WEST GODAVARI INSTITUTE OF SCIENCE & ENGINEERING

(Approved by AICTE, New Delhi and Affiliated to JNTU, Kakinada)

An ISO 9001-2015 Certified College

AVAPADU, **PRAKASARAOPALEM** – 534 112, W.G.Dist., A.P

FM & HM LAB MANUAL-R20

DEPARTMENT OF MECHANICAL ENGINEERING

II B.TECH I SEMESTER

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India

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FLUID MECHANICS AND HYDRAULIC MACHINERY

LAB RECORD

WEST GODAVARI INSTITUTE OF SCIENCE & ENGINEERING

(Affiliated To JNTU University)

Certificate

Department of ……..

This is to certify that the bonafide record of work done by

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Bearing Roll No……..is a student of ……..

In……branch has completed ……..

Experiments in ……laboratory during

the Academic year…….

……. **……**

Signature of HOD **Signature of LAB-In-charge**

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USER MANUAL

CLOSED CIRCUIT ORIFECE METER TEST RIG &

VENTURIMETER TEST RIG

ORIFICEMETER TEST RIG

INTRODUCTION

Closed Circuit self sufficient portable package system calibration test rig for Orificemeter is primarily designed to study and calibrate the flow meter like orifice meter. This unit has several advantages like this does not require any foundation, trench work etc. so that you can conduct the experiment keep the unit anywhere in the laboratory.

GENERAL DESCRIPTION

he apparatus consists of (1) Orifice meter (2) Piping system (3) supply pump set (4) Measuring tank (5) Differential manometer (6) Sump

CONSTRUCTIONAL SPECIFICATION

FLOW METERS

Consists of Orifice meter of size 25 mm provided for experiments. The meter has the adequate cocks also with them.

PIPING SYSTEM

Consists of a set of G.I. piping of size 25 mm with sufficient upstream and down stream lengths provided with separate control valves and mounted on a suitable stand. Separate upstream and downstream pressure feed pipes are provided for the measurement of pressure heads with control valves situated on a common plate for easy operation.

SUPPLY PUMP SET

Is rigidly fixed on sump. The mono block pump with motor. Operating on single phase 220/240 volts 50 Hz AC supply.

MEASURING TANK

Measuring tank with gauge glass and scale arrangement for quick and easy measurement.

DIFFERENTIAL MANOMETER

Differential manometer with 1 mm scale graduations to measure the differential head produced by the flow meter.

SUMP

Sump to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONNING

Check whether all the joints are leak proof and water tight.

- Fill the manometer to about half the height with mercury
- Close all the cocks, pressure feed pipes and manometer to prevent damage and over loading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.
- Check proper electrical connections to the switch, which is internally connected to the motor.

EXPERIMENTS

The apparatus is primarily designed for conducting experiments on the coefficient of discharge of flow meters. Each flow meter can be connected to the manometer through the pressure feed opening and the corresponding cocks.

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

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

The actual discharge is measured with the help of the measuring tank. The differential head produced by the flow meter can be found from the manometer for any flow rate.

TABULAR FORM

S. No.	Time for (10 cm) raise of water level in sec.	Actual discharge = Qa	Differential head in mm of mercury			Theoretical discharge = Qth	cd = Qa/Qth
			h1	h2	H		

CALIBRATION OF ORIFICE METER

Aim: - To calibrate a given Orifice meter and to study the variation of coefficient of discharge of it with discharge.

Apparatus: -Orifice meter, manometer, stop watch, experimental set-up.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.

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

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

5. Note down the time required for the rise of 10cm (i.e. 0.01m) water in the collecting tank by using stop watch. Calculate actual discharge using below formula.

Discharge: - The time taken to collect some 'R' cm of water in the collecting tank in m^3/sec.

$$Q_{act} = \frac{A \times R}{t}$$

Where: A = area of the collecting tank in m^2 (0.3m X 0.3m)

R = rise of water level taken in meters (say 0.2m or 20cm)

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

6. Using difference in mercury level "h"calculate the theoretical discharge of venturimeter by using following expression.

$$Q_{th} = \frac{a_1 x a_2 \sqrt{2gH}}{\sqrt{a_1^2 - a_2^2}}$$

Where

H= difference of head in meters = $(h^1 - h^2) \times (\frac{S_m}{S_w} - 1) = (h^1 - h^2) \times 12.6$

a_1 = area of orifice at inlet = $\frac{\pi D_1^2}{4}$

a_2 = area of orifice at inlet = $\frac{\pi D_2^2}{4}$

g =Acceleration due to gravity

d1 =Inlet diameter in meters.

d2 =Throat diameter in meters.

7. Calculate the coefficient of discharge of orifice meter (Cd):

$$Cd = \frac{Q_{act}}{Q_{theo}}$$

8. Repeat the steps 3 to 7 for different sets of readings by regulating the discharge valve.

S. No.	Orifice inlet diameter d1	Orifice diameter d2
1.	25mm	12.5

S. No.	Time for (20 cm) raise of water level in sec.	Actual discharge = Qa	Differential head in mm of mercury			Theoretical discharge = Qth	cd = Qa/Qth
			h1	h2	H		

RESULTS AND CONCLUSIONS

Calculation:-

CLOSED CIRCUIT VENTURIMETER

INTRODUCTION

The Closed Circuit self sufficient portable package system calibration test rig for Venturimeter is primarily designed to study and calibrate the flow meter like orifice meter. This unit has several advantages like this does not require any foundation, trench work etc. so that you can conduct the experiment keep the unit anywhere in the laboratory.

GENERAL DESCRIPTION

The apparatus consists of (1) Venturimeter (2) Piping system (3) supply pump set (4) Measuring tank (5) Differential manometer (6) Sump

CONSTRUCTIONAL SPECIFICATION

FLOW METERS

Consists of Venturimeter of size 25 mm provided for experiments. The meter has the adequate cocks also with them.

PIPING SYSTEM

Consists of a set of G.I. piping of size 25 mm with sufficient upstream and down stream lengths provided with separate control valves and mounted on a suitable stand. Separate upstream and down stream pressure feed pipes are provided for the measurement of pressure heads with control valves situated on a common Pipe for easy operation.

SUPPLY PUMP SET

Is rigidly fixed on sump. The mono block pump with motor, operating on single phase 220/240 volts 50 Hz AC supply.

MEASURING TANK

Measuring tank with gauge glass and scale arrangement for quick and easy measurement.

DIFFERENTIAL MANOMETER

Differential manometer with 1 mm scale graduations to measure the differential head produced by the flow meter.

SUMP

Sump to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONNING

- Check whether all the joints are leak proof and water tight.
- Fill the manometer to about half the height with mercury
- Close all the cocks, pressure feed pipes and manometer to prevent damage and over loading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed watetight and vertically.

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

EXPERIMENTS

The apparatus is primarily designed for conducting experiments on the coefficient of discharge of flow meters. Each flow meter can be connected to the manometer through the pressure feed opening and the corresponding cocks.

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

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

The actual discharge is measured with the help of the measuring tank. The differential head produced by the flow meter can be found from the manometer for any flow rate.

TABULAR FORM

S. No.	Time for (10 cm) raise of water level in sec.	Actual discharge Qa	Differential head in mm of mercury			Theoretical discharge = Qt	cd = Qa/Qth
			h1	h2	h		

CALIBRATION OF VENTURI METER

Aim: - To calibrate a given venturi meter and to study the variation of coefficient of discharge of it with discharge.

Apparatus: - Venturimeter, manometer, stop watch, experimental set-up.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.

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

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

5. Note down the time required for the rise of 10cm (i.e. 0.01m) water in the collecting tank by using stop watch. Calculate actual discharge using below formula.

Discharge: - The time taken to collect some 'R' cm of water in the collecting tank in m^3/sec.

$$Q_{act} = \frac{A \times R}{t}$$

Where: A = area of the collecting tank in m^2 (0.3m X 0.3m)

R = rise of water level taken in meters (say 0.2m or 20cm)

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

6. Using difference in mercury level "h"calculate the theoretical discharge of venturimeter by using following expression.

$$Q_{th} = \frac{a_1 x a_2 \sqrt{2gH}}{\sqrt{a_1^2 - a_2^2}}$$

Where

H= difference of head in meters = $(h^1 - h^2) \times (\frac{S_m}{m\ S_w} - 1) = (h^1 - h^2) \times 12.6$

a_1 = area of venturi at inlet = $\pi D_1^2 / 4$

a_2 = area of venturi at throat = $\pi D_2^2 / 4$

g =Acceleration due to gravity

d1 =Inlet diameter in meters.

d2 =Throat diameter in meters.

7. Calculate the coefficient of discharge of orifice meter (Cd):

$$Cd = \frac{Q_{act}}{Q_{theo}}$$

8. Repeat the steps 3 to 7 for different sets of readings by regulating the discharge valve.

S. No.	Venturi inlet diameter d1	Throat Diameter d2
1.	25mm	12.5 mm

S. No.	Time for (20 cm) raise of water level in sec.	Actual discharge = Qa	Differential head in mm of mercury			Theoretical discharge = Qt	cd = Qa/Qth
			h1	h2	H		

RESULTS AND CONCLUSIONS

Calculation:-

CLOSED CIRCUIT SINGLE STAGE CENTRIFUGAL PUMP TEST RIG

CENTRIFUGAL PUMP

INTRODUCTION

Closed Circuit Self sufficient portable package system Experimental single stage Centrifugal pump Test Rig is designed to study the performance of the single stage Centrifugal pump. In this equipment one can study the relationship between

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

This unit has several advantages like does not require any foundation, trench keeping in the laboratory.

GENERAL DESCRIPTION

The Test Rig mainly consists of (1) centrifugal pump set (2) Panel Board, (3) Pressure and vacuum gauges to measure the head (4) SS Measuring Tank to measure the discharge (5) Energy meter to measure the input to the motor and .(6) SS Sump.

CONSTRUCTIONAL SPECIFICATION

CENTRIFUGAL PUMPSET

The pump set is of special design, horizontal spindle, and vertical split case. The pump is of such a size, type & design that 1) The total head 2) Discharge and 3) Power requirements at normal speed is well suited for the experimental purposes in technical institutions.

A.C. MOTOR

The electric motor suitable for operation on 50 cycles A.C. Supply is provided.

GAUGES

Suitable range of pressure and vacuum gauges to measure the total head on the pump with reasonable accuracy.

SS MEASURING TANK

Is provided to measure the discharge of the pump with overflow arrangement. The tank is complete with gauge glass and scale arrangement.

PIPING SYSTEM

Suitable piping system with pipes, bends and valves are provided. A Simple strainer valve is provided on the suction side to prevent any foreign matter entering into the pump. The gate valve is provided in the delivery side to control the head on the pump. While starting the motor always keep the valve in close position.

PANEL BOARD

The Panel Board houses all the necessary electrical items, like switch, starter for the above pump set and an energy meter to read the power input and it is fitted with the unit on a strong iron base with sufficient height.

INPUT POWER MEASUREMENT

A Kilowatt-hour meter is provided to measure the power input to the motor. The energy meter constant (The Number of Revolutions per minute of the energy meter Disc) is stamped on the meter from this the input power can be easily calculated.

SS SUMP

Is provided to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONING

- Check whether all the joints are leak proof and watertight.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.
- Check whether all the electric connection is correct.
- See that the gauges are mounted on the correct position and their cocks closed.

STARTING

Before starting the required electrical connection should be done correctly.

EXPERIMENTS

The apparatus is designed to study the performance of a single stage Centrifugal Pump. The readings to be taken on the single stage centrifugal pump are (1) Total Head (2) Discharge (3) Power input and (4) Efficiency. Provision has been made to measure all these and hence the complete characteristics of the single stage Centrifugal pump in question can be studied.

First prime the pump and start the motor. While starting closing and delivery valve and the gauge cocks. Then slowly open the delivery valve and adjust to the required total head. The total head is measured with the help of the pressure gauge. Total head is the sum of the pressure head, Velocity head and the datum head.

Discharge is the amount of liquid the pump delivers over a definite period of time. It is usually expressed in liter per minute. The actual discharge is measured with the help of the measuring tank.

In this case the power input into the pump cannot be measured directly. Hence the power input into the AC motor is measured with the help of the energy meter connected in the line.

Efficiency is the relation between the power input into the pump and the power output from the pump. The power output from the pump is directly proportional to the total head and discharge. As the power input into the pump cannot be measured the power input into the motor only is taken into account and the overall efficiency of the pump is calculated.

If the total head (H) is measured in meters and the discharge (0) in liter per minute. The kilowatt input to the motor is measured with the help of the meter constant stamped on the energy meter. The efficiency is calculated by dividing the output by input.

For a particular desired speed of the pump, the entire above variable can be studied individually, Thus the complete characteristics can be studied.

PERFORMANCE TEST ON CENTRIFUGAL PUMP

Aim: - To conduct a test at various heads of given centrifugal pump find its efficiency.

Apparatus: - centrifugal pump, stop watch, scale, collecting tank.

Procedure:-

1. Start the motor keeping the delivery valve close.

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 = Kg/cm^2 x 10 = meters.

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

Datum head = Distance between pressure and vacuum gauge in meters

Total head (H) = Pressure Head + Vacuum Head + Datum Head

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 'X' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A\ x}{R\ t}$$

Where:

A = area of the collecting tank in m^2 (0.35m X 0.35m)

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.

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

$$\text{Input power} = \frac{X \times 3600 \times 0.80}{C \times T}$$

0.80 =Motor efficiency.

X = No. of revolutions of energy meter disc

T = Time for Energy meter revolutions disc. In seconds

C = Energy meter constant

5. Now calculate the output power

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

Where:

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

Q = Discharge

H = Total Head

6. Repeat the steps from 2 to 5 for various heads by regulating the delivery valve. A Typical tabular form is given below for convenience during experiments.

TABULAR FORM

S. No.	Pressure gauge reading	Vacuume gauge reading	Time taken for 5rev of energy Meter disc	Time taken for collecting 10cm rise of water In collecting tank	Total head (P + V) meters	Discharge Q	Input Power Kw	Out put Power Kw	Efficiency

RESULTS AND CONCLUSIONS

Graphs for :-

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

Calculation:-

CLOSED CIRCUIT MULTI STAGE CENTRIFUGAL PUMP TEST RIG

MULTI STAGE CENTRIFUGALPUMP

INTRODUCTION

Closed Circuit Self sufficient portable package system Experimental Multi stage Centrifugal pump Test Rig is designed to study the performance of the Multi stage Centrifugal pump. In this equipment one can study the relationship between

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

This unit has several advantages like does not require any foundation, trench keeping in the laboratory.

GENERAL DESCRIPTION

The Test Rig mainly consists of (1) Multi stage centrifugal pump set (2) Panel Board, (3) Pressure and vacuum gauges to measure the head (4) SS Measuring Tank to measure the discharge (5) Energy meter to measure the input to the motor and .(6) SS Sump.

CONSTRUCTIONAL SPECIFICATION

MULTI STAGE CENTRIFUGAL PUMPSET

The pump set is of special design, horizontal spindle, and vertical split case. The pump is of such a size, type & design that 1) The total head 2) Discharge and 3) Power requirements at normal speed is well suited for the experimental purposes in technical institutions.

A.C. MOTOR

The electric motor suitable for operation on 50 HZ A.C. Supply is provided.

GAUGES

Suitable range of pressure and vacuum gauges to measure the total head on the pump with reasonable accuracy

SS MEASURING TANK

It is provided to measure the discharge of the pump. The tank is complete with piezo meter and scale arrangement.

PIPING SYSTEM

Suitable piping system with pipes, bends and valves are provided. A Simple strainer valve is provided on the suction side to prevent any foreign matter entering into the pump. The gate valve is provided in the delivery side to control the head on the pump. While starting the motor always keep the valve in close position.

PANEL BOARD

The Panel Board houses all the necessary electrical items, like switch for the above pump set and an energy meter to read the power input and it is fitted with the unit on a strong iron base with sufficient height and with provisions for foundation. .

INPUT POWER MEASUREMENT

A Kilowatt-hour meter is provided to measure the power input to the motor. The energy meter constant (The Number of Revolutions per minute of the energy meter Disc) is stamped on the meter from this the input power can be easily calculated.

SS SUMP

Is provided to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONING

- Check whether all the joints are leak proof and watertight.
- Check the piezo meter assembly of the measuring tank and see that it is fixed water tight and vertically.
- Check whether all the electric connection is correct.
- See that the gauges are mounted on the correct position and their cocks closed.

STARTING

Before starting the required electrical connection should be done correctly.

EXPERIMENTS

The apparatus is designed to study the performance of a multi stage Centrifugal Pump. The readings to be taken on the single stage centrifugal pump are (1) Total Head (2) Discharge (3) Power input and (4) Efficiency. Provision has been made to measure all these and hence the complete characteristics of the single stage Centrifugal pump in question can be studied.

First prime the pump and start the motor. While starting closing and delivery valve and the gauge cocks. Then slowly open the delivery valve and adjust to the required total head. The total head is measured with the help of the pressure gauge. Total head is the sum of the pressure head, Velocity head and the datum head.

Discharge is the amount of liquid the pump delivers over a definite period of time. It is usually expressed in liter per minute. The actual discharge is measured with the help of the measuring tank. In this case the power input into the pump cannot be measured directly. Hence the power input into the AC motor is measured with the help of the energy meter connected in the line.

Efficiency is the relation between the power input into the pump and the power output from the pump. The power output from the pump is directly proportional to the total head and discharge. As the power input into the pump cannot be measured the power input into the motor only is taken into account and the overall efficiency of the pump is calculated.

If the total head (H) is measured in meters and the discharge (0) in liter per minute, the HO/6120 gives the output in kW. The kilowatt input to the motor is measured with the help of the meter constant stamped on the energy meter. The efficiency is calculated by dividing the output by input.

For a particular desired speed of the pump, the entire above variable can be studied individually, thus the complete characteristics can be studied.

PERFORMANCE TEST ON MULTI STAGE CENTRIFUGAL PUMP

Aim: - To conduct a test at various heads of given multistage centrifugal pump find its efficiency.

Apparatus: - multistage centrifugal pump, stop watch, collecting tank.

Procedure:-

1. Start the motor keeping the delivery valve close.

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 = Kg/cm^2 x 10 = meters.

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

Datum head = Distance between pressure and vacuum gauge in meters

Total head (H) = Pressure Head + Vacuum Head + Datum Head

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 'X' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A\ x}{R\ t}$$

Where:

A = area of the collecting tank in m^2 (0.35m X 0.35m)

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.

1. Note down the time taken for ‘x’ revolutions of energy meter disk and calculate the Input power

$$\text{Input power} = \frac{X \times 3600 \times 0.60}{C \times T}$$

0.6 = combined motor (0.75) and transmission losses (0.8).

X = No. of revolutions of energy meter disc (say 5 Rev.) T =

Time for Energy meter revolutions disc. In seconds

C = Energy meter constant

5. Now calculate the output power

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

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

Q = Discharge

H = Total Head

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

A Typical tabular form is given below for convenience during experiments.

TABULAR FORM

S. No.	Pressure gauge reading	Vacuum gauge reading	Time taken for 5rev of energy Meter disc	Time taken for collecting 10 cm rise of water In collecting tank	Total head (P + V) meters	Discharge Q

RESULTS AND CONCLUSIONS

Graphs for :-

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

Calculation:-

USER MANUAL

CALIBRATION OF FLOW METER

APPARATUS

TURBINE FLOW METER

INTRODUCTION

The Closed Circuit Self- sufficient portable package system Apparatus for CALIBRATION OF FLOW METER is primarily designed for conducting experiments to calibrate the flow meter This unit has several advantages like, this does not require any foundation, trench work, etc, and so that you can conduct the experiments keeping the unit anywhere in the laboratory soon after receiving the equipment

GENERAL DESCRIPTION

The unit consists mainly of 1) Piping System 2) Measuring Tank 3) Supply pump set 4) Sump.

CONSTRUCTIONAL SPECIFICATION

PIPING SYSTEM

Piping System of size 25 mm dia with a flow control valve.

MEASURING TANK

Measuring tank is provided to measure the discharge of water from the unit.

SUPPLY PUMP SET

Supply pump set is rigidly fixed on the sump. The pump set is mono block pump with 0.5 HP motor operating on single phase 220 volts 50 Hz AC supply.

SUMP

Sump is provided to store sufficient waters for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONING

- Check whether all the joints are leak proof and watertight.
- Close all the cocks on the pressure feed pipes and Manometer to prevent damage and overloading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertical.
- Check proper electrical connections to the switch, which is internally connected to

CALIBRATION OF TURBINE FLOW METER

Aim: - To calibrate a given turbine flow meter.
Apparatus: -Turbine flow meter, stop watch, experimental set-up.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the selected pipe by selecting the appropreate ball valve.

3. Maintain certain level of water in collecting tank say some 5cm which is initial h (H1).

4. Stop the pump and note down the reading of flow meter (F1).

5. Again start the pump allow to flow some liters (i.e 10) of water and stop the pump.

6. Take final reading of flow meter (F2) and water level in the tank (H2).

7. Calculate the correction factor for turbine flow meter.

$$\text{Correction factor (C)} = \frac{\text{Water flown through turbine flow meter .}}{\text{Actual flow}}$$

Actual flow = area of collecting tank X Water collected in collecting tank X 1000 liters

H = 0.3m x 0.3m x h x 1000 Liters

F - Water flown through turbine flow meter. = F2 – F1 liters

h - Water collected in collecting tank. =h2 – h1 meteres

C – Correction factor.

8. Repeat steps 2 to 7 for different valve openings (i.e discharge)

TABULAR FORM

A Typical tubular is given below for the convenience during experiments

S. No.	Flow meter reading In liters		Collecting tank reading in liters			Total flow in liters	Total water collected in liters	Correction factor
	F1	F2	h1	h2	h=h2-h1	F=F2-F1 Ltrs	H=Axhx1000 Ltrs.	C = H X100 / F
1								
2								
3								
4								

RESULTS AND CONCLUSIONS

Calculation:-

LOSS OF HEAD DUE TO SUDDEN CONTRACTION

APPARATUS

LOSS OF HEAD DUE TO SUDDEN CONTRACTION IN A PIPE LINE

INTRODUCTION

The Closed Circuit Self- sufficient portable package system Apparatus for loss of head due to sudden contraction is primarily designed for conducting experiments on the loss of head due to sudden contraction of pipeline. This unit has several advantages like, this does not require any foundation, trench work, etc, and so that you can conduct the experiments keeping the unit anywhere in the laboratory soon after receiving the equipment.

GENERAL DESCRIPTION

The unit consists mainly of 1) Piping System 2) Measuring Tank 3) Differential Manometer 4) Supply pump set 5) Sump.

CONSTRUCTIONAL SPECIFICATION

PIPING SYSTEM

Piping System of size 25 mm dia and 12.5mm with a flow control valve.

MEASURING TANK

Measuring tank is provided to measure the discharge of water from the unit.

DIFFERENTIAL MANOMETER

Differential manometer with 1 mm scale graduations to measure the loss of head due to sudden contraction of the pipeline.

SUPPLY PUMP SET

Supply pump set is rigidly fixed on the sump. The pump set is mono block pump with 0.5 HP motor operating on single-phase 220 volts 50 Hz AC supply.

SUMP

Sump is provided to store sufficient waters for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONING

- Check whether all the joints are leak proof and watertight.
- Close all the cocks on the pressure feed pipes and Manometer to prevent damage and overloading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertical.
- Check proper electrical connections to the switch, which is internally connected to the motor.

EXPERIMENTS

The apparatus is primarily designed for conducting experiments on the loss of head due to sudden contraction of the pipeline. Pipeline can be connected to the Manometer through the pressure feed pipes having individual quick operating cocks.

While taking reading close all the cocks in the pressure feed pipe except the two (upstream and downstream) cocks, which directly connect the manometer to the required pipe for which the loss of head has to be determined. (Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes).

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

The actual discharge is measured with the help of the measuring tank. For each size of the pipe the area of cross section of flow can be calculated from the known diameter of the pipes. From these two valves and the average velocity of stream through the pipe can be calculated.

Loss of Head due to Sudden Contraction. Consider a liquid flowing in a pipe which has a sudden contraction. Consider two sections 1-1 and 2-2 before and after, contraction. As the liquid flows from the large pipe to smaller pipe, the area of flow goes on decreasing and becomes minimum at a section C-C as shown in the below figure. The section C-C is called Vena-contraction. After section C-C a sudden enlargement of the area takes place. The loss of head due to sudden contraction is actually due to sudden enlargement from Vena-contracta to smaller pipe.

A = Area of flow at section

V = Velocity of flow at section

hc =

K = Factor of coefficient.

$$\text{Velocity} = V = \frac{\text{discharge}}{\text{Area}} = Q/a$$

$$\text{Discharge } (Q) = \frac{\text{collecting tank area X rise of water level taken}}{\text{Time taken for rise of water in collecting tank}} \ m^3/sec$$

$$hc = \frac{\text{manometer head X12.6}}{1000} \ m$$

$$hc = \frac{V2^2}{2g}\left[\frac{1}{Cc} - 1\right]$$

$$H = (h1-h2)(Sn/So - 1) = (h1-h2)12.6$$

V2 = Dia. Meter of the pipe (12.5mm)

Sn - specific gravity of mercury = 13.6

So - specific gravity of water = 1.0

Cc is between 0.4 to 0.7

LOSS OF HEAD DUE TO SUDDEN CONTRACTION

Aim: - To determine the coefficient of loss in sudden contraction.

Apparatus: - experimental set-up, stop watch.

Procedure:-

1. Start the motor keeping the delivery valve close. Make sure that ball valve is fully open which is at the collecting tank.

2. Slowly open the cocks which are fitted at sudden contraction end and make sure that manometer is free from air bubbles.

3. Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes. Note down the loss of head "hc" from the manometer scale.

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

Discharge: - The time taken to collect some 'x' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A\,x}{R\,t}$$

A = area of the collecting tank in m^2 (0.3m X 0.3m)

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

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

5. Calculate the velocity of the jet by following formula

$$V = \frac{\text{Discharge}}{\text{Area of the pipe}} = \frac{Q}{A}\ \text{m/sec}$$

A = cross sectional area of the pipe= $\Pi d^2/4$

d =diameter of the pipe

6. Calculate the coefficient of contraction for the given pipe by

$$hc = \frac{V2^2}{2g}\left[\frac{1}{Cc} - 1\right]$$

Where:-

hc - Loss of head due to sudden contraction. = (h1-h2)(Sn /So – 1) = (h1-h2) 12.6/1000 m

Sn - Specific gravity of mercury 12.6

So - specific gravity of water

Cc- Coefficient of contraction.

V - Average velocity of flow in m/sec

7. Repeat the steps 2 to 6 for different sets of readings by regulating the discharge valve.

A Typical tubular is given below for the convenience during experiments.

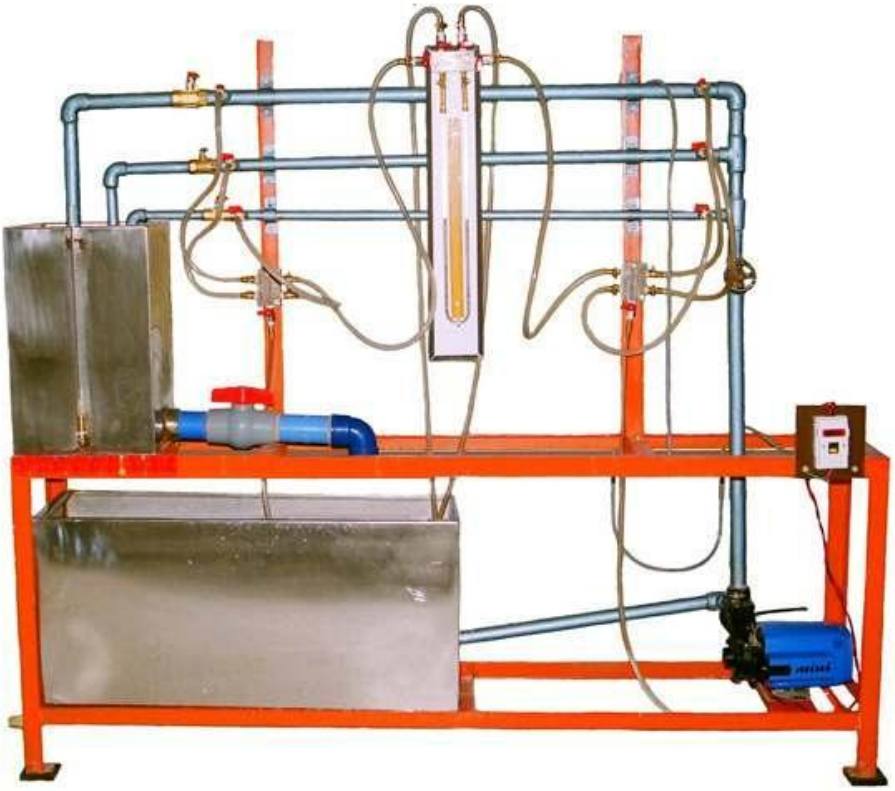
TABULAR FORM

S. No.	Diameter of pipe	Area m^3	Time for rise Of 10 cm water	Discharge Q	Velocity V2	Manometric head in mm of hg h	hc	Coefficient of contraction
1.								
2.								
3.								
4.								
5.								

RESULTS AND CONCLUSIONS

Calculation:-

CLOSED CIRCUIT PIPE FRICTION APPARATUS



FRICTION FACTOR FOR A GIVEN PIPE LINE

INTRODUCTION

The Closed Circuit Self- sufficient portable package system Apparatus for frictional losses in pipes is primarily designed for conducting experiments on the frictional losses in pipes of different sizes. This unit has several advantages like, this does not require any foundation, trench work, etc, and so that you can conduct the experiments keeping the unit anywhere in the laboratory soon after receiving the equipment.

GENERAL DESCRIPTION

The unit consists mainly of 1) Piping System 2) Measuring Tank 3) Differential Manometer 4) Supply pump set 5) Sump.

CONSTRUCTIONAL SPECIFICATION

PIPING SYSTEM

Piping System of size 12.7 mm, 20 mm and 20 mm (S.S.) dia. With tapings at 1 meter distance and a flow control valve.

MEASURING TANK

Measuring tank is provided to measure the discharge of water from the unit.

DIFFERENTIAL MANOMETER

Differential manometer with 1 mm scale graduations to measure the loss of head in the pipe line.

SUPPLY PUMP SET

Supply pump set is rigidly fixed on the sump. The pump set is mono block pump with 0.5 HP motor operating on single phase 220 volts 50 Hz AC supply.

SUMP

Sump is provided to store sufficient waters for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONING

- Check whether all the joints are leak proof and watertight.
- Close all the cocks on the pressure feed pipes and Manometer to prevent damage and overloading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertical.
- Check proper electrical connections to the switch, which is internally connected to the motor.

EXPERIMENTS

The apparatus is primarily designed for conducting experiments on the frictional losses in pipes of different sizes. Three different sizes of pipes are provided for wide range of experiments. Each individual pipe can be connected to the Manometer through the pressure feed pipes having individual

quick operating cocks.

While taking reading close all the cocks in the pressure feed pipe except the two (upstream and downstream) cocks, which directly connect the manometer to the required pipe for which the loss in head has to be determined. (Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes).

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

The actual discharge is measured with the help of the measuring tank. For each size of the pipe the area of cross section of flow can be calculated from the known diameter of the pipes. From these two valves and the average velocity of stream through the pipe can be calculated.

The actual loss of head is determined from the Manometer readings. The frictional loss of head in pipes is given by the Darcy's formula

The friction coefficient indicates 'f '.

TABULAR FORM

S. No.	Ø of pipe	Area (a)	Time for rise of 10 cm water	Discharge	Velocity	Loss of Head hf	Co-efficient of friction f
1.							
2.							
3.							
4.							
5.							

FRICTION FACTOR FOR A GIVEN PIPE LINE

Aim: - To calculate the friction factor for a given pipe line.

Apparatus: - experimental set-up, stop watch.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.

3. By regulating the valve control the flow rate and select the corresponding pressure tapings.

4. Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes. Note down the loss of head "hf" from the manometer scale.

5. 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 'x' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A\,x}{R\,t}$$

A = area of the collecting tank in m^2 (0.3m X 0.3m)

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

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

6. Calculate the velocity of the jet by following formula

$$V = \frac{\text{Discharge}}{\text{Area of the pipe}} = Q/A \text{ m/sec}$$

A = cross sectional area of the pipe= $\Pi d^2/4$

d = pipe diameter

7. Calculate the coefficient of friction for the given pipe by

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

Where,

h_f - Loss of head of water = (h1-h2)(Sn /So – 1) = (h1-h2) 12.6/1000 m

f - Co-efficient of friction for the pipe

L - Discharge between sections for which loss of head is measured (1 meter)

v - Average velocity of flow in m/sec

g - Acceleration due to gravity 9.81m/sec d

- Pipe diameter in meters

8. Repeat the steps 2 to 7 for different sets of readings by regulating the discharge valve.

TABULAR FORM (1)

S. No.	Ø of pipe	Area (a)	Time for rise of 10 cm water	Discharge	Velocity	Loss of Head hf	Co-efficient of friction f
1.							
2.							
3.							
4.							
5.							

RESULTS AND CONCLUSIONS

TABULAR FORM (2)

S. No.	Ø of pipe	Area (a)	Time for rise of 10 cm water	Discharge	Velocity	Loss of Head hf	Co-efficient of friction f
1.							
2.							
3.							
4.							
5.							

RESULTS AND CONCLUSIONS

TABULAR FORM (3)

S. No.	Ø of pipe	Area (a)	Time for rise of 10 cm water	Discharge	Velocity	Loss of Head hf	Co-efficient of friction f
1.							
2.							
3.							
4.							
5.							

RESULTS AND CONCLUSIONS

Calculation:-

MEASURING FORCE DUE TO IMPACT OF JET OF WATER ON VANE

IMPACT OF JET OF WATER ON VANES

INTRODUCTION

This apparatus is specially designed for conducting experiments on the impact of jet of water on fixed vane. The dynamic force in the direction of the jet can be practically determined and could be verified with the theoretically force gives the co-efficient of the impact of jet on the vanes. Nozzles of 8 mm and flow control valve for varying the velocity of jet are provided for carrying out the tests extensively.

GENERAL DESCRIPTION

The apparatus consists of mainly (1) Nozzle housing, (2) Nozzle, (3) Vane, (4) Transparent Tank

(5) Measuring Tank and (6) Sump.

NOZZLE HOUSING:

It is of M.S rigidly fixed to the bottom of the tank having transparent tube and suitable to accommodate nozzle.

NOZZLE:

It is of Gun Metal machined and polished nozzle of 8 mm is supplied.

VANE:

It is of Gun Metal machined all over and interchangeable.

(1) Flat vane with normal input.
(2) Hemi Spherical vane with normal input.

TRANSPARENT TANK:

To observe the flow and jet deflection the tank is fitted with transparent tube.

MEASURING TANK:

It is of suitable size and provided with gauge glass, scale arrangement for quick and easy measurements. A Ball valve is provided to empty the tank.

SUMP:

It is of suitable size with a supply pump set of 1 HP operating on single phase 220-240V 50Hz AC Supply, and a drain plug to drain the water when the unit is not in use.

INSTALLATION

Fix the transparent tube on the measuring tank with the help of four bolts and nuts provided. Make sure that the discharge spout is exactly center of the vane and connect the necessary piping to the apparatus.

BEFORE COMMISSIONING

- Check whether the nozzle housing, discharge pipe flange etc are fitted with gaskets to prevent water leakage.

- Check the gauge glass and meter scale assembly of the Measuring tank and see that it is fixed water tight and vertical.

EXPERIMENTS

The jet of water impinging on vane exerts force on it. The force exerted on it is derived by applying impulse momentum equation to control volume of water. The force exerted by a jet of fluid on symmetric vane is given by

$$F\ th = \rho a V^2$$

The apparatus is primarily designed for measuring the force on vane due to the impact of jet of water. Aluminum Vane is supplied to study the effect of the deflection of the impinging jet on the vane. The actual discharge is measured by using the measuring tank, by noting the time for a definite rise of water level when the water is collected in the tank. One gunmetal Nozzle of diameter 8 mm is provided. The *Co*-efficient of contraction of the nozzle can be taken as 0.67. The actual impinging jet velocity (V) in meters per second be calculated from the above flow rate and the area of the nozzle (a) in square mm.. The theoretical force (F1 in Kg) on the vane in the direction of the jet is equal to the change of momentum per second.

A Typical tabular form for use during experiments is attached herewith.

S. No.	Fact Newton	Time taken for 10cm rise of water	Q m^3/sec	Velocity Q/Cc x A	F th $\rho a V^2$ Newton	Vane coeff. Fact/Fth

For flat vane $F\ th = \rho a V^2$

For hemispherical vane $F\ th = 2\rho a V^2$

Fact = (observed reading in gm+ 250 gm) x 9.81 Newton

MEASURING FORCE DUE TO IMPACT OF JET OF WATER ON VANE

Aim: - To find the coefficient of impact of jet on flat circular and hemispherical vanes.

Apparatus: - experimental set-up, stop watch.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the pipe by regulating the flow control valve up to some extent of actual force say 100gm. Convert the 100gm into Newton's and note down as actual force.

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 'x' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A \times R}{t}$$

Where:

A = area of the collecting tank in m^2 (0.3m X 0.3m)

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

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

4. Calculate the velocity of the jet by following formula

$$V = \frac{\text{Discharge . } = Q/Cc \times A \text{ m/sec Co.eff. Of contraction X}}{\text{Area of the jet}}$$

a = cross sectional area of the jet = $\Pi d^2 /4$

Cc =coefficient of contraction=0.67

d =diameter of the nozzle =8mm= 0.008m

5. Calculate the theoretical force by the momentum equation

$$F_{th} = \rho a V^2$$

ρ = Density of water =1000 kg/m³

Ø = angle made by the velocity of the jet with outlet tangent of the vane which is zero in our case.

For flat vane $F_{th} = \rho a V^2$.

For hemispherical vane $F_{th} = 2\rho a V^2$.

F_{act} = (observed reading in gm+ 250 gm) x 9.81 **N**ewton

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

A Typical tabular form for use during experiments is attached herewith.

S. No.	Fact Newton	Time taken for 10cm rise of water	Q m^3/sec	Velocity Q/Cc x A	F_{act}	F_{th} $\rho a V^2$ Newton	Vane coeff. F_{act}/F_{th}

RESULTS AND CONCLUSIONS

Calculation:-

CLOSED CIRCUIT RECIPROCATING PUMP TEST RIG

RECIPROCATING PUMP TEST

INTRODUCTION

The Closed Circuit self sufficient portable package system Experimental Reciprocating Pump Test Rig is designed to study the performance of the Reciprocating pump at different heads. This unit has several advantages like does not require any foundation, trench keeping in the laboratory.

GENERAL DESCRIPTION

The Reciprocating Pump Test Rig mainly consists of

1) A Reciprocating Pump
2) A Single phase 2.0 HP 1440 RPM AC Motor
3) Piping system & Collecting tank
4) Input power Measuring arrangement and
5) SS Sump tank

CONSTRUCTIONAL SPECIFICATION

RECIPROCATING PUMP

The Reciprocating pump is of single acting type. The suction & delivery size are 1" x 3/2" respectively.

Bore: 38 mm, Stroke: 48 mm.

MOTOR

The Motor supplied is of 2 HP 1440 RPM. It can be operated on AC 50 cycles 220 / 230 V, through mains. A smaller HP motor can be used for normal working conditions, a higher power motor is selected to test the pump at higher speed, high pressure combinations, without over loading it.

PIPING SYSTEM

Suitable piping system with pipes, bends valves etc. Arrangement with cocks is , also provided for connecting pressure and vacuum gauges to the delivery and suction pipes.

A simple strainer valve is provided on the suction side to prevent any foreign matter from entering into the pump. The gate valve is provided on the delivery side to control the Head of the pump. Note that the **delivery valve should never be closed when the pump is working**. While starting the motor always keep the valve in **open** position. Otherwise the pump parts will be damaged.

SS COLLECTING TANK

A Collecting tank is provided to measure the discharge water through pizeo meter arrangement.

INPUT POWER MEASUREMENT

A Kilowatt-hour meter is provided to measure the power input to the motor. The energy meter constant (The Number of Revolutions per minute of the energy meter Disc) is stamped on the meter. From this the input power can be easily calculated.

SS SUMP

A Sump is provided compactly with in the (Floor space of the main unit to store adequate water for circulation through the unit for experimentation)

BEFORE COMMISSIONING

- Check whether all the joints are leak proof and watertight.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.
- Check whether all the electric connection are correct.
- See that the gauges are mounted on the correct position and their cocks closed.
- Delivery valve should be in fully **open** condition.

STARTING

Pour the lubricating oil **SAE 40** in the crankcase of the reciprocating pump to the required level once in a year . This will require about 250 cc of oil prime the pump before starting see that the V belt are in proper tension. Start the Motor keeping the delivery valve in fully **open** position. Open the gauge cocks, and see the pressure developed by the pump. Delivery control valve may be closed up to about 30 meters of the water head on the delivery side. Under any circumstances the valve should not be closed beyond 40 meters head on the delivery side. If the pressure exceeds this valve (40 Kg/sq.cm) the cylinder head gasket joints, piston, pressure gauge etc. would be damaged. To stop the pump set, first close the gauge cocks. Do not close the delivery valve on the other hand it may open fully. Then switch off the motor.

EXPERIMENTS

Start the pump and run it at a constant speed and the hand head may be tried, say from 10 meters to 30 meters. The discharge will be more or less thank same depending upon the leakage past the piston, which is dependent this on the total on the pump 6 to 8 readings can be taken within this head range. The above procedure can be repeated and the pump tested the different heads.

MAINTENANCE

As these units are built very sturdily, they do not require any routine or regular maintenance; however we recommend the following to be checked then and there to increase the life of the elements.

Lubricate all the working parts where provision for lubrication is made Grease cups are provided for lubricating ball bearings. Remove the grease drain plugs where fitted, and inject fresh grease through grease cups until waste grease along with a portion of fresh grease is ejected out through the grease drain hole.

Then run the machine for a few minutes to eject the excess grease in the bearing housings. Then fix the grease drain plug. Over greasing results in excessive heat due to a pumping action of the bearings, and

it is as harmful as under greasing. Suitable grease should contain no mineral acid, free alkali or foreign matter. Suitability is of the at most importance and the grease should show no tendency to run, thin out or separate into its constituents on standing or in of such substances as graphite, talcum etc., even in an extremely finely divided state will give rise to lapping of the bearing parts. For normal condition of operation soda soap grease of softer consistency for working temperature up to 75 ° C having a melting point of about 150° / 175°C shall be used.

Never run the pump without water in it, as this would cause damage to stuffing box, bush bearings etc. Never try to throttle the suction side of the pump to control discharge, as it would seriously affect the performance of the pump.

PERFORMANCE TEST ON RECIPROCATING PUMP

Aim: - To conduct a test at various heads of given reciprocating pump find its efficiency.

Apparatus: - Reciprocating pump , stop watch , scale , collecting tank.

Procedure:-

1. Start the motor keeping the delivery valve fully open.

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).

$$\text{Pressure Head} = \text{Kg/cm}^2 \times 10 = \text{meters.}$$

$$\text{Vacuum Head} = \frac{\text{mm of hg X 13.6}}{1000} \text{ meters}$$

Datum head = Distance between pressure and vacuum gauge in meters

Total head (H) = Pressure Head + Vacuum Head + Datum Head

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 'x' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A \times h}{t}$$

A = area of the collecting tank in m^2 (0.3m X 0.3m)

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.

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

$$\text{Input power} = \frac{X \times 3600 \times 0.70 \times 0.80}{C \times T} \text{ Kw}$$

Where,

0.70= Combined motor losses. 0.80

= Belt (or) transmission losses.

X = No. of revolutions of energy meter disc (say 5 Rev.)

T = Time for Energy meter revolutions disc. In seconds

C = Energy meter constant

5. Now calculate the output power

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

Where:

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

Q = Discharge

H = Total Head

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

Note: -- Maximum head should not exceed 2.5m (i.e. **2.5kg/sq. cm**)

Check the lubricating oil **SAE 40** in the crankcase of the reciprocating pump to the required level i.e 400ml.

A Typical tabular form is given below for convenience during experiments.

TABULAR FORM

S. No.	Pressure gauge reading	Time taken for No. of rev of energy Meter disc	Time taken for collecting 10cm rise of water In collecting	Total head (P + V) meters	Discharge Q	Input Power Kw	Output Power Kw	Efficiency

	(t)	tank (T)					

SHUT DOWN

Before switching off the pump, open the discharge valve; close the pressure & vacuum gauge cocks fully.

RESULTS AND CONCLUSIONS

Calculation:-

CLOSED CIRCUIT PELTON WHEEL TURBINE TEST RIG

CLOSED CIRCUIT PELTON WHEEL TURBINE TEST RIG

INTRODUCTION

The Closed circuit self-sufficient portal package system Pelton Turbine is of improved version. This system has several advantages, like does not require foundation; trench work etc. so that the experiments can be conducted with the unit soon after arrival of the equipment and it can be placed anywhere in the laboratory.

The Pelton wheel Turbine Test Rig is supplied as a complete set to conduct experiments on model Pelton Turbine Test Rig in Engineering Colleges and Technical Institutions. I t has been specially designed to conduct experiments in S.I units. The test rig mainly consists of 1) A Pelton Turbine, 2) A Supply pump unit to supply water to the above Pelton Turbine, 3) Flow Measuring unit consisting of a Venturimeter and Pressure Gauges, 4) Piping system and (5) Sump.

GENERAL DESCRIPTION

The unit essentially consists of casing, with a circular transparent window kept at the front for the visual inspection of the impact of the Jet on buckets. a bearing pedestal, a rotor assembly of shaft, Runner & brake drum, all mounted on a suitable sturdy iron base plate, A rope brake arrangement is provided to load the turbine. The input to the turbine can be controlled by adjusting the spear position by means of a hand wheel fitted. The water inlet pressure is measured by a pressure gauge and for the measurement of speed a digital tachometer is used.

An Optimum size sump is provided to store sufficient water from independent circulation through the unit for experimentation.

CONSTRUCTIONAL SPECIFICATIONS

CASING: of a iron having a large circular transparent Window.

RUNNERS: of electroplated MS disc fitted with accurately finished electroplated buckets.

SHAFT: of Stainless steel for rust free operation and for high strength.

NOZZLE: designed for smooth flow and efficient operation.

SPEAR: of stainless steel designed for efficient operation.

BALL BEARINGS: of double row deep groove rigid type in the casing and double row self aligning type in the pedestal both of liberal size.

TECHNICAL SPECIFICATIONS

PELTON TURBINE

1. Power output	:	1 K Watt
2. No. of Buckets	:	17Nos.

SUPPLY PUMPSET

Capacity	:	5 HP
Type	:	Centrifugal

FLOW MEASURING UNIT

1. Size of Venturi meter	:	50 mm.
2. Diameter of inlet	:	50 mm
3. Diameter of throat	:	25 mm.

BEFORE COMMISSIONING

1. Check whether all the joints are perfectly matched.

2. Check whether all the electric connection is correct.

3. See that the gauges are mounted on the correct position and their cocks are closed.

STARTING UP

Pour adequate water in the sump. Make sure before starting that the pipe lines are free from foreign matter. Also note whether all the joints are water tight and perfectly matched. Prime the pump and start it with closed gate valve. Then slowly open the gate valve situated above the turbine and open the cock fitted to the pressure gauge and so that the pump develops the rated head. If the pump develops the required head, slowly open the turbine spear by rotating the hand wheel until the turbine attains the normal rated speed (1000 RPM). Run the turbine at the normal speed for about 10 minutes and carefully note the following:

1. Operation of the bearings, temperature rise, noise etc.,

2. Vibration of the unit.

3. Steady constant speed and speed fluctuations if any.

In addition to this, on the sump side note the operation of the stuffing box. (The stuffing box should show an occasional drip of water. If the gland is over tightened, the leakage stops but the packing will heat up burn and damage the shaft.) .If the operation of the above parts is normal, load the turbine slowly and take readings. Open the water inlet valve and allow some cooling water through the brake drum when the turbine runs under load, so that the heat generated by the brake drum is carried away by the cooling water.Do not suddenly load the turbine, load the turbine gradually and at the same time open the spear to run the turbine at normal speed.

EXPERIMENTS

Water turbines are tested in the hydraulic laboratory to demonstrate the principles of water turbines, to study their construction, and to give the students a clear knowledge about the different types of turbines and their characteristics. Turbines shall be first tested at constant net supply head by varying the load, speed and spear setting. However the net supply head on the turbines tested in which case the power developed by the turbine and the best efficiently speed will also be reduced. The output power from the turbine is calculated from the readings taken on the brake and the speed of the shaft. The input power supplied to the turbine is calculated from the net supply head on the turbine and discharge through the turbine. Efficiency of the turbine being the ratio between the output and input and can be determined from these two readings. The discharge is measured by the 50mm Venturi meter and with the Pressure Gauges. Supply Head is measured with the help of the pressure gauge. The speed of the turbine is measured with digital tachometer fitted to the turbine. After starting and running the turbine at normal speed for the some time, load the turbine and take readings.

Note the following:

1. Net supply head (pressure gauge reading + height of the gauge center above the center line of the jet).
2. Discharge (Pressure Gauges readings)
3. Turbine shaft speed.
4. Alternator readings

For any particular setting of the spear first run the turbine at light load and then gradually load it. The net supply head on the turbine shall be maintained constant at the rated value and this can be done by adjusting the gate valve fitted just above the turbine. A typical tabular form is given below for the convenience during experiment.

TABULAR FORM

S. No.	speed	Supply head	Pressure Gauges Readings			Discharge m^3/sec	Break wt W1-W2	Input Power	Output Power	Efficiency
			P1	P2	P1 - P2					

IMPORTANT FORMULA

$$\text{Efficiency} = \frac{\text{Output power}}{\text{Input Power X frictional efficiency}} \text{ X } 100$$

Input Power = 9810 x Supply head in meters (H) x Discharge(Q) = $\frac{W \times Q \times H}{1000}$ kw;

Frictional efficiency =85%= 0.85

Discharge = $K\sqrt{h}$ m^3/sec

Where,

h = (P1 - P2) x 10 m

$$K = \frac{a1\ a2\ \sqrt{2g}}{\sqrt{(a1^2 - a2^2)}}$$

Where, a1= Diameter of the venturimeter inlet = 50 mm/0.05m

a2= Diameter of the Venturimeter throat = 25 mm /0.025m

P1 = Inlet pressure, P2 = Throat pressure

Output Power = $\frac{2\Pi NT}{60000}$ Kw.

N = RPM of the turbine shaft

T= Torque of the turbine shaft

T= (W1-W2) x R x 9.81

W = Load applied on the turbine.

R = Radius of the brake drum with rope in meters = 0.12 meters

SHUT DOWN

Before switching off the supply pump set, first remove the load on the brake down. Close the cooling inlet water Jet valve. Slowly close the spear to its full closed position. Then close the gate valve just above the turbine. Pressure Gauge cocks and Venturimeter cocks should be closed in order to isolate the pump set when the turbine is working under load. If the electric line trips off when the turbine is working first unload the turbine, close all the valves and cocks. Start the electric motor against, when

the line gets the power and then operate the turbine by opening the valve in the order said above.

PERFORMANCE TEST ON PELTON WHEEL TURBINE

AIM: To conduct performance test on the given Pelton wheel turbine

APPARATUS: Pelton wheel turbine test rig.

SPECIFICATIONS:

PELTON TURBINE

1. Power output : 1 K Watt
2. No. of Buckets : 17Nos.

SUPPLY PUMPSET

Capacity : 5 HP

Type : Centrifugal

FLOW MEASURING UNIT

1. Size of Venturi meter : 50 mm.
2. Diameter of inlet : 50 mm
3. Diameter of throat : 25 mm.

PROCEDURE:

1) Connect the supply water pump-water unit to 3 ph, 440V, 30A, electrical supply, with neutral and earth connections and ensure the correct direction of the pump motor unit.
2) Keep the Gate Valve and Sphere valve closed.
3) Keep the Brake Drum loading at zero.
4) Press the green button of the supply pump starter. Now the pump picks-up the full speed and becomes operational.
5) Slowly open the Sphere Valve so that the turbine rotor picks the speed and conduct experiment on constant speed.
6) Note down the speed, load, and pressure gauge readings.
   Tabulate the readings.

TABULAR FORM

S. No.	speed	Supply head	Pressure Gauges Readings			Discharge m^3/sec	Break wt W1-W2	Input Power	Output Power	Efficiency
			P1	P2	P1 - P2					

IMPORTANT FORMULA

Efficiency = $\frac{\text{Output power}}{\text{Input Power X frictional efficiency}}$ X 100

Input Power = 9810 x Supply head in meters (H) x Discharge(Q) = $\frac{W \times Q \times H}{1000}$ kw;

Frictional efficiency =85%= 0.85

Discharge = $K\sqrt{h}$ m^3/sec Where,

$$h = (P1 - P2) \times 10 \text{ m}$$

$$K = \frac{a1\ a2\ \sqrt{2g}}{\sqrt{(a1^2 - a2^2)}}$$

Where, a1= Diameter of the venturimeter inlet = 50 mm/0.05m a2=

Diameter of the Venturimeter throat = 25 mm /0.025m

P1 = Inlet pressure, P2 = Throat pressure

Output Power = $\frac{2\Pi NT}{60000}$ Kw.

N = RPM of the turbine shaft

T= Torque of the turbine shaft

T= (W1-W2) x R x 9.81

W = Load applied on the turbine.

R = Radius of the brake drum with rope in meters = 0.12 meters

RESULTS AND CONCLUSIONS

Calculation:-

ROUGH WORK