGINEERING

FLUID MECHANICS

LAB MANUAL

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“FLUID MECHANICS –II”

SUBJECT: - Fluid Mechanics-II

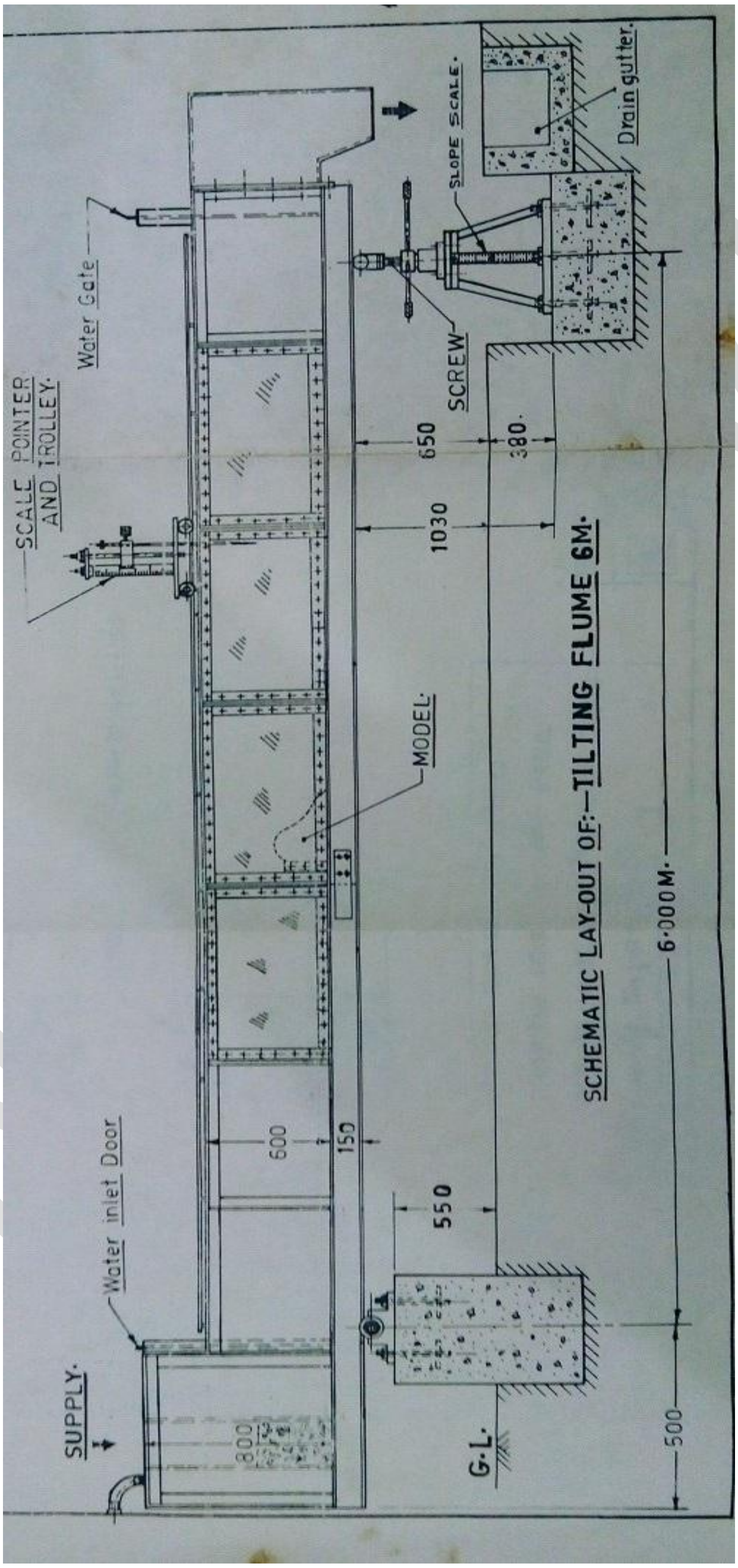
CLASS: - Second Year Civil Engineering

LIST OF EXPERIMENTS

Time Allotted for each Practical Session = 02 Hrs.

EXPERIMENT NO: 01

CHEZYS AND MANNINGS CONSTANT



AIM: To determine chezy's and manning's constant.

EXPERIMENTAL SETUP:

For conducting this experiment long hollow rectangular channel is used with bed slope adjustments, point gauge is kept on upstream side of channel to measure the depth of water. 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:

In open channel water flows under atmospheric pressure, when water flows in an open channel, resistance is offered to it, which causes loss of energy. A uniform flow will be developed if the resistance is balanced by the gravity forces. The magnitude of the resistance when other physical factors of the channel are kept unchanged depends on the velocity of the flow. The following formulae are used to measure the velocity are :

Chezy's formula is $V=C\sqrt{(RS_o)}$
Where C= chezy's constant
R = Hydraulic mean radius
S_o = Channel Bottom Slope
Manning's formula is $V= (1/N)*R^{2/3}S_O^{1/2}$
Where N is manning's roughness coefficient
R is hydraulic mean radius
S_o is channel bottom slope
The relation between chezy and manning's formula is
$C = (1/N)R^{1/6}$

PROCEDURE:
1. Remove all the obstructions in the channel

2. Prepare the unit for open channel experiment by lifting both the gates so that there is no obstruction to the flow of water.

3. By screwing up the wheel of the tilting arrangement the required slope for the channel can be attained. Note the readings in the vertical scale as shown.

4. Allow the water in the channel, so that the water flows along the open channel at the steady condition.

5. With the help of the point gauge, find the head of water in the channel. Let it be y=__________ m

6. Take manometer reading L.

7. Calculate the discharge by using formula,

$$Q_{act} = Cd.a\sqrt{(2gh)}.$$

8. Repeat Steps 1 to 6 for different readings. i.e. head of water and for different channel slope.

OBSERVATIONS:

1. Width of channel " B "= 30 cm

2. Diameter of orifice "d"= 4.8 cm

3. Area of orifice "a" = 18.09 cm^2

3. Length of channel= 6 m = 6000 mm

OBSERVATION TABLE:

S.NO	BED SLOPE(So)	C.B.	W.S	DIFF. "Y" (cm)	Manometer Reading " **h'** "	h	Qact	Hydraulic Depth "R"	V=Q/a	C	1/N	N
1	5/6000											
2	10/6000											
3	15/6000											
4	20/6000											
5	25/6000											
6	30/6000											

SAMPLE CALCULATIONS:

1. Y = W.S. - C.B
2. h = **h'** *(13.6-1)
3. Q_{act} = Cd.a √(2gh)
   Where Cd= 0.611; g= 981 cm/s^2
4. R= Area / Wetted Perimeter
   = B*Y/ B+2Y
5. Velocity = Qact/Area
6. V=C $\sqrt{(RS_o)}$
7. V= (1/N)*$R^{2/3}S_O^{1/2}$

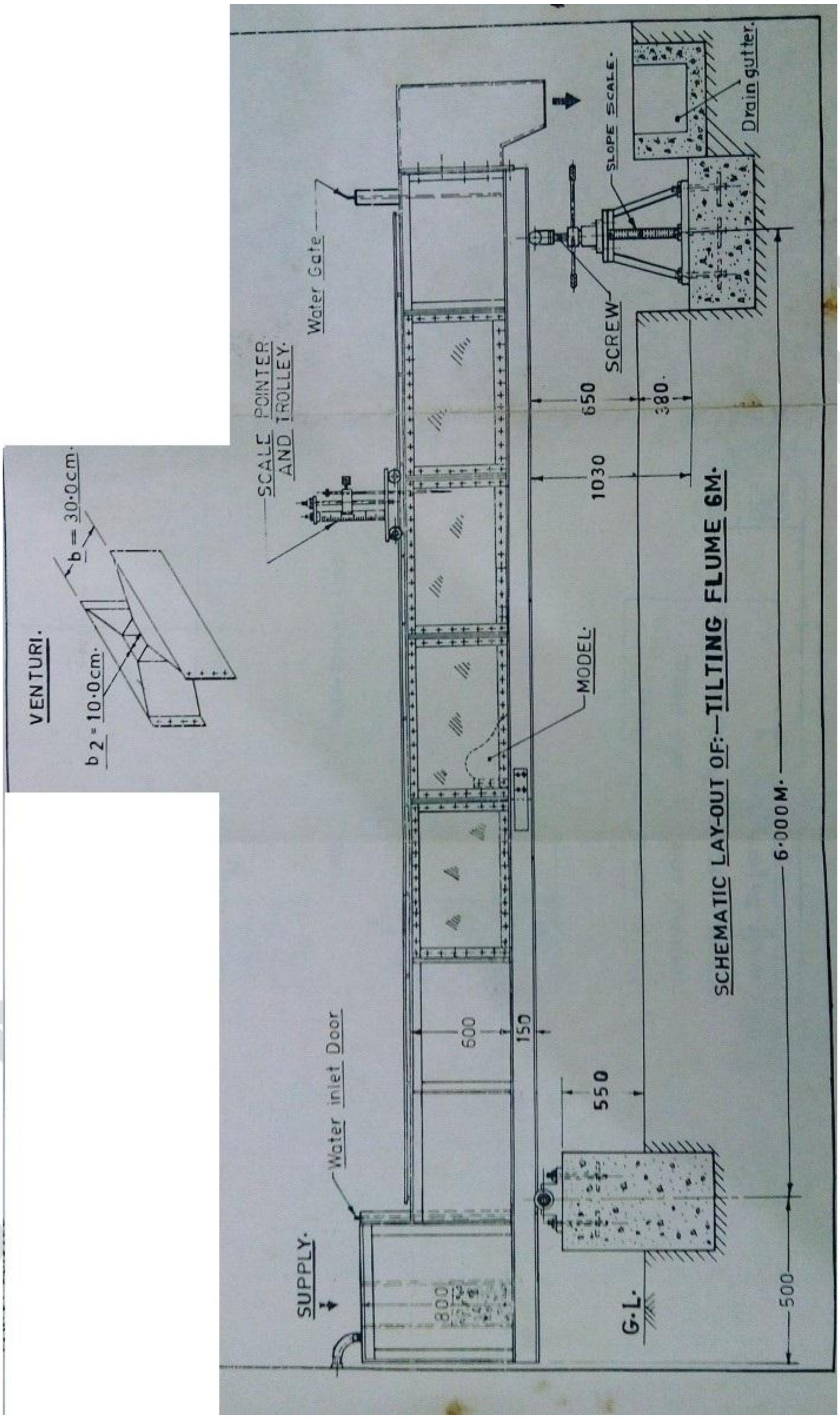
RESULTS:

1. Average value of chezy's constant =C=_______

2. Average value of manning's constant =N=_______

EXPERIMENT NO: 02

VENTURI-FLUME



AIM: To find Coefficient of discharge of venture flume

APPARATUS: A flume fitted with venture flume, point gauge, orifice meter, etc.

DESCRIPTION:

A venturiflume is a critical-flow open flume with a constricted flow which causes a drop in the hydraulic grade line, creating a critical depth.

It is used in flow measurement of very large flow rates, usually given in millions of cubic units. A venturimeter would normally measure in millimeters, whereas a venturiflume measures in meters.

Measurement of discharge with venturiflumes requires two measurements, one upstream and one at the throat (narrowest cross-section), if the flow passes in a subcritical state through the flume. If the flumes are designed so as to pass the flow from sub critical to supercritical state while passing through the flume, a single measurement at the throat (which in this case becomes a critical section) is sufficient for computation of discharge. To ensure the occurrence of critical depth at the throat, the flumes are usually designed in such way as to form a hydraulic jump on the downstream side of the structure. These flumes are called 'standing wave flumes'

PROCEDURE:

- The slope of the flume is adjusted as required.
- The bed level reading of the point gauge is recorded.
- A small quantity of water is allowed to flow through venturiflume .The water surface level readings at the entrance and throat of the flume are taken by point-gauge after steady conditions are reached.
- The manometer reading at the orifice meter is noted.
- 6-8 readings of the orifice meter are noted.
- By increasing the discharges, observe if the flume behaves as a standing wave flume. (Observation or demonstration only, if possible)

OBSERVATION:

- Diameter of the orifice=4.8 cm.
- Bed level of the flume:
  a) At inlet = S1 = cm.
  b) At throat = S2 = cm.
- Width of flume
  a) At inlet = b1 = 30 cm.
  b) At throat = b2= 10 cm.

OBSERVATION TABLE:

	INLET			THROAT			MANOMETER				
SR	S_1	WS_i	d_1	S_2	WS_t	d_2	h'	h=h'*12.6	Qact	Qth	Cd.
1											
2											
3											
4											
5											
6											

SPECIMEN CALCULATIONS:

1. $d_1 = WS_i - S_1$ (cm)
2. $d_2 = WS_t - S_2$ (cm)
3. h=h' (13.6-1) = h' 12.6cms.
4. Qact =Cd*a*√(2g*h)   cc/sec. (Take Cd=0.611; g= 981 cm/s^2)
5. $Qth = \frac{(b1\,d1 * b2d2 * \sqrt{2g(d2-d1)}}{\sqrt{(b1^2\,d1^2 - b2^2\,d2^2\,)}}$
6. Cd=Qact /Qth

Result:

Coefficient of discharge of venture flume = _____

EXPERIMENT NO:3

DETERMINATION OF PIPE FRICTION FACTOR.

AIM: To determine Fluid friction factor for the given pipes.

Introduction and Theory

The flow of liquid through a pipe is resisted by viscous shear stresses within the liquid and the turbulence that occurs along the internal walls of the pipe, created by the roughness of the pipe material. This resistance is usually known as pipe friction and is measured is meters head of the fluid, thus the term head loss is also used to express the resistance to flow.

Many factors affect the head loss in pipes, the viscosity of the fluid being handled, the size of the pipes, the roughness of the internal surface of the pipes, the changes in elevations within the system and the length of travel of the fluid.
The resistance through various valves and fittings will also contribute to the overall head loss. In a well designed system the resistance through valves and fittings will be of minor significance to the overall head loss and thus are called Major losses in fluid flow.

The Darcy-Weisbach equation

Weisbach first proposed the equation we now know as the Darcy-Weisbach formula or Darcy-Weisbach equation:

$$hf = f\,(L/D) \times (v^2/2g)$$

where:

- hf = head loss (m)
- f = Darcy friction factor
- L = length of pipe work (m)
- d = inner diameter of pipe work (m)
- v = velocity of fluid (m/s)
- g = acceleration due to gravity (m/s^2)

The Darcy Friction factor used with Weisbach equation has now become the standard head loss equation for calculating head loss in pipes where the flow is turbulent.

Apparatus Description

The experimental set up consists of a large number of pipes of different diameters. The pipes have tapping at certain distance so that a head loss can be measure with the help of a U - Tube manometer. The flow of water through a pipeline is regulated by operating a control valve which is provided in main supply line. Actual discharge through pipeline is calculated by collecting the water in measuring tank and by noting the time for collection.

TECHNICAL SPECIFICATION:

Pipe: MOC = G.I./ P.U.
Test length = 1000 mm

Pipe Diameter:

Pipe 1: ID:
Pipe 2: ID:
Pipe 3: ID:

Experimental Procedure:

1) Fill the storage tank/sump with the water.
2) Switch on the pump and keep the control valve fully open and close the bypass valve to have maximum flow rate through the meter.
3) To find friction factor of pipe 1 open control valve of the same and close other to valves
4) Open the vent cocks provided for the particular pipe 1 of the manometer.
5) Note down the difference of level of mercury in the manometer limbs.
6) Keep the drain valve of the measuring tank open until the start time of collecting the water.
7) Close the drain valve of the measuring tank and collect known quantity of water
8) Note down the time required for the same.
9) Change the flow rate of water through the meter with the help of control valve and repeat the above procedure.
10) Similarly for pipe 2 and 3 . Repeat the same procedure indicated in step 4-9
11) Take about 2-3 readings for different flow rates.

Observations Table:
Length of test section (L) = 1000 mm = 1 m

Pipe 1

Internal Diameter of Pipe D= ___mm
Cross Sectional Area of Pipe = ____ m^2

Sr no	Qty (liter)	T sec	h1-h2 (mm)	V (m/s)

Pipe 2

Internal Diameter of Pipe D= ___mm
Cross Sectional Area of Pipe = ____ m^2

Sr no	Qty (liter)	T sec	h1-h2 (mm)	V (m/s)

Pipe 3

Internal Diameter of Pipe D= ___mm
Cross Sectional Area of Pipe = ____ m^2

Sr no	Qty (liter)	T sec	h1-h2 (mm)	V (m/s)

Calculations

Mean velocity of flow, V = Q/A m/s

Where, Q = 0.01/time required for 10 lit in m^3/sec

According to Darcy- Weisbach Equation for frictional loss of head due to pipe friction:-

$$hf = h1 - h2 = \frac{f * l * V^2}{D * 2g}$$

In the above equation, everything is known to us except "f"

Conversion Factor :- 1 mm of Hg = 0.0126 m of water

Conclusion

1) The friction factor for pipe is as follows:

- Pipe 1 =
- Pipe 2 =
- Pipe 3 =

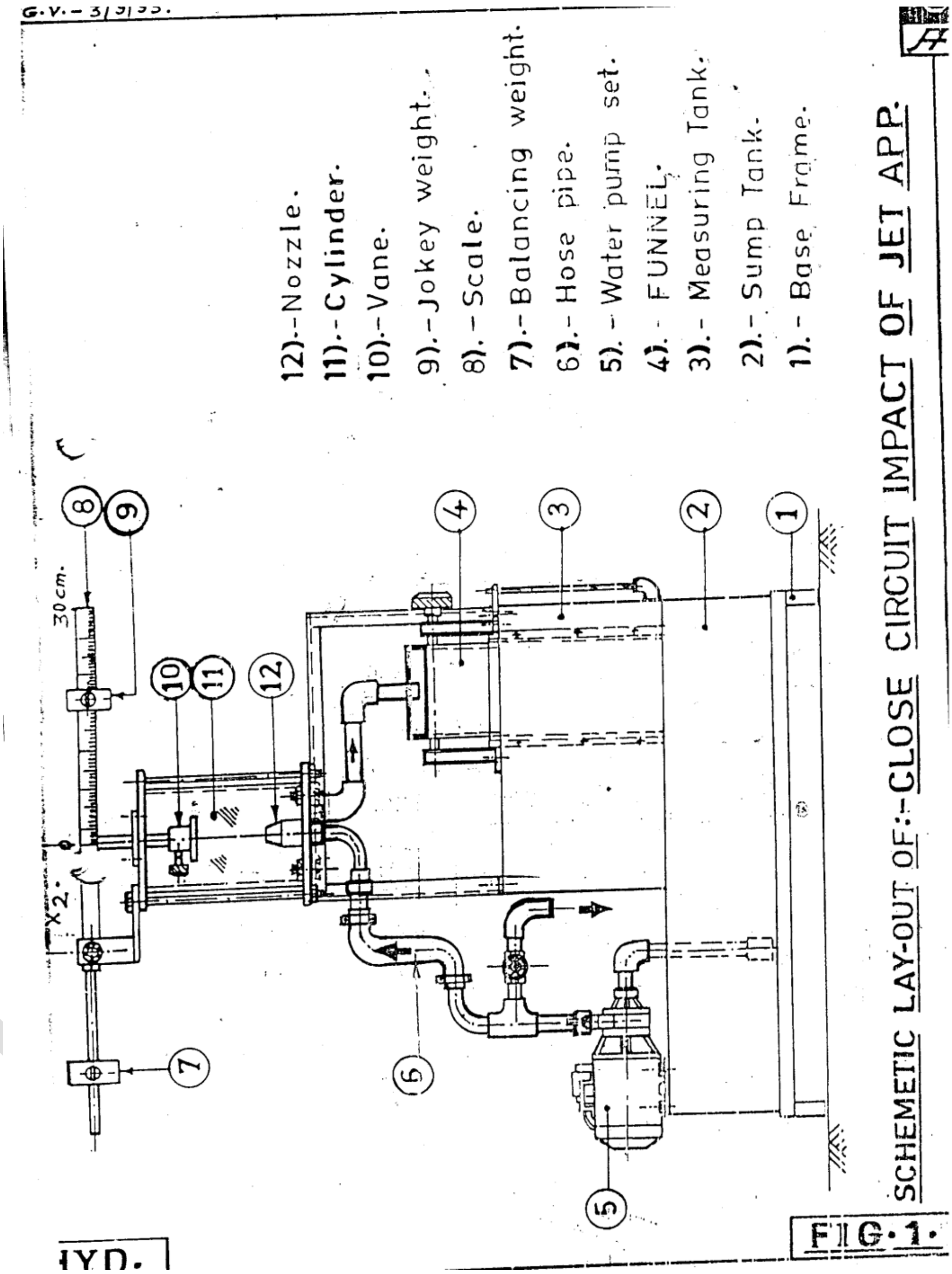
2) For same size pipe G.I./P.U. has more frictional loss compared to G.I./PU pipes

EXPERIMENT NO:4

EXPERIMENT NO:5

EXPERIMENT NO:6

IMPACT OF JET APPARATUS



AIM: To find the coefficient of impact of jet for vane, ‘K’

(Stationary & Inclined).

APPARATUS:

1. Impact of Jet experimental Set up
2. Stopwatch

DESCRIPTION:

The apparatus consists of an Acrylic cylinder. At the center of the cylinder, a nozzle is provided. On the top of the cylinder, lever is provided for which fulcrum is given at one end. At another end of the lever, Balancing Weight is provided. On the lever, required vane is attached. A Movable Weight is provided on the scale to get lever balance. The discharge is led into the Measuring Tank.

PROCEDURE:

1. Fix a required vane (suppose a Flat Plate) to the lever.
2. Adjust the Balancing Weight so that the lever becomes horizontal.
3. Start the supply. The jet of water through the nozzle will impinge on the vane. The force due to impact of water will be acting on the vane in the upward direction. This will disturb the initial balance of the lever.
4. Suitably adjust the position of the Sliding (Movable) Weight, so that the lever becomes horizontal or takes the balanced position.
5. Adjust the Supply Valve and take few more readings / observations.
6. With different vanes attached, F, repeat the procedure.

OBSERVATIONS:

- Diameter of Nozzle **“d”** =1.0 cm ; a = 0.786 cm^2
- Distance of vane from hinge **“X_2”** cm =14 cms
- Weight of Jockey **“ W_1 ”** =0.250 Kgs =250 gms.
- Volume of water collected in lit “ q” = 5 lit
- Gravitational Constant **“g”** =9.81 m/s^2 = 981 cm/s^2

Observetion Table:

Curved Vane

SR	X_1	t	Q	v	F_a	F_t	K
1							
2							
3							
4							
5							

Flat Vane

SR	X_1	t	Q	v	F_a	F_t	K
1							
2							
3							
4							
5							

Calculations:

1. X_1 = Displacement of final balancing in cm
2. Actual Force $Fa = \frac{W1*X1}{X2}$
3. Theoretical Force $Ft = \frac{Q*v}{t}$

   Where Q= discharge measured in cm^3/sec $Q = \frac{q*1000}{g}$

   t = time required for collecting q liters of water in sec

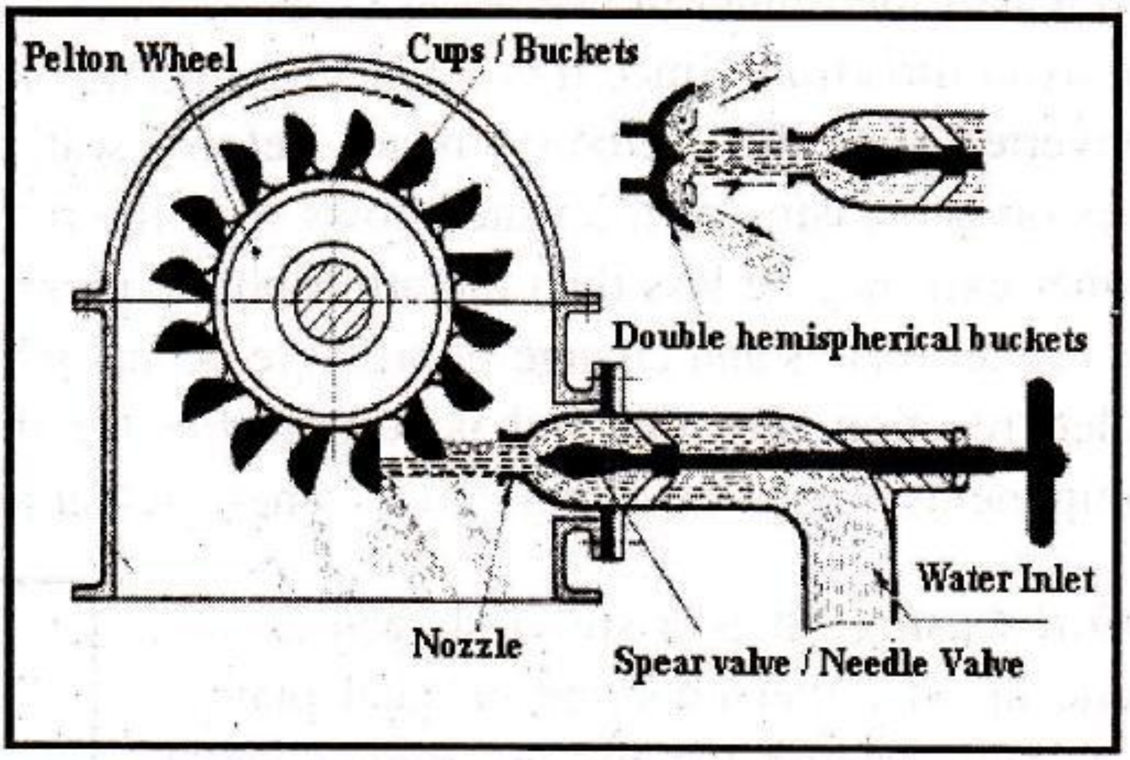
   v = velocity of water through jet in cm/sec $v = \frac{Q}{a}$
4. Coefficient of impact $K = \frac{Fa}{Ft}$

RESULT:

- Average Coefficient of Impact of Jet for Curved Vane =…………
- Average Coefficient of Impact of Jet for Flat Vane =…………

EXPERIMENT NO:7

PELTON WHEEL TURBINE



AIM: To conduct a test on Pelton Wheel Turbine at a Constant Head

APPARATUS:

1. Pelton Wheel Turbine
2. Nozzle & Spear Arrangement
3. Pressure Gauges (03 Nos. – Range = 00 – 07 kg/cm^2)

THEORY:

Pelton Wheel Turbine is an IMPULSE type of turbine which is used to utilize high head for generation of electricity. All the energy is transferred by means of Nozzle & Spear arrangement. The water leaves the nozzle in a jet formation. The jet of water then strikes on the buckets of Pelton Wheel Runner. The buckets are in the shape of double cups joined together at the middle portion. The jet strikes the knife edge of the bucket with least resistance and shock. Then the jet glides along the path of the cup & jet is deflected through more than 160 – 170 degrees. While passing through along the buckets, the velocity of water is reduced & hence impulse force is applied to the cups which are moved & hence shaft is rotated.

The Specific Speed of Pelton wheel varies at constant head.

TEST REQUIREMENTS:

The Pelton Wheel is supplied with water at high pressure by Centrifugal Pump. The water is converged through Venturimeter to the Pelton Wheel. The Venturimeter with manometer connection is to be determined. The nozzle opening can be positioned and decreased by operating Spear wheel at the entrance side of turbine. The Spear wheel can be positioned in 8 places, i.e. 1/8,2/8,3/8,4/8,5/8,6/8,7/8,8/8 of nozzle opening. The turbine can be loaded by applying loads on brake drums by means of placing the given loads on the loading arm also placing the given loads on the loaded turbine.

The speeds (r.p.m.) at the entrance can be measured with the help of Tachometer.

PROCEDURE:

1. Keep the nozzle opening at the required position.
2. Do the priming & start the pump.
3. Allow the water in the turbine to rotate it.
4. Note down the speed of the turbine.
5. Take the respective readings in the respective pressure gauges.
6. Load the turbine by putting the weights.
7. Note down the dead weights.
8. Also note down the Head level.
9. Repeat the same procedure for different loading conditions.

OBSERVATION:

1. Diameter of Drum = 40 cms = 0.4 m
2. Diameter of Rope = 15 mm = 0.015 m
3. Total diameter (D) = 415 mm = 0.415 m
4. Hanger weight $T_2 = 1$ kg

OBSERVATION TABLE:

1	2			3	4	5	6	
SR	PRESSURE GUAGE			HEAD	Q_{act}	SPEED	HEAD at INLET	
	P_1	P_2	P_p	H_p		N	P_i	H_i
1								
2								
3								
4								
5								

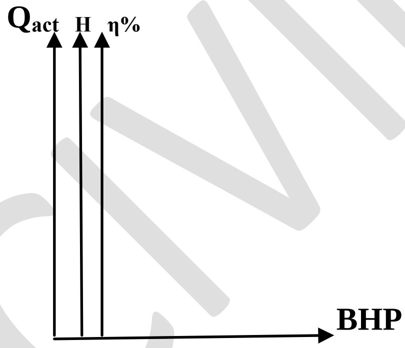
7	8	9	10	11	12
DEAD WT.	SPRING WT.	RESULT LOAD	BHP	IHP	%N
T_1	T_2	T			

Calculations:

1. $P = P_2 - P_1$
2. Head at penstock " H_p" = P_p / W (m)
3. $Q_{act} = 0.0055 \sqrt{H}$ (m^3/sec)
4. Head at inlet of turbine " H_i" = P_i / W (m)
5. Result load " T " = $T_1 + T_0 - T_2$
6. Brake horsepower $BHP = \frac{\pi DNT}{75*60}$
7. Input horsepower $IHP = \frac{WQHi}{75}$
8. Efficiency $\eta \% = \frac{BHP}{IHP} * 100$

Graph: X-Axis: BHP

Y-Axis: Q_{act} , H, η %



RESULT:

From Observations:

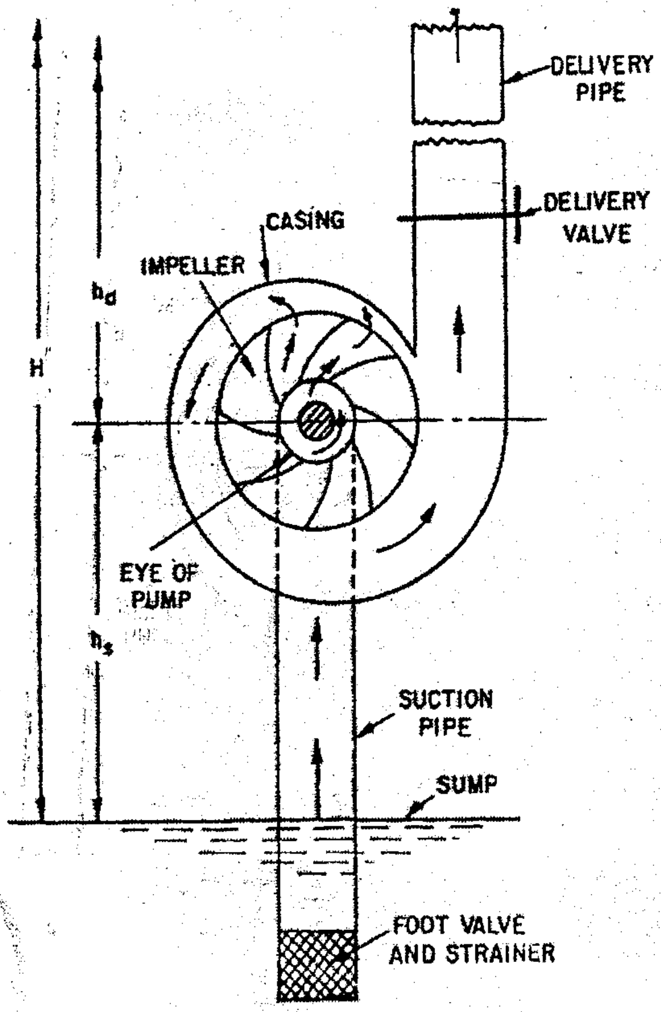
1. Maximum Efficiency of the Pelton Wheel Turbine " η " = ……………………..%
2. Actual Discharge = Q_{act} = ………
3. Head at inlet of turbine = H_i = ……..
4. B.H.P. (output) = ………….

From Observations:

1. Maximum Efficiency of the Pelton Wheel Turbine = ……………………..%
2. Actual Discharge = Q_{act} = ………
3. Head at inlet of turbine = H_i = ……..
4. B.H.P. (output) = ………….

EXPERIMENT NO:8

CENTRIFUGAL PUMP



Principal parts of a centrifugal pump

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

APPARATUS-: Centrifugal Pump Set – Up, Stop Watch, Meter Scale, etc.

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 Centrifugal Force which is acting on fluid. This 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 in both: the Pressure Energy, and the Kinetic Energy. The name of pump Centrifugal is derived from the fact that, the discharge 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.

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)

Pressure Gauge -: 0 to 2.1 kg / cm^2

Observations:

1. Area of measuring tank " A" =…..cm^2
2. X = ……..cm
3. N'= …..rpm

Observation Table -:

SR. NO.	M.T.R.			time	Q_{act}	Pre. Guage		Vac. Guage		total head
	IR (cm)	FR (cm)	R (m)	t sec	t	P_d (kg/cm2)	H_d (m)	P_v (mm hg)	H_v (m)	$H= H_d+H_v +X$
1										
2										
3										
4										
5										

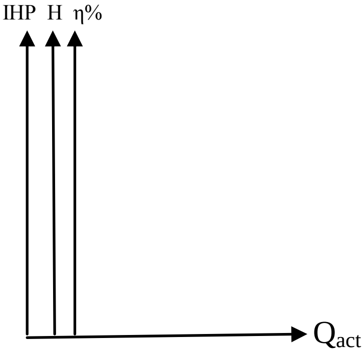
OUTPUT	SPEED	E.M.R.	INPUT	η %
WQH/75	N	5 REV		

Calculations -:

- R = Final Reading – Initial Reading = F.R. – I.R. (m)
- Actual Discharge $Qact = \frac{A*R}{t}$ (m^3/sec)
- Delivery head $H_d = P_d / W$
- Suction head $Hv = \frac{Pv}{1000} * 13.6$
- Total head " **H** " = $H_d + H_v + X$
- Out put = W Q_{act} H/75
- Input = 3600 * 1.36 * 5/ N' t

Graph: X-Axis: Q_{act}

Y-Axis: IHP , H, η %



Result -:

From Observations:

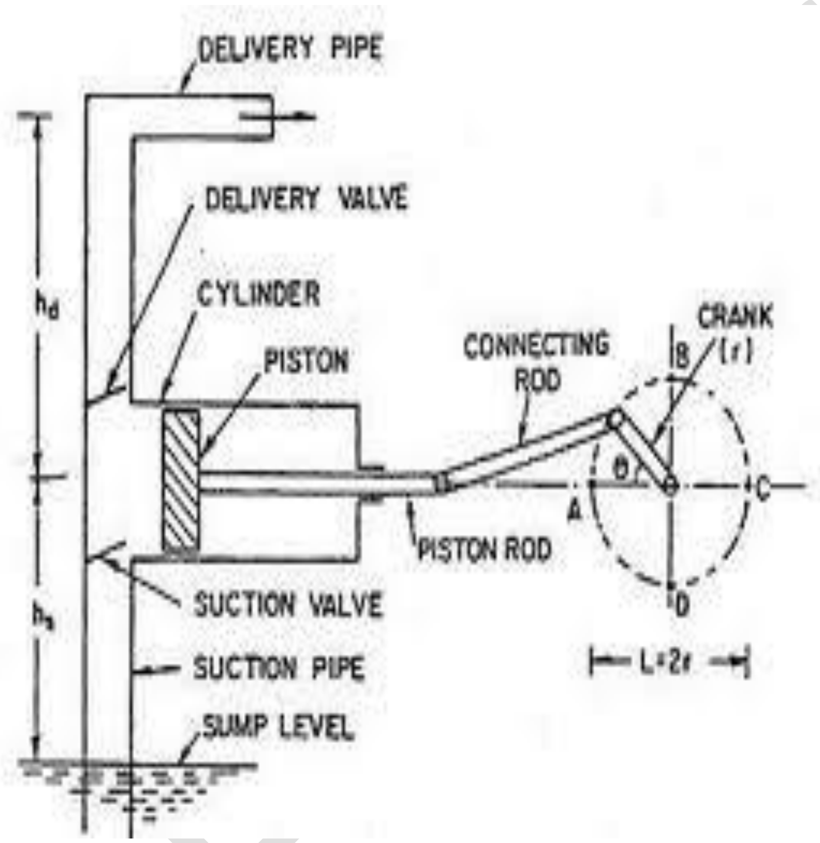
1. Maximum Efficiency = ή = ……………………..%
2. I.H.P = ………
3. Total Head = …….
4. B.H.P. (output) = ………….

From Graph:

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

EXPERIMENT NO:9

RECIPROCATING PUMP



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

INTRODUCTION:-

Reciprocating pump is a positive displacement plunger pump. It is often used where relatively small quantity of water is to be handled and delivery pressure is quite large. Reciprocating pumps are widely used as Automobile Service Stations, Chemical Industries, or as metering and dosing pumps.

The apparatus consists of a two cylinder, double acting reciprocating pump mounted over the sump tank. The pump is driven by DC motor. An energy meter measures electrical input to motor. Measuring tank is provided to measure discharge of the pump. The pressure and vacuum gauges provided to measure the delivery pressure and suction vacuum respectively

SPECIFICATIONS:-

1. Reciprocating pump - stroke length 16 mm, piston dia 22 mm. 2 piston, with air vessel on discharge side, suction 15 mm discharge 15 mm.
2. DC motor, 1 HP 1440 RPM.
3. Measuring tank – 300 X 400 X 300 mm height provided with gauge tube and funnel for diverting the flow into measuring tank or sump tank.
4. Sump tank – 600 X 500 X 300 mm height.
5. Measurements -

i) Pressure gauge 0 - 2 1 Kg/cm2 for discharge pressure,

ii) Vacuum gauge 0 -760 mm Hg for suction vacuum,

iii) Energy meter for motor input measurement.

PROCEDURE:-

1. Fill up sufficient water in sump tank.
2. Open the gate valve in the discharge pipe of the pump fully .
3. Check nut bolts & the driving belt for proper tightening.
4. Connect the electric supply and switch on the supply.
5. Slightly close the discharge valve. Note down pump speed, delivery
6. pressure, suction vacuum, time for 10imps of energy meter & for flow measurement close the measuring tanks drain valve, take time for 10 lits.
7. Repeat the procedure for different gate valve closing . Take care that discharge pressure does not rise above 8 Kg/cm2.
8. Change the speed and take readings for different gate valve openings.

OBSERVATIONS:-

- Piston Dia (m) "D" = 0.022 m
- Suction Stroke (m) "l" = 0.016 m
- Volume per Stroke(m3) "Vs" = $1.2164 * 10^{-5}$
- Volume of water collected (m^3) = 10 m^3
- Frictional Losses (m) = 2 m

OBSERVATION TABLE:

1	2	3	4	5	6	7	8	9	10
Sr NO	pump Speed "N_p"	Q_{th}	Time to collect water " t " sec	Q_{act}	Vacuum Gauge " P_s" (mm hg)	Suction Head H_s	Pressure Gauge " P_d"	Delivery Head "H_d"	Total Head "H_t"
1									
2									
3									
4									
5									

11	12	13	14	15
Output Power of pump "P_w"	Time for 10 imp. "te" sec	Input Power Ip	taking motor effeciency 80% (ISP)	Effeciency "η%"

CALCULATIONS

1. Volume per stroke = $\frac{\pi}{4} * D^2 * l * 2$

   $= \frac{\pi}{4} * 0.022^2 * 0.016 * 2 = 1.2164 * 10^{-5}$

2. Theoretical Discharge,

   $Q_{th} = \frac{Vs * Np}{60}$

3. Actual Discharge

   $Q_{act} = 0.01/t$

4. Suction Head,

   $H_s = \frac{Ps}{1000} * 13.6$

   Where,
   Sp, gravity of mercury = 13.6
   P_s = Vaccum/Suction Pressure in mm of Hg

5. Delivery head -

   $H_d = P_d/w$

6. Total head where

   H_t = Hs + Hd + 2 mtr

   where, Frictional losses = 2 mtr.

7. Output power of pump

$$P_w = \frac{W * Q_a * H_t}{1000} \; Kw$$

where, W = Specific weight of water = 9810 N/m3
Q_{act} = Discharge m3/sec.
H_t = Total head m

8. Input power to pump-Let time required for 10 indication mean pulse of energy meter be te sec. then,

$$IP = \frac{10 * 3600}{te * 1600} \; Kw$$

where,
energy meter constant is 1600 imp/Kwh.

9. Taking motor efficiency 80 %, we have input shaft power

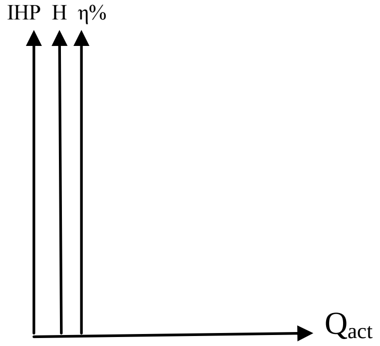
   S.P.= I.P. x 0.80

10. Overall efficiency of pump –

$$\eta = \frac{PW}{SP} * 100\%$$

Graph: X-Axis: Q_{act}

Y-Axis: IHP , H, η %



Result -:

From Observations:

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

From Graph:

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