ANNA UNIVERSITY OF TECHNOLOGY - COIMBATORE

P.A COLLEGE OF ENGINEERING AND TECHNOLOGY, POLLACHI - 02.

DEPARTMENT OF MECHANICAL ENGINEERING

YEAR / SEMESTER - II / III

ME 2208 - FLUID MECHANICS AND MACHINERY LABORATORY

LAB MANUAL FOR STUDENTS

P.A COLLEGE OF ENGINEERING AND TECHNOLOGY

POLLACHI, COIMBATORE - 642 002.

BONAFIDE CERTIFICATE

Registration No.

Certified that this is the bonafide record of work done by Mr.…………………………………………………..……… of ………… - semester B.E. Mechanical Engineering Branch / Batch during the academic year …………………………. in the Fluid Mechanics and Machinery laboratory.

Head of the Department **Staff In-Charge**

Submitted for the University practical examination held on…………………… at **P.A College of Engineering and Technology, Pollachi.**

Internal Examiner **External Examiner**

Date: ……………… **Date: ………………**

A LIST OF BASIC SAFETY RULES

1. When you handle chemicals wear eye protection (chemical splash goggles or full face shield).
2. When you work with furnaces for heat treatment procedures or other thermally activated equipment you should use special gloves to protect your hands.
3. Students should wear durable clothing that covers the arms, legs, torso and feet. (Note: sandals, shorts, tank tops etc. have no place in the lab. Students inappropriately dressed for lab, at the instructors discretion, be denied access)
4. To protect clothing from chemical damage or other dirt, wear a lab apron or lab coat. Long hair should be tied back to keep it from coming into contact with lab chemicals or flames.
5. In case of injury (cut, burn, fire etc.) notify the instructor immediately.
6. In case of a fire or imminently dangerous situation, notify everyone who may be affected immediately; be sure the lab instructor is also notified.
7. If chemicals splash into someone's eyes act quickly and get them into the eye wash station, do not wait for the instructor.
8. In case of a serious cut, stop blood flow using direct pressure using a clean towel, notify the lab instructor immediately.
9. Eating, drinking and smoking are prohibited in the laboratory at all times.
10. Never work in the laboratory without proper supervision by an instructor.
11. Never carry out unauthorized experiments. Come to the laboratory prepared. If you are unsure about what to do, please ask the instructor.
12. Always remember that HOT metal or ceramic pieces look exactly the same as COLD pieces are careful what you touch.
13. Know the location and operation of :
    - Fire Alarm Boxes
    - Exit Doors
    - Telephones

LABARATORY CLASSES - INSTRUCTIONS TO STUDENTS

1. Students must attend the lab classes with ID cards and in the prescribed uniform.
2. Boys-shirts tucked in and wearing closed leather shoes. Girls' students with cut shoes, overcoat, and plait incite the coat. Girls' students should not wear loose garments.
3. Students must check if the components, instruments and machinery are in working condition before setting up the experiment.
4. Power supply to the experimental set up/ equipment/ machine must be switched on only after the faculty checks and gives approval for doing the experiment. Students must start to the experiment. Students must start doing the experiments only after getting permissions from the faculty.
5. Any damage to any of the equipment/instrument/machine caused due to carelessness, the cost will be fully recovered from the individual (or) group of students.
6. Students may contact the lab in charge immediately for any unexpected incidents and emergency.
7. The apparatus used for the experiments must be cleaned and returned to the technicians, safely without any damage.
8. Make sure, while leaving the lab after the stipulated time, that all the power connections are switched off.
9. **EVALUATIONS:**
    - All students should go through the lab manual for the experiment to be carried out for that day and come fully prepared to complete the experiment within the prescribed periods. Student should complete the lab record work within the prescribed periods.
    - Students must be fully aware of the core competencies to be gained by doing experiment/exercise/programs.
    - Students should complete the lab record work within the prescribed periods.
    - The following aspects will be assessed during every exercise, in every lab class and marks will be awarded accordingly:
    - **Preparedness, conducting experiment, observation, calculation, results, record presentation, basic understanding and answering for viva questions.**
    - In case of repetition/redo, 25% of marks to be reduced for the respective component.

NOTE 1

- **Preparation** means coming to the lab classes with neatly drawn circuit diagram /experimental setup /written programs /flowchart, tabular columns, formula, model graphs etc in the observation notebook and must know the step by step procedure to conduct the experiment.
- **Conducting experiment** means making connection, preparing the experimental setup without any mistakes at the time of reporting to the faculty.
- **Observation** means taking correct readings in the proper order and tabulating the readings in the tabular columns.
- **Calculation** means calculating the required parameters using the approximate formula and readings.
- **Result** means correct value of the required parameters and getting the correct shape of the characteristics at the time of reporting of the faculty.
- **Viva voice** means answering all the questions given in the manual pertaining to the experiments.
- **Full marks will be awarded if the students performs well in each case of the above component**

NOTE 2

- Incompletion or repeat of experiments means not getting the correct value of the required parameters and not getting the correct shape of the characteristics of the first attempt. In such cases, it will be marked as **"IC" in the red ink** in the status column of the mark allocation table given at the end of every experiment. The students are expected to repeat the incomplete the experiment before coming to the next lab. Otherwise the marks for IC component will be reduced to **zero.**

NOTE 3

- Absenteeism due to genuine reasons will be considered for doing the **missed experiments.**
- In case of power failure, extra classes will be arranged for doing those experiments only and assessment of all other components preparedness; viva voice etc. will be completed in the regular class itself.

NOTE 4

- The end semester practical internal assessment marks will be based on the average of all the experiments.

INDEX

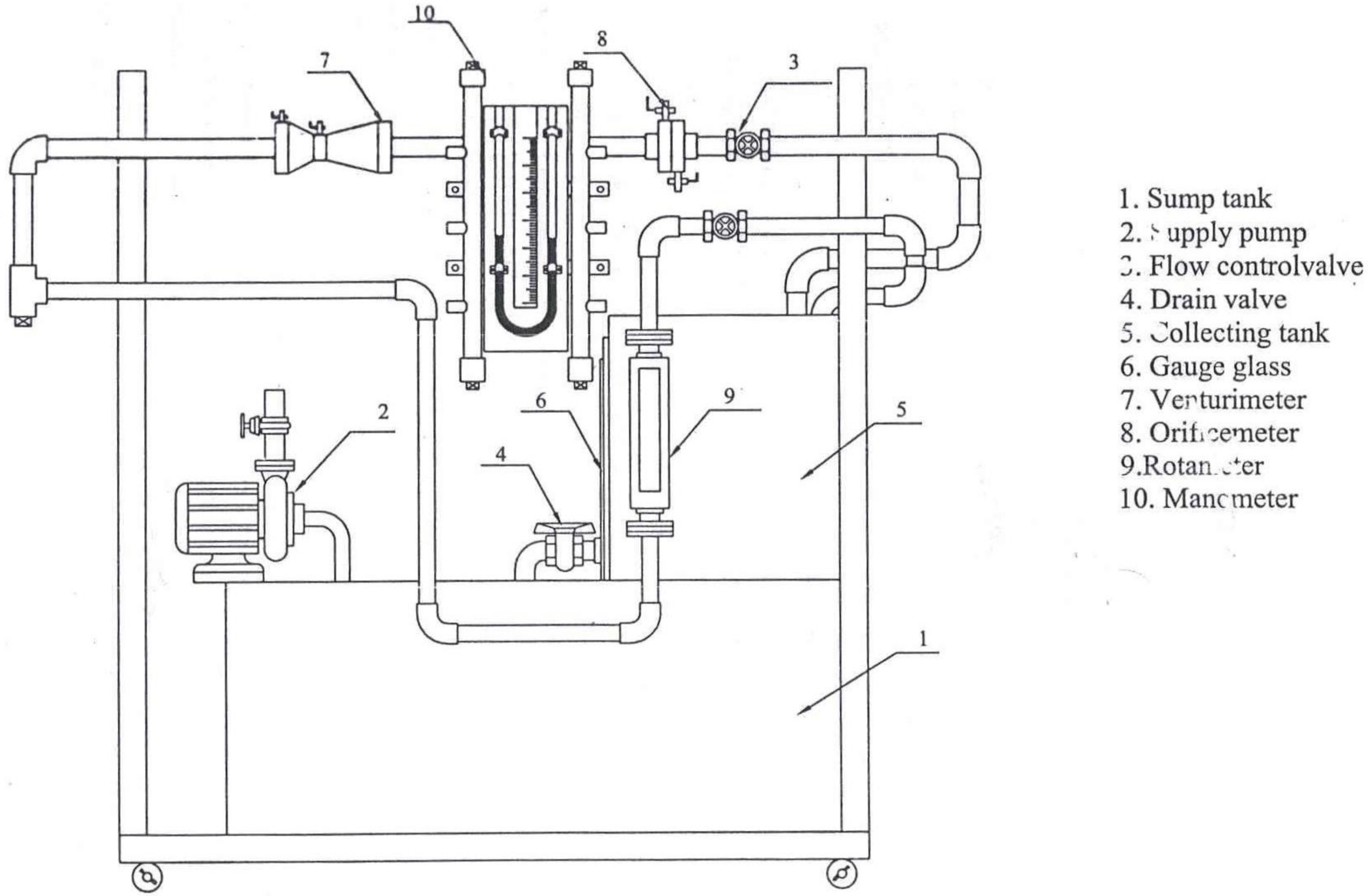
S.No	DATE	NAME OF THE EXPERIMENT	MARK	SIGNATURE
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Completed date:

Average Mark: **Staff - in - charge**

ME 2208 FLUID MECHANICS AND MACHINERY LAB

1. Determination of the coefficient of discharge of given Orifice meter.
2. Determination of the coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor of given set of pipes.
5. Conducting experiments and drawing the characteristics curves of centrifugal pump.
6. Conducting experiments and drawing the characteristics curves of reciprocating pump.
7. Conducting experiments and drawing the characteristics curves of Gear pump.
8. Conducting experiments and drawing the characteristics curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristics curves of Kaplan turbine.



VENTURIMETER, ORIFICEMETER AND ROTAMETER TEST RIG

DETERMINATION OF THE CO-EFFICIENT OF DISCHARGE OF GIVEN ORIFICE METER

AIM:

To determine the co-efficient discharge through orifice meter

APPARATUS REQUIRED:

1. Orifice meter
2. Differential U tube
3. Collecting tank
4. Stop watch
5. Scale

FORMULAE:

1. **ACTUAL DISCHARGE**:

$$Q_{act} = A \times h / t \quad (m^3 / s)$$

2. **THEORTICAL DISCHARGE**:

$$Q_{th} = a_1 \times a_2 \times \sqrt{2gh} / \sqrt{a_1^2 - a_2^2} \quad (m^3 / s)$$

Where:

A = Area of collecting tank in m^2

h = Height of collected water in tank = 10 cm

a_1 = Area of inlet pipe in, m^2

a_2 = Area of the throat in m^2

g = Specify gravity in m / s^2

t = Time taken for h cm rise of water

H = Orifice head in terms of flowing liquid

= $(H_1 \sim H_2) (s_m / s_1 - 1)$

Where:

H1 = Manometric head in first limb

H2 = Manometric head in second limb

s_m = Specific gravity of Manometric liquid

(i.e.) Liquid mercury Hg = 13.6

s_1 = Specific gravity of flowing liquid water = 1

S.No	Diameter in mm	Manometric reading		Manometric head H=(H1~H2) x 12.6 x 10^{-2}	Time taken for 'h' cm rise of water 't' Sec	Actual discharge Q act x 10^{-3} m^3 / s	Theoretical discharge Qth x 10^{-3} m^3 / s	Co-efficient of discharge Cd (no unit)
		H1 cm of Hg	H2 cm of Hg					
							Mean Cd =	

3. **CO EFFICENT OF DISCHARGE:**

Co- efficient of discharge = Q act / Q th (no units)

DESCRIPTION:

Orifice meter has two sections. First one is of area a_1, and second one of area $a_{2,}$ it does not have throat like venturimeter but a small holes on a plate fixed along the diameter of pipe. The mercury level should not fluctuate because it would come out of manometer.

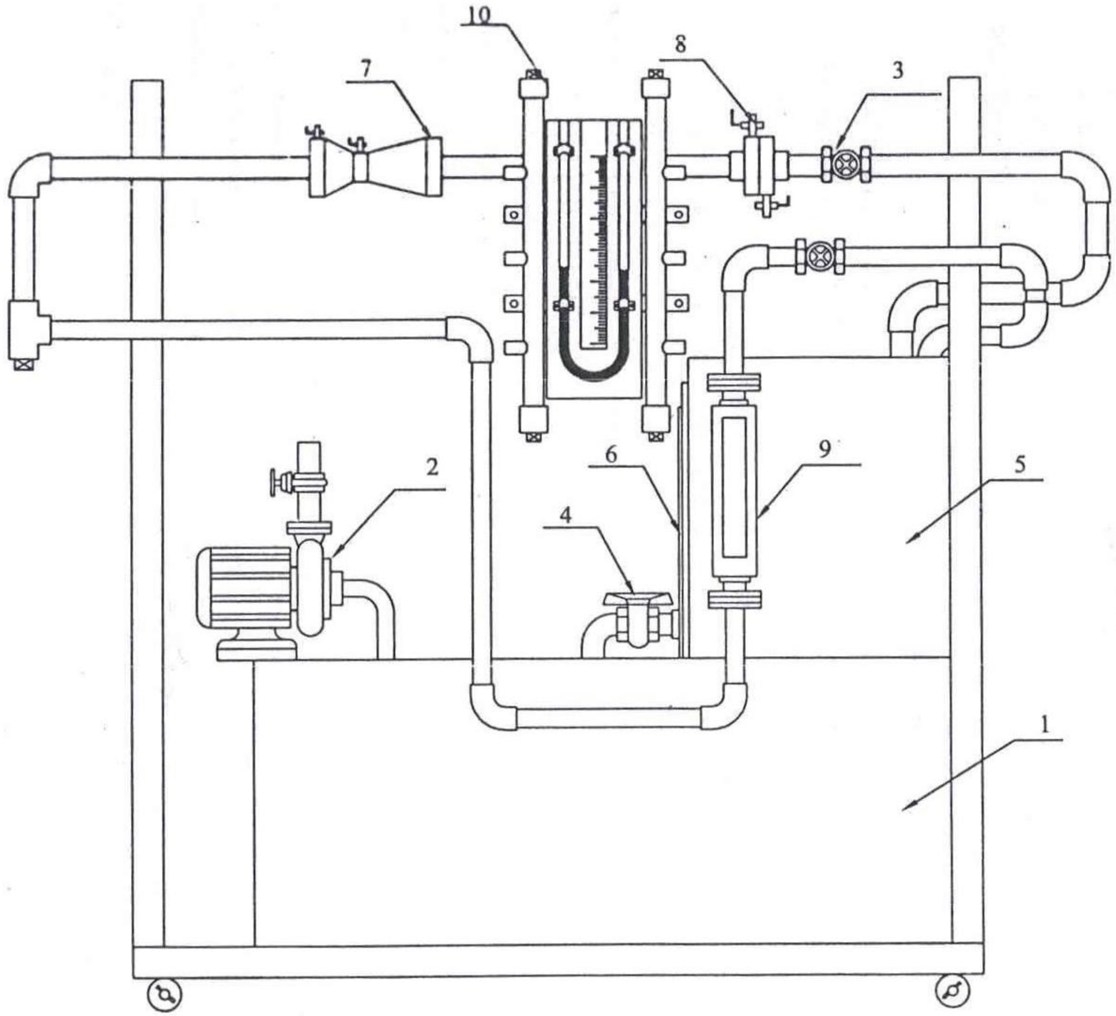
PROCEDURE:

1. The pipe is selected for doing experiments
2. The motor is switched on, as a result water will flow
3. According to the flow, the mercury level fluctuates in the U-tube manometer
4. The reading of H_1 and H_2 are noted
5. The time taken for 10 cm rise of water in the collecting tank is noted
6. The experiment is repeated for various flow in the same pipe
7. The co-efficient of discharge is calculated

MODEL CALCULATION:

RESULT:

The co efficient of discharge through orifice meter is ……… (No unit)



1. Sump tank
2. Supply pump
3. Flow controlvalve
4. Drain valve
5. Collecting tank
6. Gauge glass
7. Venturimeter
8. Orificemeter
9. Rotameter
10. Manometer

VENTURIMETER, ORIFICEMETER AND ROTAMETER TEST RIG

DETERMINATION OF THE CO EFFICIENT OF DISCHARGE OF GIVEN VENTURIMETER

AIM:

To determine the coefficient of discharge for liquid flowing through venturimeter.

APPARATUS REQUIRED:

1. Venturimeter
2. Stop watch
3. Collecting tank
4. Differential U-tube
5. Manometer
6. Scale

FORMULAE:

1. **ACTUAL DISCHARGE:**

$$Q_{act} = A \times h / t \quad (m^3 / s)$$

2. **THEORTICAL DISCHARGE:**

$$Q_{th} = a_1 \times a_2 \times \sqrt{2gh} / \sqrt{a_1^2 - a_2^2} \quad (m^3 / s)$$

Where:

A = Area of collecting tank in m^2

h = Height of collected water in tank = 10 cm

a_1 = Area of inlet pipe in m^2

a_2 = Area of the throat in m^2

g = Specify gravity in m / s^2

t = Time taken for h cm rise of water

H = Orifice head in terms of flowing liquid

$= (H_1 \sim H_2) (s_m / s_{1} - 1)$

Where:

H1 = Manometric head in first limb

H2 = Manometric head in second limb

s_m = Specific gravity of Manometric liquid

(i.e.) Liquid mercury Hg = 13.6

s_1 = Specific gravity of flowing liquid water = 1

S.No	Diameter in mm	Manometric reading		Manometric head $H = (H1 \sim H2) \times 12.6 \times 10^{-2}$	Time taken for 'h' cm rise of water 't' Sec	Actual discharge Q act $\times 10^{-3}$ m^3 / s	Theoretical discharge Qth $\times 10^{-3}$ m^3 / s	Co-efficient of discharge Cd (no unit)
		H1 cm of Hg	H2 cm of Hg					
							Mean Cd =	

3. **CO EFFICENT OF DISCHARGE:**

Co- efficient of discharge = Q act / Q th (no units)

DESCRIPTION:

Venturimeter has two sections. One divergent area and the other throat area. The former is represented as a_1 and the later is a_2 water or any other liquid flows through the Venturimeter and it passes to the throat area the value of discharge is same at a_1 and a_2 .

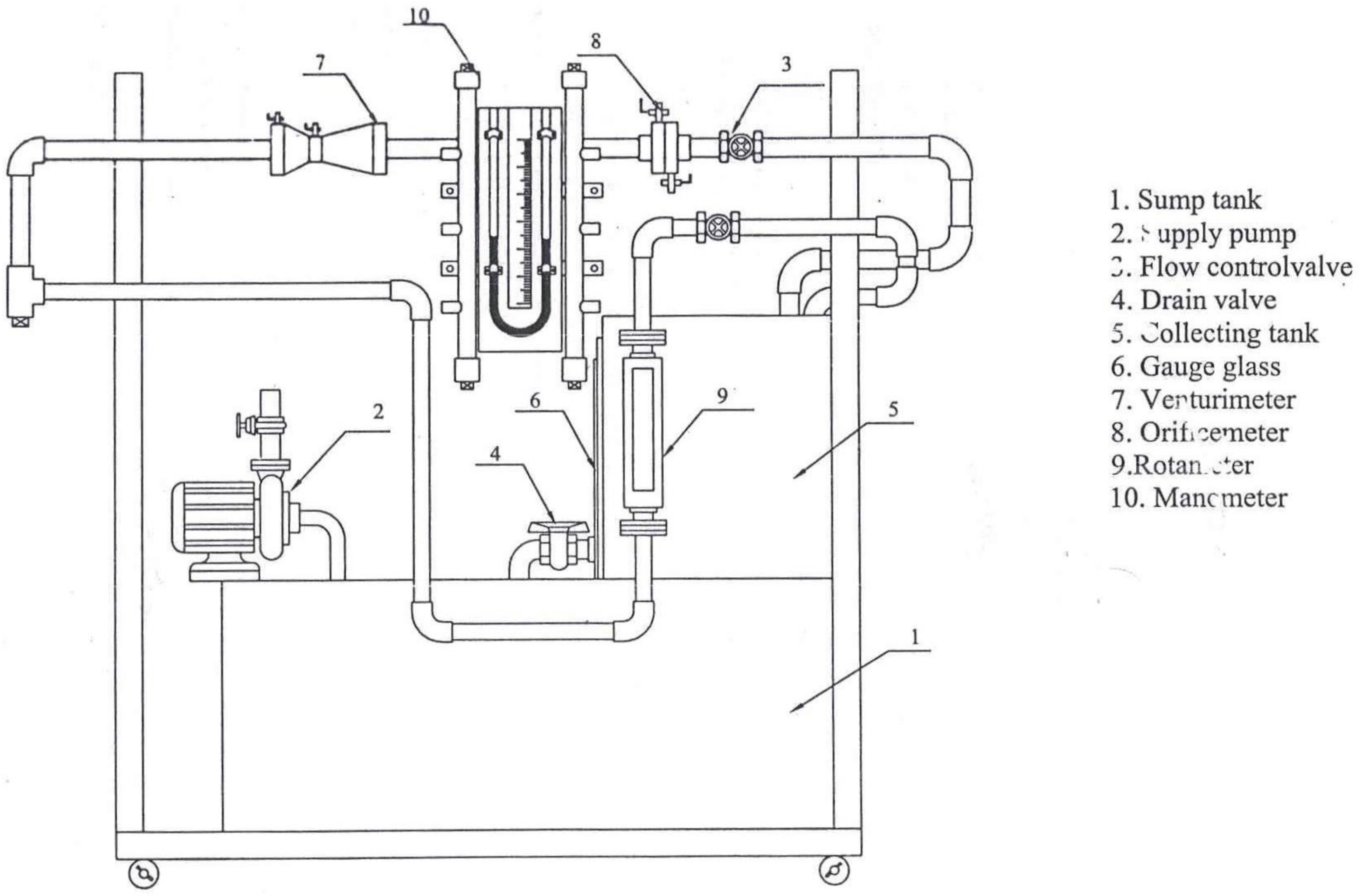
PROCEDURE:

1. The pipe is selected for doing experiments
2. The motor is switched on, as a result water will flow
3. According to the flow, the mercury level fluctuates in the U-tube manometer
4. The reading of H_1 and H_2 are noted
5. The time taken for 10 cm rise of water in the collecting tank is noted
6. The experiment is repeated for various flow in the same pipe
7. The co-efficient of discharge is calculated

MODEL CALCULATION:

RESULT:

The co efficient of discharge through Venturimeter is ……… (No unit)



VENTURIMETER, ORIFICEMETER AND ROTAMETER TEST RIG

CALCULATION OF THE RATE OF FLOW USING ROTOMETER

AIM:

To determine the percentage error in Rotometer with the actual flow rate.

APPARATUS REQUIRED:

1. Rotometer setup
2. Measuring scale
3. Stopwatch.

FORMULAE:

1. **ACTUAL DISCHARGE:**

$Q_{act} = A \times h / t \quad (m^3 / s)$

Where:

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

h= 10 cm rise of water level in the collecting tank (10^{-2} m).

t = Time taken for 10 cm rise of water level in collecting tank.

CONVERSION:

Actual flow rate (lit / min), $Q_{act} = Qact \times 1000 \times 60$ lit /min

$$\text{Percentage error of Rotometer} = \frac{\text{Rotometer reading} \sim \text{Actual} \times 100\ \%}{\text{Rotometer reading}}$$

$$= R \sim Qact / R \times 100\ \%$$

PROCEDURE:

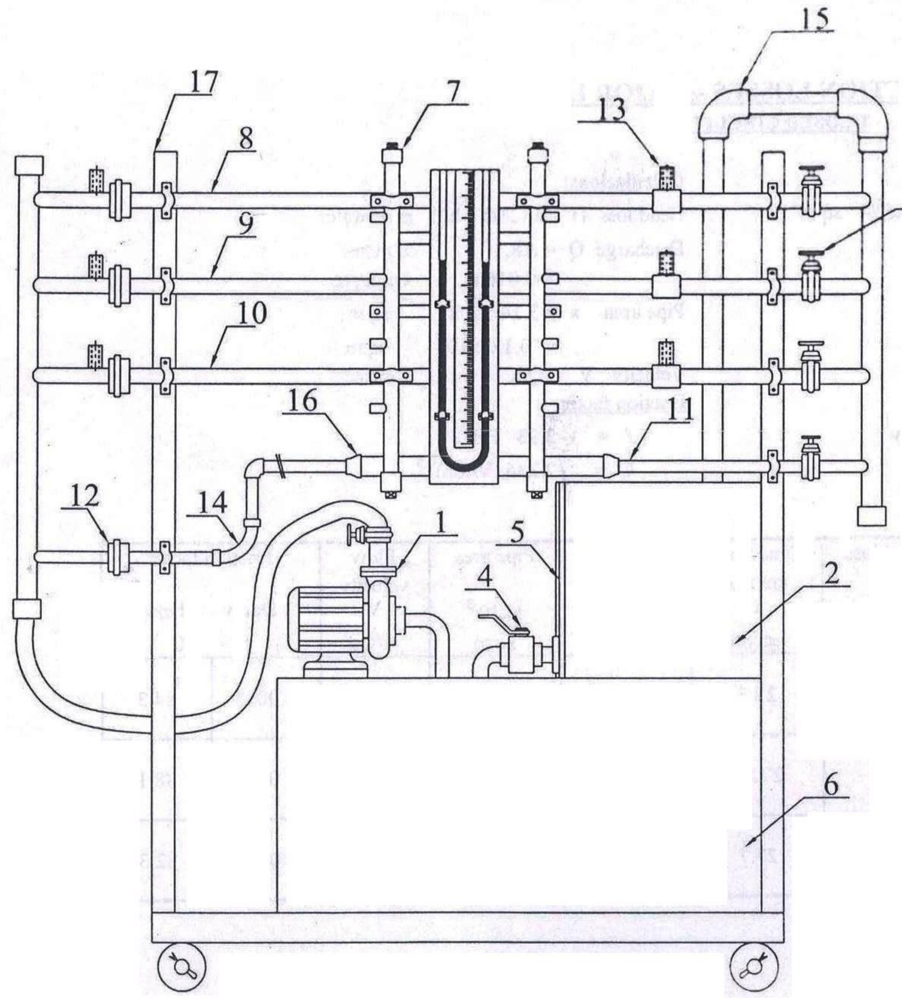
1. Switch on the motor and the delivery valve is opened
2. Adjust the delivery valve to control the rate in the pipe
3. Set the flow rate in the Rotometer, for example say 50 liters per minute
4. Note down the time taken for 10 cm rise in collecting tank
5. Repeat the experiment for different set of Rotometer readings
6. Tabular column is drawn and readings are noted
7. Graph is drawn by plotting Rotometer reading Vs percentage error of the Rotometer

S.No	Rotometer Reading (lpm)	Actual Discharge Q_{act} (m^3/sec)	Time taken for 10cm rise of water In tank (t sec)	Actual discharge Q_{act} (lpm)	Percentage Error of Rotometer (%)
				Average =	

MODEL CALCULATION:

RESULT:

The percentage error of the Rotometer was found to be……………..… %



1. Supply pump
2. Sump tank
3. Flow control valve
4. Drain valve
5. Gauge glass
6. Collecting tank
7. Manometer
8. Copper pipe
9. Aluminium pipe
10. Stainless Steel pipe
11. Minor losses pipe
12. M.S Union
13. M.S Coupling
14. Bend
15. Elbow
16. Reducer
17. Support Stand

FRICTION LOSSES TEST RIG

DETERMINATION OF FRICTION FACTOR OF GIVEN SET OF PIPES

AIM:

To find the friction ‘f’ for the given pipe.

APPARATUS REQUIRED:

1. A pipe provided with inlet and outlet and pressure tapping
2. Differential u-tube manometer
3. Collecting tank with piezometer
4. Stopwatch
5. Scale

FORMULAE:

1. **FRICTION FACTOR (F):**

$$f = 2 \times g \times d \times h_f / l \times v^2 \quad \text{(no unit)}$$

Where,

g = Acceleration due to gravity (m / sec^2)

d = Diameter of the pipe (m)

l = Length of the pipe (m)

v = Velocity of liquid following in the pipe (m / s)

h_f = Loss of head due to friction (m)

= $h_1 \sim h_2$

Where

h_1 = Manometric head in the first limbs

h_2 = Manometric head in the second limbs

2. **ACTUAL DISCHARGE:**

$$Q = A \times h / t \quad (m^3 / sec)$$

Where

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

h = Rise of water for 5 cm (m)

t = Time taken for 5 cm rise (sec)

S.No	Diameter of pipe mm	Manometer readings			Time for 5cm rise of water t sec	Actual discharge $Q_{act} \times 10^{-3}$ m^3 / s	Velocity V m/s	V^2 m^2 / s^2	Friction factor $f \times 10^{-2}$
		$h_1 \times 10^{-2}$	$h_2 \times 10^{-2}$	$h_f = (h1-h2) \times 10^{-2}$					
								Mean f =	

3. VELOCITY:

$$V = Q / a \quad (m / sec)$$

Where

Q = Actual discharge (m^3/ sec)

A = Area of the pipe (m^2)

DESCRIPTION:

When liquid flows through a pipeline it is subjected to frictional resistance. The frictional resistance depends upon the roughness of the pipe. More the roughness of the pipe will be more the frictional resistance. The loss of head between selected lengths of the pipe is observed.

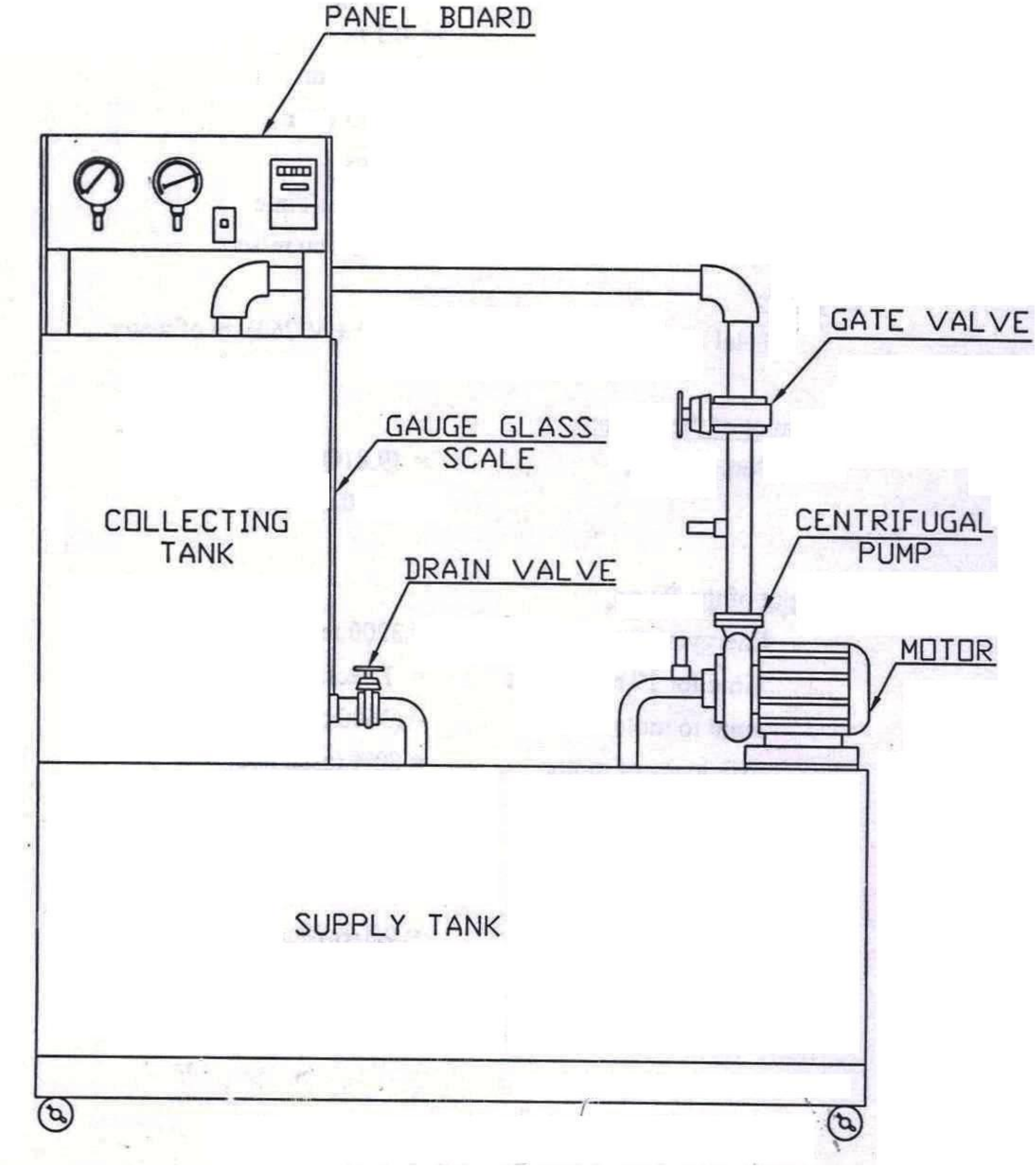
PROCEDURE:

1. The diameter of the pipe is measured and the internal dimensions of the collecting tank and the length of the pipe line is measured
2. Keeping the outlet valve closed and the inlet valve opened
3. The outlet valve is slightly opened and the manometer head on the limbs h_1 and h_2 are noted
4. The above procedure is repeated by gradually increasing the flow rate and then the corresponding readings are noted.

MODEL CALCULATION:

RESULT:

1. The frictional factor ‘f ‘ for given pipe = x 10^{-2} (no unit)
2. The friction factor for given pipe by graphical method = …… x 10^{-2} (no unit)



CENTRIFUGAL PUMP TEST RIG

CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF CENTRIFUGAL PUMP

AIM:

To study the performance characteristics of a centrifugal pump and to determine the characteristic with maximum efficiency.

APPARATUS REQUIRED:

1. Centrifugal pump setup
2. Meter scale
3. Stop watch

FORMULAE:

1. **ACTUAL DISCHARGE:**

$$Q_{act} = A \times y / t \quad (m^3 / s)$$

Where:

A = Area of the collecting tank (m^2)
y = 10 cm rise of water level in the collecting tank
t = Time taken for 10 cm rise of water level in collecting tank.

2. **TOTAL HEAD:**

$$H = H_d + H_s + Z$$

Where:

H_d = Discharge head, meter
H_s = Suction head, meter
Z = Datum head, meter

3. **INPUT POWER:**

$$I/P = (3600 \times N \times 1000) / (E \times T) \quad \text{(watts)}$$

Where:

N = Number of revolutions of energy meter disc
E = Energy meter constant (rev / Kw hr)
T = time taken for 'Nr' revolutions (seconds)

S.No	Suction gauge Hs m of water	Suction head Hs \m of water	Delivery Gauge Reading (hd) m of water	Delivery Head (Hd) m of water	Total Head (H) m of water	Time taken for ‘h’ rise of water (t) S	Time taken for Nr revolution t S	Actual Discharge (Qact) x10^{-3} m^3\sec	Input Power (Pi) watt	Output Power (Po) watt	% η
										Average =	

4. **OUTPUT POWER:**

$$P_o = \rho \times g \times Q \times H / 1000 \quad \text{(watts)}$$

Where,

ρ = Density of water (kg / m^3)

g = Acceleration due to gravity (m / s^2)

H = Total head of water (m)

5. **EFFICIENCY:**

$$\eta_o = (\text{Output power o/p / input power I/p}) \times 100\ \%$$

Where,

O/p = Output power kW

I/ p = Input power kW

DESCRIPTION:

PRIMING:

The operation of filling water in the suction pipe casing and a portion delivery pipe for the removal of air before starting is called priming.

After priming the impeller is rotated by a prime mover. The rotating vane gives a centrifugal head to the pump. When the pump attains a constant speed, the delivery valve is gradually opened. The water flows in a radially outward direction. Then, it leaves the vanes at the outer circumference with a high velocity and pressure. Now kinetic energy is gradually converted in to pressure energy. The high-pressure water is through the delivery pipe to the required height.

PROCEDURE:

1. Prime the pump close the delivery valve and switch on the unit
2. Open the delivery valve and maintain the required delivery head
3. Note down the reading and note the corresponding suction head reading
4. Close the drain valve and note down the time taken for 10 cm rise of water level in collecting tank
5. Measure the area of collecting tank
6. For different delivery tubes, repeat the experiment
7. For every set reading note down the time taken for 5 revolutions of energy meter disc.

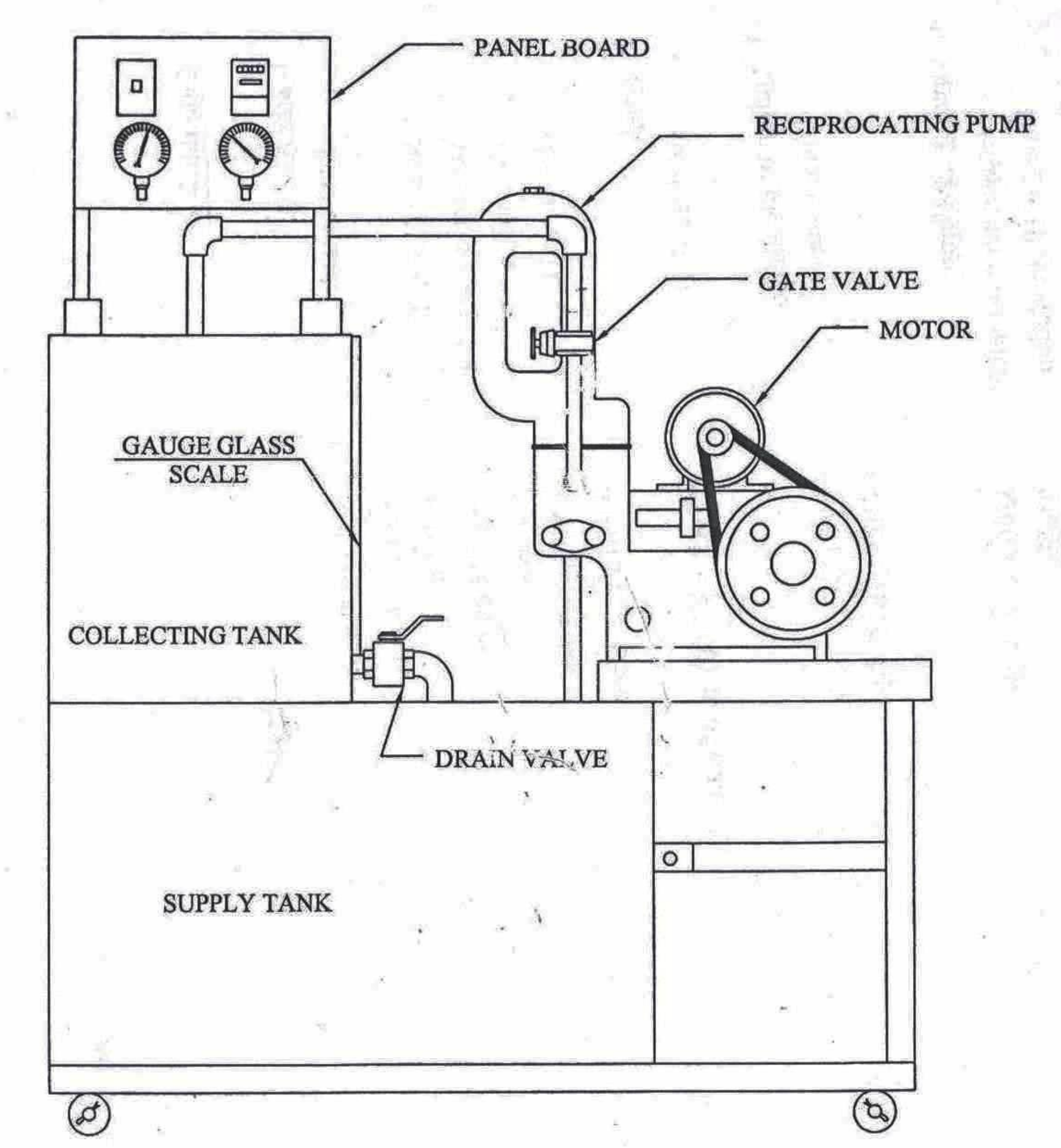
GRAPHS:

1. Actual discharge Vs Total head
2. Actual discharge Vs Efficiency
3. Actual discharge Vs Input power
4. Actual discharge Vs Output power

MODEL CALCULATION:

RESULT:

Thus the performance characteristics of centrifugal pump was studied and the maximum efficiency was found to be _____________



RECIPROCATING PUMP TEST RIG

CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF RECIPROCATING PUMP

AIM:

To study the performance characteristics of a reciprocating pump and to determine the characteristic with maximum efficiency.

APPARATUS REQUIRED:

1. Reciprocating pump
2. Meter scale
3. Stop watch

FORMULAE:

1. **ACTUAL DISCHARGE:**

$$Q_{act} = A \times y / t \quad (m^3 / s)$$

Where:

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

y = 10 cm rise of water level in the collecting tank

t = Time taken for 10 cm rise of water level in collecting tank

2. **TOTAL HEAD:**

$$H = Hd + Hs + Z$$

Where:

Hd = Discharge head; Hd = Pd x 10, m

Hs = Suction head; Pd = Ps x 0.0136, m

Z = Datum head, m

Pd = Pressure gauge reading, kg / cm^2

Ps = Suction pressure gauge reading, mm of Hg

3. **INPUT POWER:**

$$P_i = (3600 \times N) / (E \times T) \quad (Kw)$$

Where,

N = Number of revolutions of energy meter disc

E = Energy meter constant (rev / Kw hr)

T = time taken for 'N' revolutions (seconds)

S.No	Delivery pressure reading Pd kg / cm^2	Suction pressure reading Ps mm of Hg	Delivery head Hd = Pdx10.0	Suction head Hs = Ps x 0.0136	Datum head Z m	Total head H	Time taken for 10 cm of rise of water in tank t sec	Actual discharge Q_{act} m^3/s	Time taken for N rev of energy meter disc t sec	Input power Pi kw	Output power Po kw	η %
											Mean =	

4. **OUTPUT POWER:**

$$P_o = \rho \times g \times Q \times H / 1000 \quad (Kw)$$

Where,

ρ = Density of water (kg / m³)

g = Acceleration due to gravity (m / s^2)

H = Total head of water (m)

Q = Discharge (m^3 / sec)

5. **EFFICIENCY:**

$$\eta_o = (\text{Output power po / input power pi}) \times 100 \%$$

Where,

Po = Output power KW

Pi = Input power KW

PROCEDURE:

1. Close the delivery valve and switch on the unit
2. Open the delivery valve and maintain the required delivery head
3. Note down the reading and note the corresponding suction head reading
4. Close the drain valve and note down the time taken for 10 cm rise of water level in collecting tank
5. Measure the area of collecting tank
6. For different delivery tubes, repeat the experiment
7. For every set reading note down the time taken for 5 revolutions of energy meter disc.

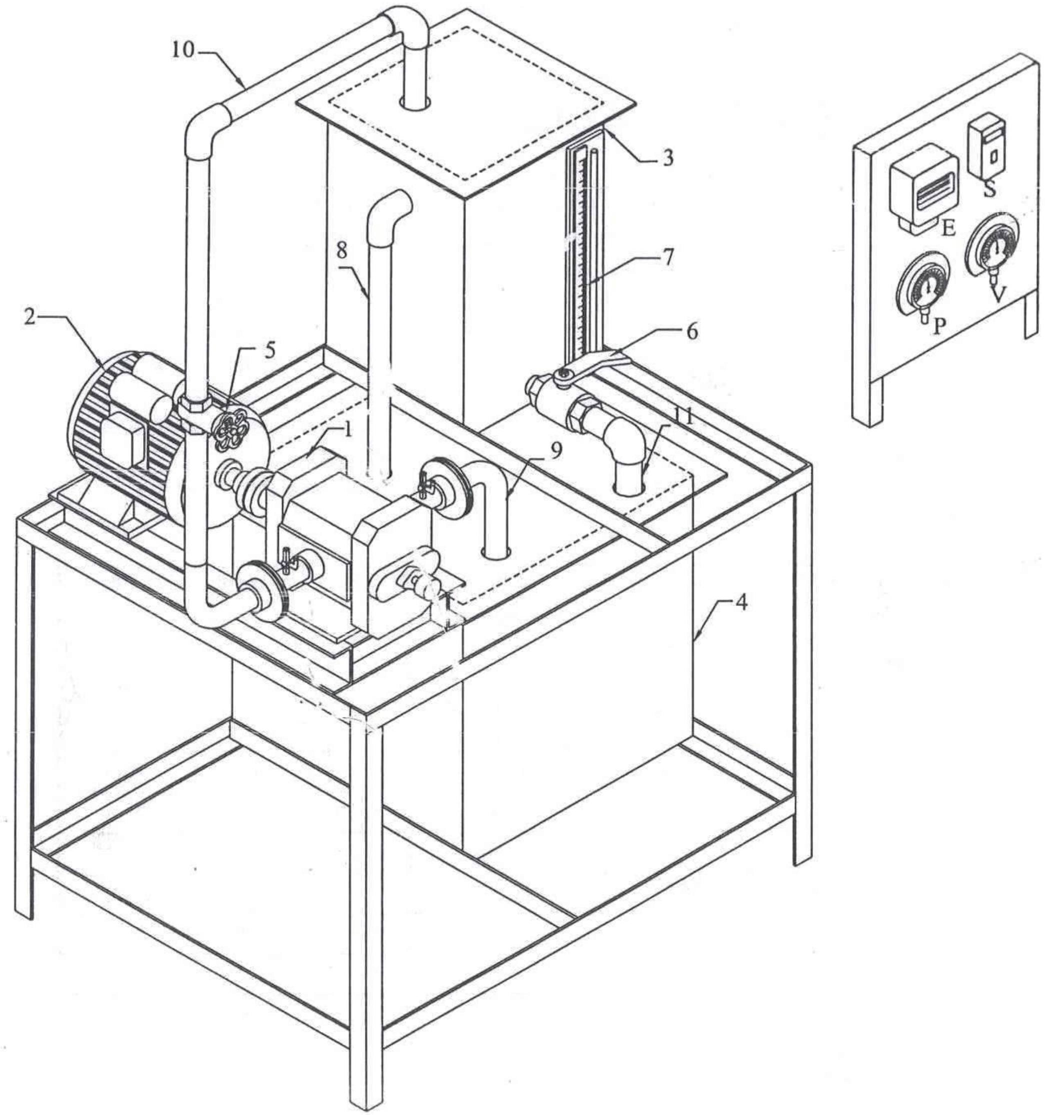
GRAPHS:

1. Actual discharge Vs Total head
2. Actual discharge Vs Efficiency
3. Actual discharge Vs Input power
4. Actual discharge Vs Output power

MODEL CALCULATION:

RESULT:

The performance characteristic of the reciprocating pump is studied and the efficiency is calculated …………… %



1. Gear pump
2. Motor
3. Collecting tank
4. Sump tank
5. Flow regulating valve
6. Drain valve
7. Gauge glass scale
8. Overflow pipe
9 Suction pipe
10 Delivery pipe
11 Drain pipe
E - Energy meter
P - Pressure gauge
V- Vacuum gauge
S- Switch

GEAR PUMP TEST RIG

CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF GEAR OIL PUMP

AIM:

To draw the characteristics curves of gear oil pump and also to determine efficiency of given gear oil pump.

APPARATUS REQUIRED:

1. Gear oil pump setup
2. Meter scale
3. Stop watch

FORMULAE:

1. **ACTUAL DISCHARGE:**

$Q_{act} = A \times y / t$ (m^3 / sec)

Where,

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

y = Rise of oil level in collecting tank (cm)

t = Time taken for 'h' rise of oil in collecting tank (s)

2. **TOTAL HEAD:**

$H = H_d + H_s + Z$

Where

Hd = Discharge head; Hd = Pd x 12.5, m

Hs = Suction head; Pd = Ps x 0.0136, m

Z = Datum head, m

Pd = Pressure gauge reading, kg / cm^2

Ps = Suction pressure gauge reading, mm of Hg

3. **INPUT POWER:**

$P_i = (3600 \times N) / (E \times T)$ (kw)

Where,

Nr = Number of revolutions of energy meter disc

Ne = Energy meter constant (rev / Kw hr)

te = Time taken for 'Nr' revolutions (seconds)

S.No	Delivery pressure reading Pd kg / cm^2	Suction pressure reading Ps mm of Hg	Delivery head Hd = Pdx12.5 m	Suction head Hs = Ps x 0.0136 m	Datum head Z m	Total head H m	Time taken for 10 cm of rise of water in tank t sec	Actual discharge Q_{act} m^3/s	Time taken for N rev of energy meter disc t sec	Input power Pi kw	Output power Po kw	η %
											Mean =	

4. **OUTPUT POWER:**

$$Po = W \times Qact \times H /1000 \quad \text{(watts)}$$

Where,

W = Specific weight of oil (N / m³)

Q_{act} = Actual discharge (m³ / s)

h = Total head of oil (m)

5. **EFFICIENCY:**

$$\eta\% = (\text{Output power Po / input power Pi}) \times 100$$

DESCRIPTION:

The gear oil pump consists of two identical intermeshing spur wheels working with a fine clearance inside the casing. The wheels are so designed that they form a fluid tight joint at the point of contact. One of the wheels is keyed to driving shaft and the other revolves as the driven wheel.

The pump is first filled with the oil before it starts. As the gear rotates, the oil is trapped in between their teeth and is flown to the discharge end round the casing. The rotating gears build-up sufficient pressure to force the oil in to the delivery pipe.

PROCEDURE:

1. The gear oil pump is stated.
2. The delivery gauge reading is adjusted for the required value.
3. The corresponding suction gauge reading is noted.
4. The time taken for ‘N’ revolutions in the energy meter is noted with the help of a stopwatch.
5. The time taken for ‘h’ rise in oil level is also noted down after closing the gate valve.
6. With the help of the meter scale the distance between the suction and delivery gauge is noted.
7. For calculating the area of the collecting tank its dimensions are noted down.
8. The experiment is repeated for different delivery gauge readings.
9. Finally the readings are tabulated.

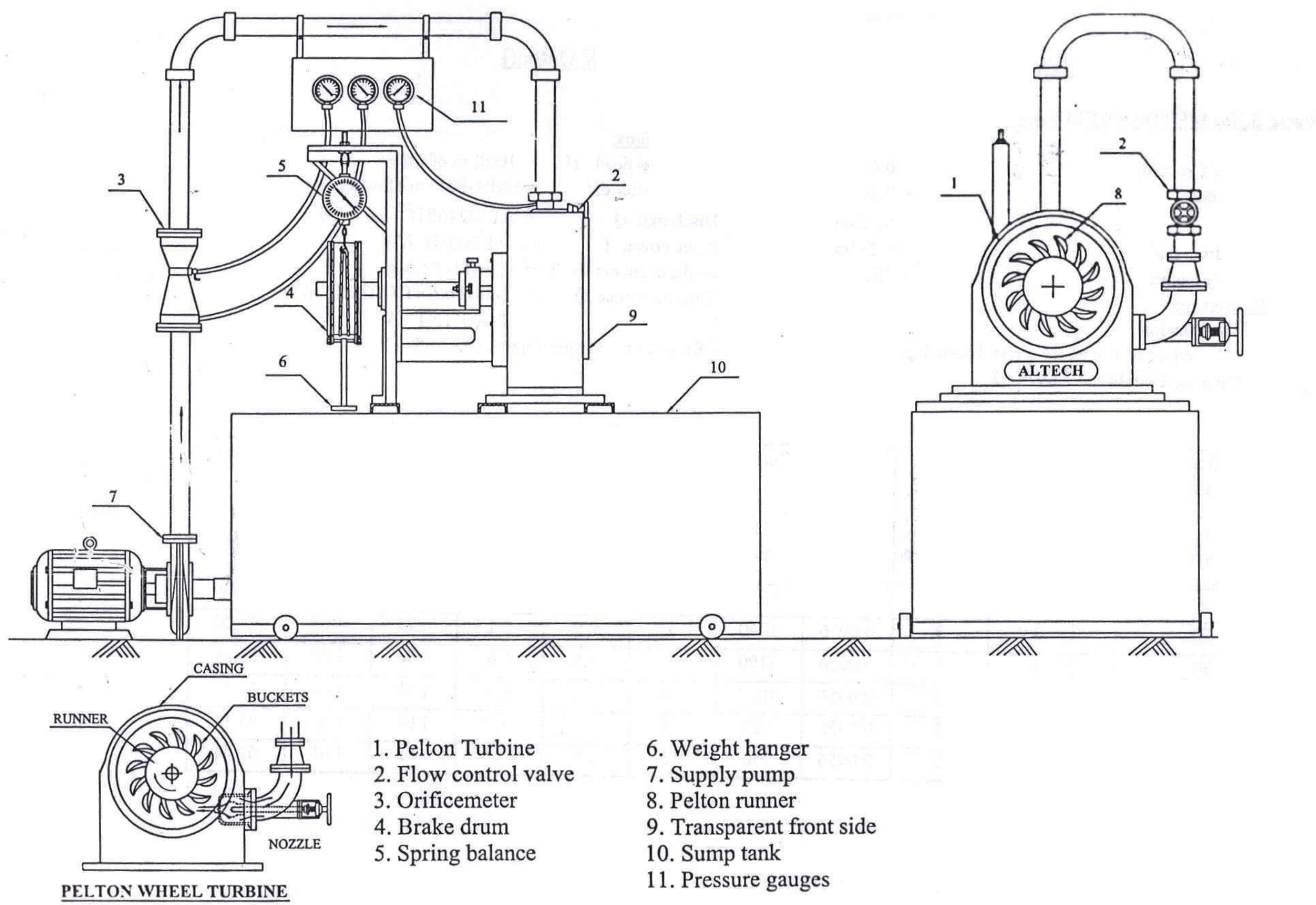
GRAPH:

1. Actual discharge Vs Total head
2. Actual discharge Vs Efficiency
3. Actual discharge Vs Input power
4. Actual discharge Vs Output power

MODEL CALCULATION:

RESULT:

Thus the performance characteristic of gear oil pump was studied and maximum efficiency was found to be. ………%.



PELTON WHEEL TURBINE TEST RIG

CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF PELTON WHEEL TEST RIG

AIM:

To conduct load test on pelton wheel turbine and to study the characteristics of pelton wheel turbine.

APPARATUS REQUIRED:

1. Venturimeter
2. Stopwatch
3. Tachometer
4. Dead weight

FORMULAE:

1. **VENTURIMETER READING:**

$h = (P1 \sim P2) \times 10$ (m of water)

Where,

P1, P2 - Venturimeter reading in Kg /cm^2

2. **DISCHARGE:**

$Q = 0.0055 \times \sqrt{h}$ (m^3 / s)

3. **BRAKE HORSE POWER:**

$BHP = (\pi \times D \times N \times T) / (60 \times 75)$ (hp)

Where,

N = Speed of the turbine in (rpm)

D = Effective diameter of brake drum = 0.315 m

T = Torsion in To + T1 – T2 (Kg)

4. **INDICATED HORSE POWER:**

$IHP = (1000 \times Q \times H) / 75$ (hp)

Where,

H = Total head (m)

5. **PERCENTAGE EFFICIENCY:**

$\%\eta = (B.H.P / I.H.P \times 100)$ (%)

S.No	Pressure Gauge Reading [Hp] Kg\cm^2	Total Head [H] m of water	Venturimeter reading Kg/cm^2		H = (P1-P2) x 10 m of water	Weight of hanger To Kg	Speed of turbine N Rpm	Weigh of hanger [T1] kg	Spring Balance T2 Kg	Tension [T] Kg	Discharge Q x10^{-3} m^3/sec	B.H.P hp	I.H.P hp	η %
			P1	P2										
											Mean =			

DESCRIPTION:

Pelton wheel turbine is an impulse turbine, which is used to act on high loads and for generating electricity. All the available heads are classified in to velocity energy by means of spear and nozzle arrangement. Position of the jet strikes the knife-edge of the buckets with least relative resistances and shocks. While passing along the buckets the velocity of the water is reduced and hence an impulse force is supplied to the cups which in turn are moved and hence shaft is rotated.

PROCEDURE:

1. The Pelton wheel turbine is started.
2. All the weight in the hanger is removed.
3. The pressure gauge reading is noted down and it is to be maintained constant for different loads.
4. The Venturimeter readings are noted down.
5. The spring balance reading and speed of the turbine are also noted down.
6. A 5Kg load is put on the hanger, similarly all the corresponding readings are noted down.
7. The experiment is repeated for different loads and the readings are tabulated.

GRAPHS:

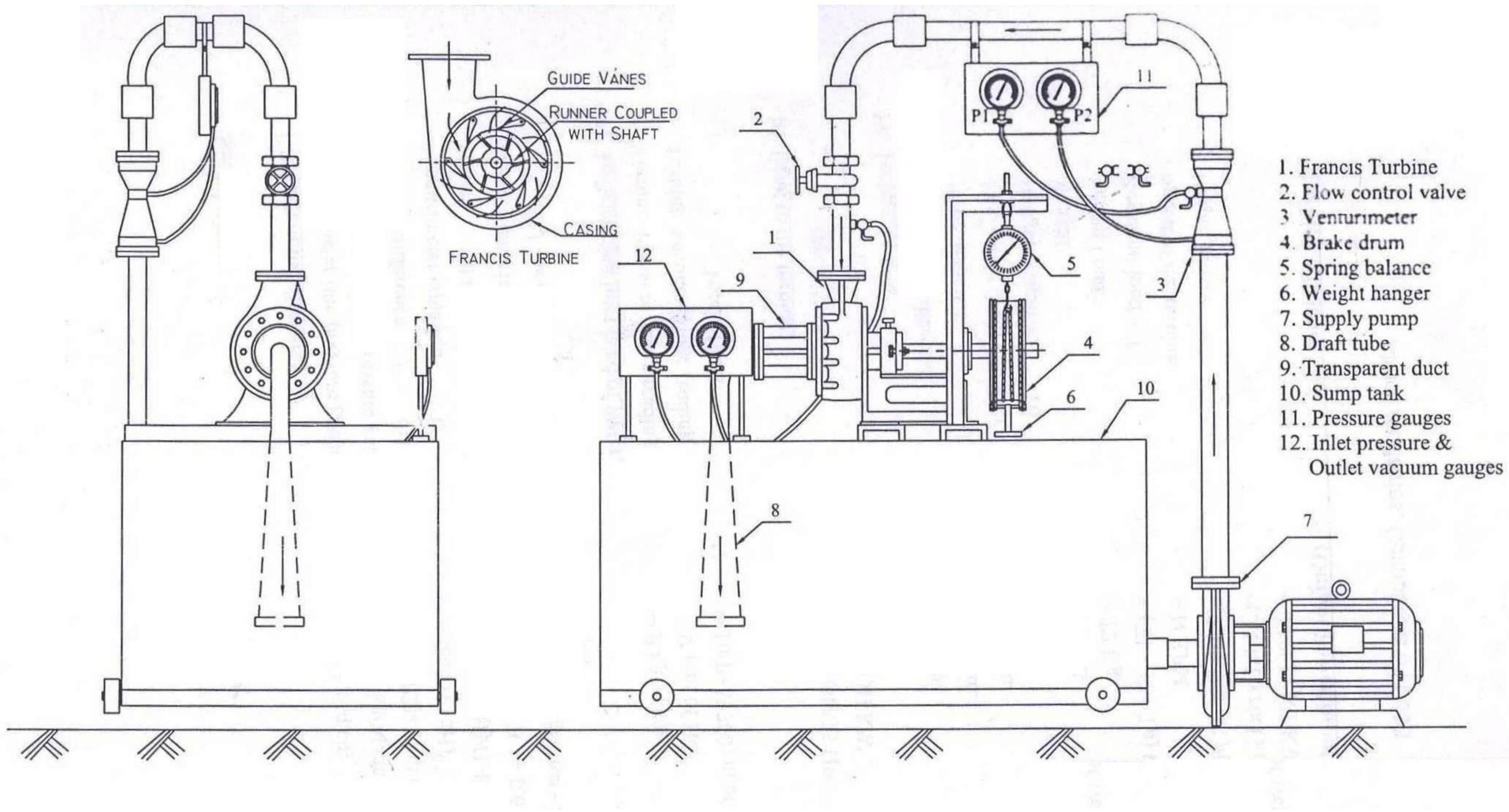
The following graphs are drawn.

1. BHP Vs IHP
2. BHP Vs speed
3. BHP Vs Efficiency

MODEL CALCULATION:

RESULT:

Thus the performance characteristic of the Pelton Wheel Turbine is done and the maximum efficiency of the turbine is ………. %



FRANCIS TURBINE TEST RIG

CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF FRANCIS TURBINE TEST RIG

AIM:

To conduct load test on Francis turbine and to study the characteristics of Francis turbine.

APPARATUS REQUIRED:

1. Stop watch
2. Tachometer

FORMULAE:

1. **VENTURIMETER READING:**

   h = (p1 - p2) x 10 (m)

   Where

   P1, P2- Venturimeter readings in kg /cm^2

2. **DISCHARGE:**

   $Q = 0.011 \times \sqrt{h}$ (m^3 / s)

3. **BRAKE HORSEPOWER:**

   BHP = π x D x N x T / 60 x 75 (hp)

   Where

   N = Speed of turbine in (rpm)

   D = Effective diameter of brake drum = 0.315 m

   T = torsion in [kg]

4. **INDICATED HORSEPOWER:**

   HP = 1000 x Q x H / 75 (hp)

   Where

   H = Total head in (m)

5. **PERCENTAGE EFFICIENCY:**

   %η = B.H.P x 100 / I.H.P (%)

S.No	Pressure Gauge Reading [Hp] Kg/cm^2		Total Head [H] m of water	Venturimeter reading Kg\cm^2		H = (P1-P2) x 10 m of water	Weight of hanger To Kg	Speed of turbine N Rpm	Weigh of hanger [T1] kg	Spring Balance T2 Kg	Tension [T] Kg	Discharge Q x10^{-3} m^3\sec	B.H.P hp	I.H.P hp	η %
	H1	H2		P1	P2										
														Mean =	

DESCRIPTION:

Modern Francis turbine in an inward mixed flow reaction turbine it is a medium head turbine. Hence it required medium quantity of water. The water under pressure from the penstock enters the squirrel casing. The casing completely surrounds the series of fixed vanes. The guides' vanes direct the water on to the runner. The water enters the runner of the turbine in the dial direction at outlet and leaves in the axial direction at the inlet of the runner. Thus it is a mixed flow turbine.

PROCEDURE:

1. The Francis turbine is started
2. All the weights in the hanger are removed
3. The pressure gauge reading is noted down and this is to be
   Maintained constant for different loads
4. Pressure gauge reading is ascended down
5. The Venturimeter reading and speed of turbine are noted down
6. The experiment is repeated for different loads and the readings are tabulated.

GRAPHS:

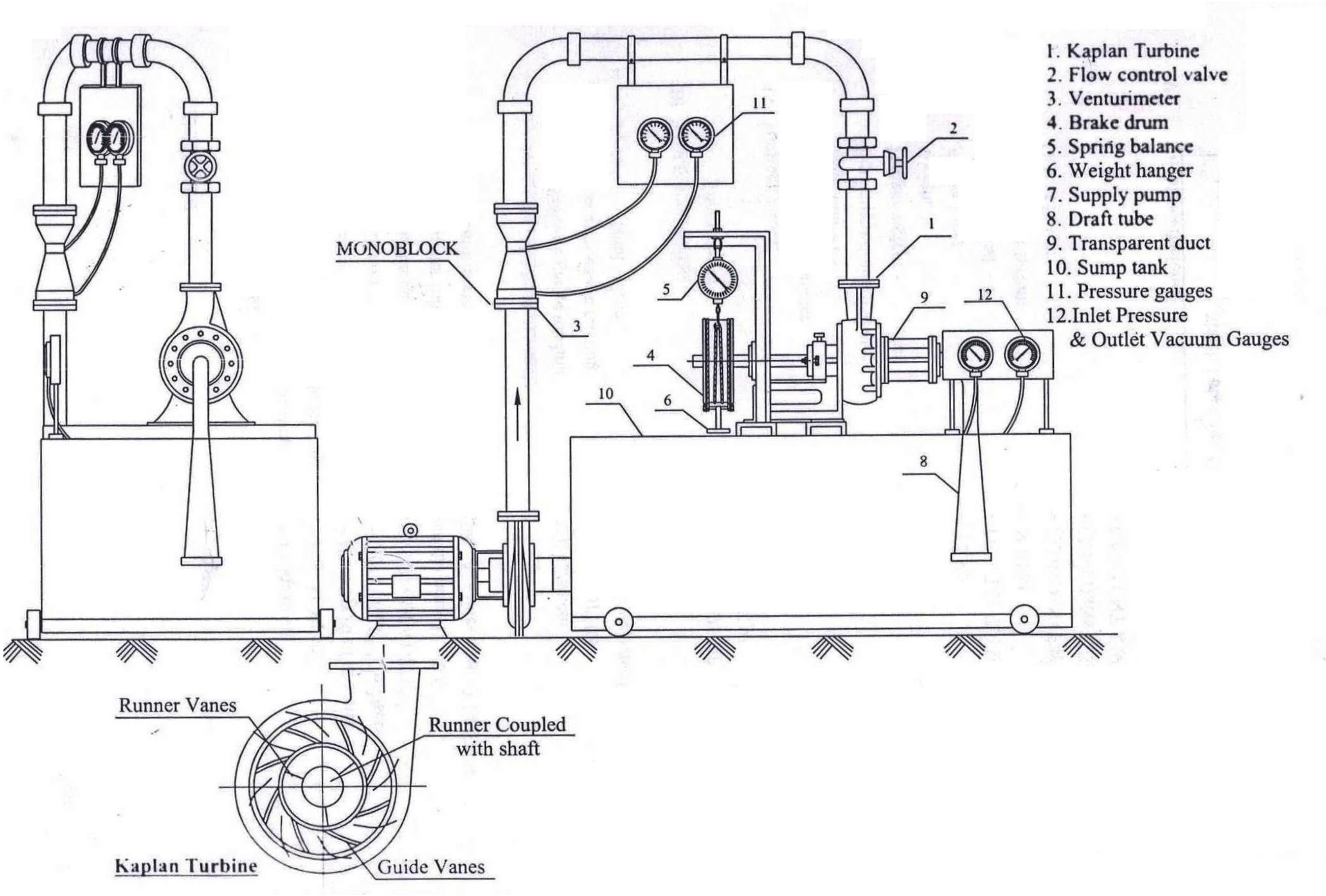
The following graphs are drawn

1. BHP (vs.) IHP
2. BHP (vs.) speed
3. BHP (vs.) % efficiency

MODEL CALCULATION:

RESULT:

Thus the performance characteristic of the Francis wheel turbine is done and the maximum efficiency of the turbine is …………. %



KAPLAN TURBINE TEST RIG

CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF KAPLAN TURBINE TEST RIG

AIM:

To study the characteristics of a Kaplan turbine

APPARATUS REQUIRED:

1. Venturimeter
2. Stopwatch
3. Tachometer
4. Dead weight

FORMULAE:

1. **VENTURIMETER READING:**

$h = (P1 \sim P2) \times 10$ (m of water)

Where,

P1, P2 - Venturimeter reading in Kg /cm^2

2. **DISCHARGE:**

$Q = 0.0055 \times \sqrt{h}$ (m^3 / s)

3. **BRAKE HORSE POWER:**

$BHP = (\pi \times D \times N \times T) / (60 \times 75)$ (hp)

Where,

N = Speed of the turbine in (rpm)

D = Effective diameter of brake drum = 0.315 m

T = Torsion in To + T1 – T2 (Kg)

4. **INDICATED HORSE POWER:**

$IHP = (1000 \times Q \times H) / 75$ (hp)

Where,

H = Total head (m)

5. **PERCENTAGE EFFICIENCY:**

$\%\eta = (B.H.P / I.H.P \times 100)$ (%)

S.No	Pressure Gauge Reading [Hp] Kg\cm^2	Total Head [H] m of water	Venturimeter reading Kg/cm^2		H = (P1-P2) x 10 m of water	Weight of hanger To Kg	Speed of turbine N Rpm	Weigh of hanger [T1] kg	Spring Balance T2 Kg	Tension [T] Kg	Discharge Q x10^{-3} m^3/sec	B.H.P hp	I.H.P hp	η %
			P1	P2										
											Mean =			

DESCRIPTION:

Kaplan turbine is an axial flow reaction turbine used in dams and reservoirs of low height to convert hydraulic energy into mechanical and electrical energy. They are best suited for low heads say from 10m to 5 m. the specific speed ranges from 200 to 1000

The flow through the pipelines into the turbine is measured with the office meter fitted in the pipeline. A mercury manometer is used to measure the pressure difference across the orifice meter. The net pressure difference across the turbine output torque is measured with a pressure gauge and vacuum gauge. The turbine output torque is determined with the rope brake drum. A tachometer is used to measure the rpm.

EXPERIMENTAL PROCEDURE:

1. Keep the runner vane at require opening
2. Keep the guide vanes at required opening
3. Prime the pump if necessary
4. Close the main sluice valve and they start the pump.
5. Open the sluice valve for the required discharge when the pump motor switches from star to delta mode.
6. Load the turbine by adding weights in the weight hanger. Open the brake drum cooling water gate valve for cooling the brake drum.
7. Measure the turbine rpm with tachometer
8. Note the pressure gauge and vacuum gauge readings
9. Note the orifice meter pressure readings.

Repeat the experiments for other loads

GRAPHS:

The following graphs are drawn.

1. BHP Vs IHP
2. BHP Vs speed
3. BHP Vs Efficiency

MODEL CALCULATION:

RESULT:

Thus the performance characteristic of the Kaplan Turbine is done and the maximum efficiency of the turbine is ………. %

ROUGH SHEET:

ROUGH SHEET:

PREPARED AND PUBLISHED BY:

Mr.M.Mohan Prasad M.E., (MBA).
Assistant Professor,
Department of Mechanical Engineering,
P.A.College of Engineering and Technology,
Pollachi, Coimbatore - 642 002.
Email: ermmpbe@gmail.com