SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR - 603 203.

DEPARTMENT OF MECHANICAL ENGINEERING

1909306 - FLUID MECHANICS AND MACHINERY

(ACADEMIC YEAR 2021-2022)

LABORATORY MANUAL

SRM VALLIAMMAI ENGINEERING COLLEGE
(An Autonomous Institution)
SRM Nagar, Kattankulathur-603 203.

DEPARTMENT OF MECHANICAL ENGINEERING

1909306 - FLUID MECHANICS AND MACHINERY LAB MANUAL

Name : ………………………………………

Reg No : ………………………………………

Branch : ………………………………………

Year & Semester : ………………………………………

SYLLABUS (REG. 2019)

1909306 FLUID MECHANICS AND MACHINERY LABORATORY L T P C
0 0 4 2

OBJECTIVES:

Upon Completion of this subject, the students can be able to:

- Understand hands on experience in flow measurements using different devices.
- Understand the working principle and performance of centrifugal and submergible pumps.
- Know, how to calculate and draw characteristics curves for various experiments related to fluid mechanics.
- Understand the energy flow pattern through the hydraulic turbines and pumps.
- Explain his/her competency towards preventive maintenance of hydraulic turbines.

LIST OF EXPERIMENTS:

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 Rotameter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able:

- Ability to use the measurement equipment for flow measurement
- Ability to do performance trust on different fluid machinery
- Conduct experiments on hydraulic turbines and pumps to draw characteristics

- Determine the energy flow pattern through the hydraulic turbines and pumps
- Exhibit his/her competency towards preventive maintenance of hydraulic turbines.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.NO	NAME OF THE EQUIPMENT	QTY.
1	Orifice meter setup	1 no
2	Venturi meter setup	1 no
3	Rotameter setup	1 no
4	Pipe flow analysis setup	1 no
5	Centrifugal pump / Submergible pump setup	1 no
6	Reciprocating pump setup	1 no
7	Gear pump setup	1 no
8	Pelton wheel setup	1 no
9	Francis turbine setup	1 no
10	Kaplan turbine setup	1 no

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3	3	3	3	3	3	3	-	3	3	-	-	1	2	2	2
2	3	3	3	3	3	3	3	-	3	3	-	-	-	2	2	2
3	3	3	3	3	3	3	3	-	3	3	-	-	-	2	2	2
4	3	3	3	3	3	3	3	-	3	3	-	-	2	2	2	2
5	2	2	2	2	2	2	3	-	2	2	-	-	2	2	2	2

CONTENTS

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

Exp No: 1
Date :

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**:

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

2. **THEORTICAL DISCHARGE**:

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

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 = Acceleration due to 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

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:

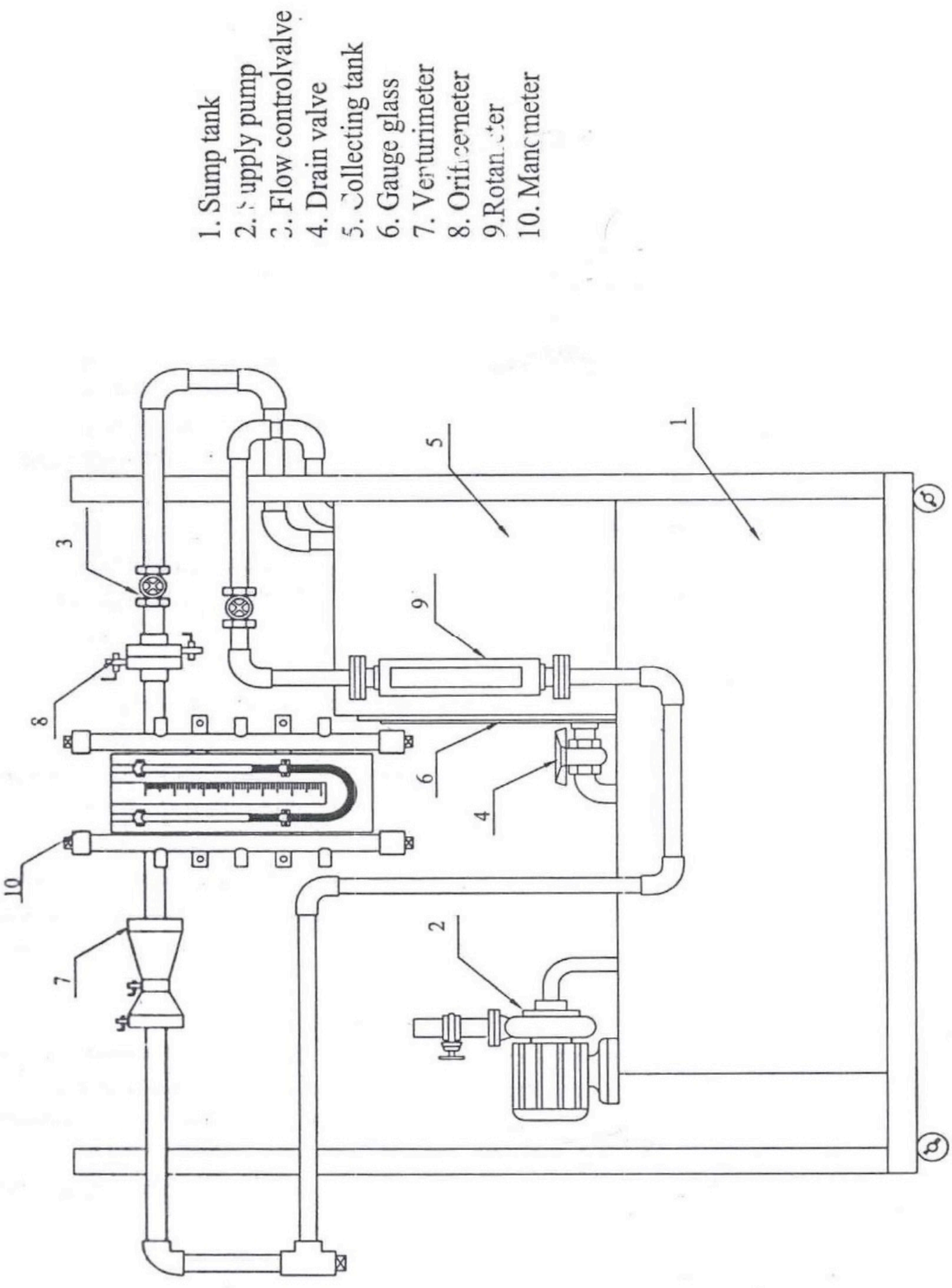
1. The pipe is selected for doing experiments
2. The motor is switched on, as a result water will flow
3. According to the flow, the mercury level fluctuates in the U-tube manometer
4. The reading of H_1 and H_2 are noted
5. The time taken for 10 cm rise of water in the collecting tank is noted
6. The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

SPECIFICATIONS

Diameter of pipe d_1 =

Diameter of throat d_2 =

Area of the collecting tank = 0.5 x 0.5 m^2


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

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 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					
Cd =							Mean	

RESULT:

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

VIVA QUESTIONS

1.Define fluid.

A Fluid is a substance that deforms continuously when subjected to a shear stress no matter how small that shear stress may be.

2.Differentiate solid and fluid.

Fluid :The fluid deforms continuously when subjected to a shear stress. When the shear stress disappears the fluid never regain in to original shape. . Solid :The Solid deforms a definite amount when subjected to a shear stress When the shear stress disappears solids gain fully or partly their original shape.

3.Define density.

Density is defined as the mass of a substance per unit volume. If a fluid element enclosing a point P has a volume dV and dm , then the density is given by r = lim dV - 0 (dm / dV) = (dm / dV) The unit of density is kg/m3 .

4.Define specific volume,.

Specific volume is defined as the reciprocal of density that is volume capacity per unit mass of fluid Vs = (1 / r) = (dV / dm) The unit of sp. Volume is m3/kg

5.Define specific weight.

Specific weight is the weight of the fluid per unit volume.

g = (weight / volume) = (m g / v) = r g The unit of specific weight is N/m3.

6.Define specific gravity (SG).

Specific gravity is the ratio of mass density (or) weight density of the fluid to the mass density (or) weight density of the standard fluid. For liquids, water at 4oc is considered as standard fluid. A liquid has a specific gravity of 1.527

7.what are the values of specific weight and specific volume ?

Specific gravity of a liquid (SG) = Sp. Weight (or) weight density of liquid / Sp. Weight (or) weight density of std liquid The standard liquid is water and its specific weight = r g = 1000 x 9.81 = 9810 N/m3

The specific weight of the liquid = 9810 x 1.527 = 14979.8 N/m3.

Density of the liquid (r) = 14979.8 / 9.81 = 1527 kg/ m3.

Specific volume of liquid = 1 /r = 1 / 1527 = 6.54 x 10 –4 m3/kg.

8.Define viscosity.

The viscosity can be defined as the property of fluid which resist relative motion of its adjacent layers. It is the measure of internal fluid friction due to which there is resistance to flow, The unit of viscosity is Ns/m2.

9.State Newton’s law of viscosity.

The shear stress on a fluid element layer is directly proportional to the rate of strain (or) velocity gradient, the constant of proportionality being called the coefficient of viscosity.

t a (du / dy) shear stress (t) = m (du / dy)

.

10.Examples for non newtanian fluid?

Blood, water, alchohol and kerosene

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DETERMINATION OF THE CO-EFFICIENT OF DISCHARGE OF GIVEN VENTURIMETER

Exp No: 2

Date:

AIM:

To determine the coefficient of discharge for liquid flowing through venturi meter.

APPARATUS REQUIRED:

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

FORMULAE:

1. **ACTUAL DISCHARGE:**

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

2. **THEORTICAL DISCHARGE:**

$Q_{th} = a_1 \times a_2 \times \sqrt{2gh} / \sqrt{a_1^2 - a_2^2}$ (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	=	Acceleration due to gravity in m / s^2
t	=	Time taken for h cm rise of water
H	=	Venturi head in terms of flowing liquid

$H = (H_1 \sim H_2) (S_m / S_1 - 1)$

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

3. **CO EFFICENT OF DISCHARGE:**

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

DESCRIPTION:

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

PROCEDURE:

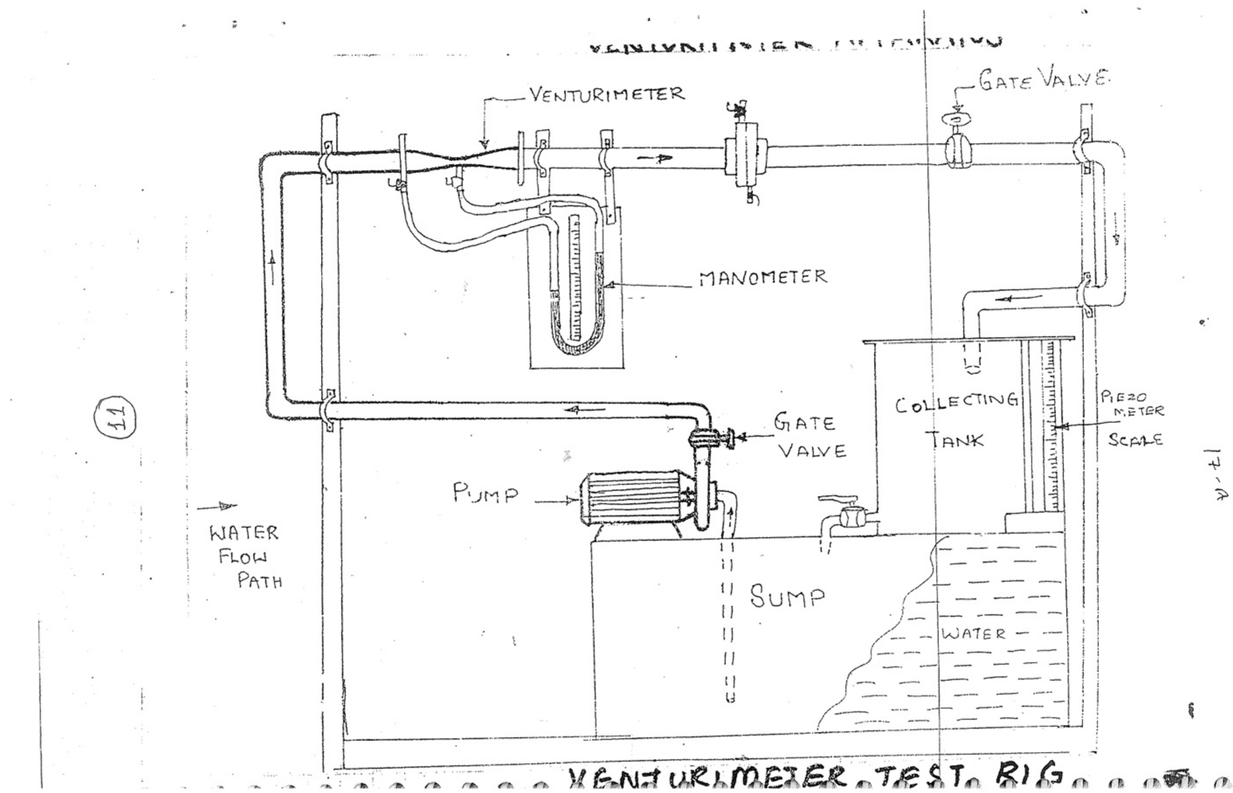
1. The pipe is selected for doing experiments
2. The motor is switched on, as a result water will flow
3. According to the flow, the mercury level fluctuates in the U-tube manometer
4. The reading of H_1 and H_2 are noted
5. The time taken for 10 cm rise of water in the collecting tank is noted
6. The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

SPECIFICATIONS

Diameter of pipe d_1 = 0.025 m.

Diameter of throat d_2 = 0.015 m.

Area of the collecting tank = 0.5 x 0.5 m^2


VENTURIMETER
GATE VALVE
MANOMETER
COLLECTING
TANK
PIEZO
METER
SCALE
GATE
VALVE
PUMP
WATER
FLOW
PATH
SUMP
WATER
VENTURIMETER TEST RIG

S.no	Diameter in mm	Manometric readier		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 =								

RESULT:

The co efficient of discharge through venturimeter is ……… (no unit)

VIVA QUESTIONS

1.Difference between venturimeter and orificemeter

Venturimeter:throat; orificemeter: hole

2.What is meant by capillarity?

The phenomenon of rise or fall of liquid in a glass tube depend upon surface tension

3.What is cause of temperature in viscosity in liquids and gases?

Liquid: temperature increases viscosity decreases

Gases: temperature increases viscosity increases

4. Define kinematic viscosity and gives its uint.
Kinematic viscosity is defined as the ratio of dynamic viscosity to density.
n = m / r The unit of kinematic viscosity is m2/s

5. State Pascal's law.
Pressure transmits equally in all directions in fluid

6.What is compressibility of fluid ?
Compressibility of substance is the measure of its change in volume under the action of external forces, namely, the normal compressive forces. The measure of compressibility of the fluid is the bulk modulus of elasticity (K)
K = lim DV - 0 (- DP) / (DV/V) The unit of compressibility is N/m2

8.Define boundary layer thickness.
The stream layer from the depth reaches its 0.99 times of the free stream velocity

9.what is real fluid ? Give examples.
The fluids in reality have viscosity m > 0 hence they are termed as real fluids and their motion is known as viscous flow. (ex) Air , water, kerosene, blood, milk

10Why are some fluids are classified as Newtonian fluid ? Give examples of Newtonian fluids.
The fluids, which obey Newton's law of viscosity are known as Newtonian fluidsFor these fluids, there is a linear relationship between shear stress and velocity gradient. (ex) Air, water, kerosene

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FLOW THROUGH PIPE – FRICTION FACTOR

Expt No: 03
Date:

AIM:

To determine the fraction factor of the given pipe.

FORMULAE USED:

=

$$f = \frac{2gd\,h_f}{4L\,v^2}$$

h_f =loss of head due to friction

$$= (h_1 - h_2)\frac{(S_m - S_l)}{S_l}$$

h_1 = Manometric head in one limb of the manometer
h_2 = Manometric head in other limb of the manometric liquid
s_1 = Specific gravity of flowing liquid
f = Friction factor
L = Length of pipe (between the pressure tapping cocks)
v = velocity of flow in the pipe, $\frac{Q}{a}$
Q = discharge, $\frac{AH}{t}$
A = internal plan area of collecting tank
H = Height of collection for H rise in collecting tank
T = Time of collection for H rise in the collecting tank
a = cross section area of pipe, $\frac{\pi d^2}{4}$
d = Diameter of pipe
g = Acceleration due to gravity

DISCRIPTION:

When liquid flows through a pipe line, it is subjected to frictional resistance. The frictional resistance depends upon the roughness of the inner surface of the pipe. More the roughness, greater is the frictional resistance. The loss of head between selected lengths of pipe is observed for a measured discharge. The test rig consist of a piping circuit with three pipe lines of nominal diameter 12.5 made of materials aluminum, copper and stainless steel. The pipes are connected in parallel and using the gate valve provided in each pipelines, water is made to flow in one pipe line at a time.

A pair of quick change cocks is fitted at 1.25m distance apart to measure the frictional loss. The cocks are connected to two common chambers which in turn are connected to the mercury. The manometer is used to measure the pressure drop, which is the head loss. The experimental unit consists of a 0.5 HP pump which supplies water from the sump to the network of pipes consisting of the three pipelines for pipe friction experiments. Water flowing out from the pipelines is collect tank to determine the flow rate and hence the velocity in the pipe.

PROCEDURE:

1. The diameter of pipe, and the internal plan dimensions of the collecting tank and the length of the pipeline between the two pressure tapping cocks are measured.
2. Keeping the outlet valve fully closed, the inlet valve is opened completely.
3. The outlet valve is slightly opened and the manometric heads in both the limbs (h_1 and h_2) are noted.
4. The outlet valve of the collecting tank is tightly close and the time ‘t’ required for ‘H’ rise of water in the collecting tank is observed using a stop watch.
5. The above procedure is repeated by gradually increasing the flow and observing the corresponding readings.
6. The observations are tabulated and the friction factor is calculated.

OBSERVATIONS AND RESULT:

Diameter of the pipe d= 15mm
Length of pipe L= 2m
Internal plan dimensions of collecting tank
Length, l = 50cm
Breadth, b = 50cm

S.No	Manometric readings (mm of mercury)			Loss of head due to friction (mm of liquid) h_f	Time for H=100mm rise 't' sec			Discharge (mm^3 /sec)	Velocity (mm/sec)	Friction factor f
	h_1	h_2	difference X= $(h_1 - h_2)$		Trials 1	Trials 2	Average			

Mean value of f=

MODEL CALCULATION: (Reading no.)

Cross sectional are of pipe , a $= \frac{\pi d^2}{4}$ (mm^2)

Internal plan area of collecting tank , A = l * b (mm^2)

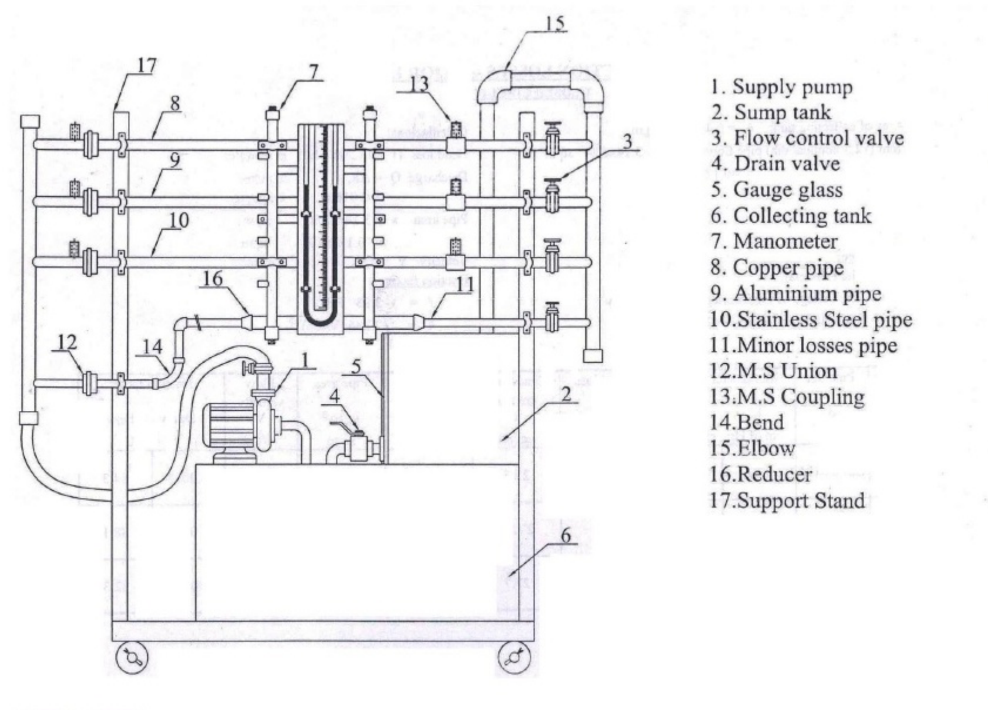
Discharge, Q $= \frac{AH}{t}$ (mm^3/sec)

Velocity , v $= \frac{Q}{a}$ (mm/sec)

Friction factor, $f = \frac{2gd\,h_f}{4L\,v^2}$

GRAPH:

h_f vs v -- h_f on X-axis



RESULT:

Average friction factor of the given pipe, f =

VIVA QUESTIONS

1.What is meant by Reynold's number?

The ratio between INERTIA FORCE TO VISCOUS FORCE

2.List the causes of minor energy losses in flow through pipes.

Due to sudden contraction,due to sudden enlargement,losses due to fluid at the inlet and due to loss of fluid at exit

3.What is meant by vapour pressure of a liquid ?

Liquids evaporate because of molecule s escaping from the liquid surface. These vapor molecules exert a partial pressure on the surface of the liquid known as vapour pressure

4. What is cavitation ?

In flowing fluid, if the pressure is equal to or less than the saturated vapor pressure, the liquid boil locally and produce vapour bubbles. These bubbles collapse in the high pressure region causing a partial vaccum. This phenomenon in known as cavitation.

5.Define surface tension and mention its unit.

A free surface of the liquid is always under stretched condition implying the existence of tensile force on the surface. The magnitude of this force per unit length of an imaginary line drawn along the liquid surface is known as surface tension. The unit of surface tension is N/m.

6. Define the pressure and mention its unit.

If the fluid is stationary, then the force (dF) exerted by the fluid on the area is normal to the surface (dA). This normal force per unit area is called pressure..

P = (dF / dA) The unit of pressure is N/m2.

7. Differentiate between absolute and gauge pressure.

Absolute pressure is measured as a pressure above absolute zero

Gauge pressure is measured as a pressure below atmospheric pressure

Gauge pressure = Absolute pressure - Atmospheric pressure

8. What is a manometer ? Name the common fluids used in it.

A manometer is a transparent tube containing a liquid of known density used for the purpose of measuring the fluid pressure. The common fluids used are mercury, alcohol.

9.Differentiate between simple manometer and differential manometer.

Simple manometer In simple manometer, one end is connected to the point at which the pressure is to be measured and the other end is open to atmosphere. Differential manometer. In differential manometer, two ends are connected to the points whose 'difference of pressure' is to be measured.

10.What is micro-manometer? Where is it used?

In this manometer a large difference in meniscus levels are obtained for very small pressure difference. This manometer is useful for precise measurement of pressure difference.

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CALCULATION OF THE RATE OF FLOW USING ROTAMETER

Expt No: 04

Date:

OBJECTIVE:

To measure discharge through rotameter.

Aim:

To calibrate the rotameter.

Introduction:

If a construction is placed in a closed channel carrying a stream of fluid there will be increase in velocity, hence increase in kinetic energy at the constriction, from an energy balance, as given by Bernoulli's Theorem, there must be corresponding reduction in pressure. Rate of discharge from the constriction can be calculated by knowing the pressure reduction, the area available for flow the constriction, the density of fluid and the coefficient of discharge. The last named is defined as the ratio of actual flow to the theoretical flow and makes allowances for stream contraction and frictional effects.

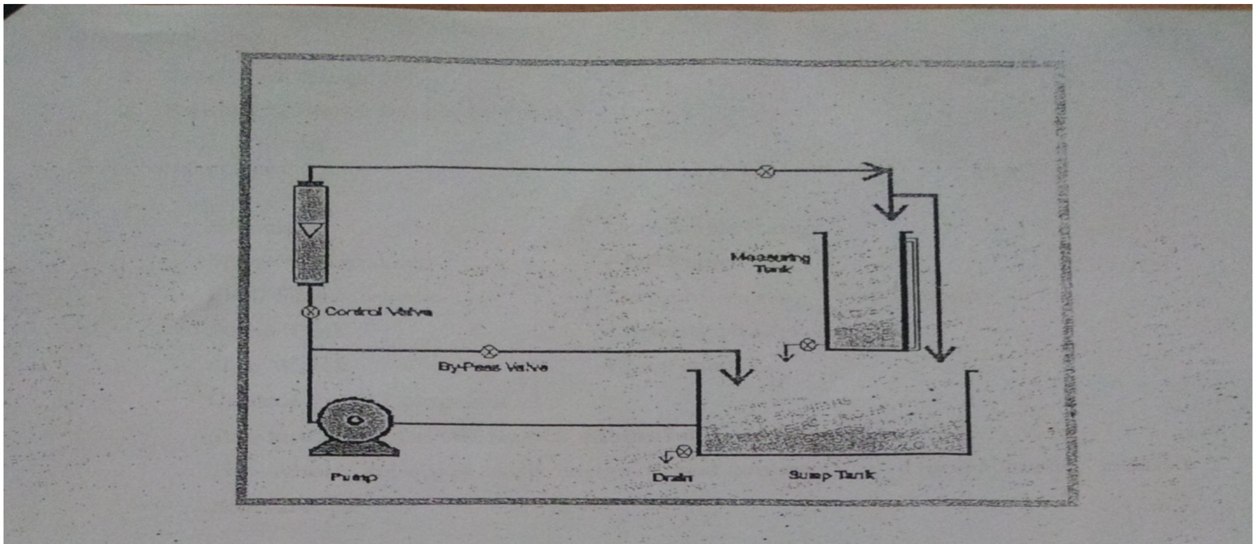
Theory:

Rotameter

The roatmeter is variable-area meter that consists of an enlarging transparent tube and metering "float" that is displaced upward by the upward flow fluid through the tube. The tube is graduated to read the flow directly. Notched in the float cause it to rotate and thus maintain a central position in the tube.

Description:

The apparatus consists of a Rotameter,fitted in a pipeline. The pipeline is taken out from an inlet. At the downstream end of the pipeline separate control valves are provided to regulate the flow to conduct experiment. Discharge is measured with the help of measuring tank and stop watch.



Schematic Diagram for Rotameter Calibration Apparatus

Utilities required:

1. Power supply: single phase, 220volts, 50 Hz, 5 amps with earth.
2. Water supply
3. Drain.
4. Space required: 1.6m*0.5m.

Experimental procedure:

Calibration of rotameter:

1. Open the ball valve provided in the rotameter pipeline.
2. Now switch on the main power supply and switch on the pump.
3. Set the flow rate with help of by pass and flow control valves provided in a rotameter pipeline.
4. Measure the discharge with help of measuring tank and stopwatch.
5. The actual discharge, verify the set value of rotameter.
6. Repeat the same procedure for different flow rates.

Closing procedure:

1. Switch off pump.
2. Switch off power supply to panel.

Specification:

Rotameter	:	compatible range
Water circulation	:	FHP pump
Flow measurement	:	Using measuring tank, capacity 25 ltrs
Sump Tank	:	capacity 50 ltrs
Stop watch	:	Electronic
Control panel comprises of	:	

Standard make on/off switch, Mains indicator, etc.

The whole set-up is well designed and arranged in a good quality painted structure.

Formulae:

Actual discharge:

Q = a*r/t*3600*1000

Observations and Calculations:

Data:

Area of measuring tank,A = 0.1m^2

Observational Table:

S.NO.	ROTAMETER READING IN LPH,Q_T	RISE OF WATER IN MEASURING TANK,R(CM)	TIME TAKEN FOR R,T (SEC)

Calculation Table:

S.NO.	ROTAMETER READING Q_b	ACTUAL DISCHARGE Q_A, M^3 /SEC	$C_d=Q_A/Q_T$

Nomenclature:

A = Area of measuring tank(m^2)
B = Rise of water level in measuring tank(sec)
C = Time taken for rise of water level in measuring tank(sec)
Q = Actual discharge.
Q = Theoretical discharge.

Precautions & maintenance instruction:

1. Donot run the pump at low voltage.i.e less voltage 180 volts.
2. Never fully closed the delivery line and by pass line valves simultaneously.
3.Always keep apparuts free from dust.
4.To prevent clogging of moving parts ,run pump atleast once in fortnight.
5.Frequently grease the moving parts,once in the month.
6.Always use clean water.
7. If apparatus will not in use for more than one month,drain the apparatus completely and fill the pump with cutting oil.

Trouble shootings:
1.if pump get jam,open the back cover of pump and rotate the shaft manually.
2.if pump get heat up,switch off the main power for 15 minutes and avoid closing the flow control valve and by pass valve simultaneously during operation.

Result:

The rate of flow of rotameter_________________

VIVA QUESTIONS

1.Define boundary layer thickness.

The boundary layer thickness is defined as the distance from the boundary in which the velocity reaches 99% of main stream velocity and usually denoted by ∂.

2.Define displacement thickness.

The distance perpendicular to the boundary , by which the stream velocity is displaced due to the formation of boundary layer. It is denoted by ∂^*.

3.Define momentum thickness.

Momentum thickness is defined as the distance, measured perpendicular to the boundary of the solid body, by which the boundary should be displaced to compensate for the reduction in momentum of the flowing fluid on account of boundary layer formation. It is denoted by q.

4.Define Energy thickness .

Energy thickness is defined as the distance, measured perpendicular to the boundary of the solid body, by which the boundary should be displaced to compensate for the reduction in kinetic energy of the fluid flowing on account of boundary layer formation.

5.What are energy lines ?

The energy line is a longitudinal display of the total head at all salient sections of the pipe. The energy line therefore represents the degradation of energy along the flow due to friction, minor losses etc as well as additional input or output by means of pumps and turbines.

6.What are hydraulic gradient lines ?

A hydraulic gradient line is a longitudinal display of the pressure and datum head ie., piezometric head at all salient sections of the pipe line.

7.What is a compound pipe ?

A compound pipe is one in which a number of pipes of different diameters, different lengths and different friction factors are connected in series

8. What is an equivalent pipe ?

The equivalent pipe is the pipe of uniform diameter having loss of head and discharge equal to the loss of head and discharge of a compound pipe consisting of several pipes of different lengths and diameters.

9. Explain the term pipes in parallel.

If two pipes are connected between two given points of a flow system it is called a parallel pipe system.

10. What is a boundary layer?

For fluids having relatively small viscosity, the effect of internal friction in a fluid is appreciable only in a harrow region surrounding the boundaries, where the velocity gradients are large and also larger shear stress. This region is known as boundary layer

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CHARACTERISTICS TEST ON CENTRIFUGAL PUMP

Exp No: 5

Date:

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:**

$Q_{act} = A \times y / t$ (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)

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:

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

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.

SPECIFICATIONS

Diameter of INLET d_1 = 0.05 m.

Diameter of throat d_2 = 0.03 m.

Datum difference level (x) = 0.05 m

Area of the collecting tank = 0.5 x 0.5 m^2

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

RESULT:

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

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

VIVA QUESTIONS

1.what are the purposes of casing of a centrifugal pump

i) To provide water to and from the impeller

ii) To partially convert the kinetic energy in to pressure energy

2.What are the different types of casing in centrifugal pump ?

i) Volute casing ii) Turbine casing (or) casing with guide blades

3.what is the principle of centrifugal pump?

The centrifugal pump works on the principle of centrifugal force

4.what is what is meant by meant by mechanical efficiency?

The ratio between shaft power and water power called mechanical efficiency

5.what is meant by cavitation?

The phenomenon of formation of vapour bubbles and sudden collapsing of the vapour bubbles.

6.what is the use of characteristic curves?

The characteristic curves are used for predicting the behavior and performance of the pump when it is working under different flow rate, head and speed.

7.what are the efficiency of centrifugal pump?

1)manometric efficiency2)mechanical efficiency3)overall efficiency

8.what is meant by delivery head?

The vertical distance between the center line of pump and water surface of the tank to which water is lifted.

9.What is meant by multi stage pump?

If a centrifugal pump constits of two or more impellers,that pump is called multistage pump.to produce a head the impellers are connected in series , for discharge the impellers are connected in parallel.

10.what is meant by manometric efficiency?

The ratio of the manometric head to the head imparted by the impeller to the water is known as manometric efficiency

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CHARACTERISTICS CURVES OF RECIPROCATING PUMP

Exp No: 6

Date:

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:

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

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; Hd = Pd x 10, m

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

Z = Datum head, m

P_d = Pressure gauge reading, kg / cm^2

P_s = Suction pressure gauge reading, mm of Hg

3. INPUT POWER:

P_i = (3600 × N) / (E × T) (Kw)

Where,

N = Number of revolutions of energy meter disc

E = Energy meter constant (rev / Kw hr)

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

4. OUTPUT POWER:

Po = ρ x g x Q x H / 1000 (Kw)

Where,

ρ = Density of water (kg / m^3)

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

H = Total head of water (m)

Q = Discharge (m^3 / sec)

5.EFFICIENCY:

η_o = (Output power po / input power pi) × 100 %

Where,

Po = Output power KW

Pi = Input power KW

SPECIFICATIONS

Size = 0.025 x 0.020 m.

Stroke length of the pump L = 0.045m.

Bore diameter d = 0.5 x 0.5 x 0.5 m.

Speed of the pump = 300 rpm.

Area of the collecting tank = 0.3 x 0.2 m^2.

Speed of motor = 1390 rpm.

S.no	Delivery pressure reading Pd kg / cm^2	Suction pressure reading Ps mm	Delivery head Hd=Pdx 10.0	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 =	

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

RESULT:

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

VIVA QUESTIONS

1.What is a positive displacement pump ?

In the case of positive displacement pumps, the fluid is physically pushed from an enclosed space. The positive displacement pumps can be either reciprocating type or rotary type.

2.Where is the reciprocating pump well suited ?

The reciprocating pump is well suited for relatively small capacities and high heads.

3.what are the main components of a reciprocating pump ?

1)cylinder 2) Piston 3) suction valve 4) Delivery valve 5) Suction pipe 6) delivery pipe 7) crank shaft and connecting rod mechanism..

4.Define coefficient of discharge of reciprocating pump.

The ratio between the actual discharge and theoretical discharge is known as coefficient of discharge. Cd = Qact / Qthe.

5. Define slip of the reciprocating pump.

The difference between theoretical discharge and actual discharge is called the slip of the pump. Slip = Qthe. - Qact , % of slip = (Qthe. - Qact) x 100 / Qthe.

6. When does the negative slip occurs ?

Negative slip occurs when delivery pipe is short suction pipe is long and pump is running at high speed.

7. How does single acting pump reciprocating pump works?.

In single acting pump, there is one suction valve and one delivery valve. On the backward stroke of the piston, the suction valve opens and water enters into the cylinder space. On the forward stroke, the suction valve closes and delivery valve opens, the water is forced through the delivery pipe

8. How does double acting pump reciprocating pump works?

In the double acting pump, there are two suction valves and two delivery vales one in the front and one in the rear. When the piston moves backward, the suction valve in the front opens and delivery valve in the rear opens and water is forced through it. When the piston moves forward, the suction valve in the rear opens and delivery valve in the front opens and water is forced through it.

9. What is an indicator diagram of a reciprocating pump ?

The indicator diagram of a reciprocating pump is the diagram which shows the pressure head in the cylinder corresponding to any position during the suction and delivery strokes.

10. Name some rotary positive displacement pumps.
    a. Gear pumps.
    b. Vane Pumps.
    c. Piston pumps.
    d. Screw pumps.

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Rough work

CHARACTERISTICS CURVES OF GEAR OIL PUMP

Exp No: 7

Date:

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:

Qact = A x 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 = Hd + Hs + 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:

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

Where,

Nr = Number of revolutions of energy meter disc

Ne = Energy meter constant (rev / Kw hr)

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

4. OUTPUT POWER:

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

Where,

W = Specific weight of oil (N / m^3)

Qact = Actual discharge (m^3 / 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.

SPECIFICATIONS

Size of pump = 0.02 x 0.02 m^2.

Datum head (Z) = 0.3 m.

Datum difference level (x) = 0.05 m.

Area of the collecting tank = 0.3 x 0.3 m^2

Efficiency of motor = 80%

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

RESULT:

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

S. no	Delivery pressure reading Pd kgf /	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 =	

VIVA QUESTIONS

1. State the Buckingham’s-p theorem.

Buckingham’s-p theorem states n quantities with in base dimensions can generally be arranged to provide only (n-m) independent dimensionless parameters also referred as p terms.

2.what do you mean by repeating variables? How are the repeating variables selected for dimensional analysis ?

In dimensional analysis, it is necessary to recognize the common variables for grouping. These common variables are known as repeating variables. The repeating variables should be chosen in such a way that one variable contain geometric property, other variable contains flow property and third contains fluid property. Normally the characteristic length (L), the velocity (u) and the density are chosen.

3.What is a Mach number? Mention its field of use.

The Mach number is the square root of ratio of inertia force to the elastic force

4.For surface tension and capillarity studies which dimensionless number is used?

The surface tension forces are associated with Weber number

Weber Number = inertia force/surface tention force

So for surface tension and capillarity studies Weber number is used.

5.Mention any two applications of Euler’s number.

i) flow through hydraulic turbines and pumps

ii) flow over submerged bodies iii) flow through penstocks.

6.Name the three types of similarity.

a) geometric similarity b) Kinematic similarity c) Dynamic similarity.

7.What is geometric similarity?

Geometric similarity concerns the length dimensions. A model and prototype are geometrically similar if and only if all body dimensions in all three coordinates have the same linear scale ratio. scale ratio = Lm/Lp

8.In fluid flow , what does dynamic similarity mean ?

Dynamic similarity exists when the model and prototype have the same length scale ratio, time scale ratio and force scale ratio. So the forces at homogeneous points are related through a constant called the force ratio.

9. What is the difference between a laminar flow ?

In the laminar flow the fluid particles move along smooth paths in laminas (or) layers with one layer gliding over the adjacent layer .

10. What is the difference between a turbulent flow?

In turbulent flow the fluid particles move in a very irregular path causing an exchange of momentum from one portion of the fluid to the other. The turbulence setup greater shear stress throughout the fluid and causes more irreversibility and losses.

Rough Work

CHARACTERISTICS CURVES OF PELTON WHEEL

Exp No: 8

Date:

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:

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

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.

SPECIFICATIONS

Rated supply head = 45m.

Rated speed = 1000rpm.

Power output = 3.7kw

Pitch circle diameter = 0.26 m.

Jet ratio = 12

Brake drum diameter = 0.3m

Rope brake diameter = 0.015m

No. of buckets = 18

Pump set

Rated head = 53 m.

Normal speed = 2880 rpm.

Size of pump = 0.065 x 0.065 m.

Impeller diameter = 0.21 m.

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.

S.no	Pressure Gauge Reading [Hp] Kg\cm²	Total Head [H] m of water	Venturimeter reading Kg\cm²		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 m³\sec	B.H.P hp	I.H.P hp	η %
			P1	P2										
Mean =														

GRAPHS:

The following graphs are drawn.

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

RESULT:

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

VIVA QUESTIONS

1.What is a fluid Machine ?

A fluid machine is a device which converts the energy stored by a fluid in to mechanical energy or work.

2.What are positive displacement machines ?

The machine functioning depend essentially on the change of volume of a certain amount of fluid within the machine. There is a physical displacement of the boundary of certain fluid hence it is called positive displacement machine.

3.Based on the direction of fluid flow how are the fluid machines classified ?

According to the flow direction of fluid, the fluid machines are classified as

Axial flow machines - The main flow direction is parallel to the axis of the machine.

Radial flow machines - The main flow direction is perpendicular to the axis of the machine ie. in radial direction

Mixed flow machines - The fluid enters radially and leaves axially or vice-versa.

4.What is a turbine ?

A turbine converts the energy of the fluid in to mechanical energy which is then utilized in running a generator of a power plant.

5.State the difference between impulse and reaction turbines ?

At the inlet of the turbine the energy available is only kinetic energy, the turbine is known as impulse turbine. If the inlet of the turbine, possesses kinetic energy and pressure energy, the turbine known as reaction turbine.

6.What are Homologous units?

In utilizing scale models in designing turbo machines, geometric simililitude is necessary as well as geometrically similar velocity diagrams at entrance and exit from impellers. Two geometrically similar units having similar vector diagrams are called homologous units.

7.Define specific speed based on power.

The specific speed (Ns) of turbine is defined as the speed of some unit of series of such size that it produces unit power with unit head. .

8.Define specific speed based on discharge.

The specific speed (Ns) of the pump is defined as the speed of some unit of the series of such size that it delivers unit discharge at unit speed

9.What is the significance of specific speed ?

The specific speed inversely proportional to the head across the machine. So low specific speed corresponds to high head across it and vice-versa.

The specific speed is directly proportional to the discharge through the machine or power produced by the machine. So low specific speed therefore refers to low discharge or low power machine and vice-versa.

10.Name the main parts of a radial flow reaction turbine?

i) Casing ii) Guide vane iii) Runner iv) Draft tube.

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Rough work

CHARACTERISTICS CURVES OF FRANCIS TURBINE

Exp No: 9

Date:

AIM:

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

APPARATUS REQUIRED:

1. Stop watch
2. Tachometer

FORMULAE:

1. VENTURIMETER READING:

$h = (p1 - p2) \times 10$ (m)

Where

P1, p2- venturimeter readings in kg / cm^2

2. DISCHARGE:

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

3. BRAKE HORSEPOWER:

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

Where

N = Speed of turbine in (rpm)

D = Effective diameter of brake drum = 0.315m

T = torsion in [kg]

4. INDICATED HORSEPOWER:

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

Where

H – total head in (m)

5. PERCENTAGE EFFICIENCY:

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

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.

SPECIFICATIONS

Rated supply head = 15m.

P.C.D guide vanes = 0.23m.

Discharge = 2000 lpm

Runner diameter = 0.16 m.

Brake drum diameter = 0.3m

Size of pump = 0.1 x 0.1 m.

No. of guides to vanes = 0.23 m.

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 assended 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

RESULT :

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

VIVA QUESTIONS

1.What is the purpose of the guide vanes in radial flow reaction turbine?

The purpose of the guide vane is to convert a part of pressure energy of the fluid at its entrance to the kinetic energy and then direct the fluid on to the number of blades.

2.What is a draft tube ? In which turbine it is mostly used.

The draft tube is a conduit which connects the runner exit to the trail race, when water is being finally discharged from the turbine. In reaction turbine , the draft tube is mostly used.

3.What is the primary function of a draft tube ?

The primary function of the draft tube is to reduce the velocity of the discharged water to minimize the loss of kinetic energy at the outlet.

4.Name the main parts of Kaplan turbine.

i). Scroll casing ii). Guide vanes iii). Hub with vanes iv). draft tube

5.Name the main parts of pelton wheel .

i) Nozzle ii) Runner with buckets iii) Casing.

6.What are the different performance characteristic curves ?

i) Variable speed curves (or) main characteristics
ii) Constant seed curves (or) operating characteristics
iii) Constant efficiency curves (or) Muschel characteristics

7.Give an example for a low head turbine , a medium head turbine and a high head turbine.

Low head turbine - Kaplan turbine
Medium head turbine - Francis turbine
High head turbine - Pelton wheel.

8.What are Homologous units?

In utilizing scale models in designing turbo machines, geometric simililitude is necessary as well as geometrically similar velocity diagrams at entrance and exit from impellers. Two geometrically similar units having similar vector diagrams are called homologous units.

9.Define specific speed based on power.

The specific speed (Ns) of turbine is defined as the speed of some unit of series of such size that it produces unit power with unit head. .

10Define specific speed based on discharge.

The specific speed (Ns) of the pump is defined as the speed of some unit of the series of such size that it delivers unit discharge at unit speed

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KAPLAN TURBINE TEST RIG

Exp No: 10

Date:

AIM:

To study the characteristics of a Kaplan turbine

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 turbine test rig consists of a 3.72 KW (5 Hp) turbine supplied with water from a suitable 20 Hp mixed flow pump through pipelines, sluice valve, and a flow measuring orifice meter. The turbine consists of a cast-iron body with a volute casing, and axial flow gunmetal runner with adjustable pitch vanes, a ring of adjustable guide vanes and draft tube. The runner consists of four numbers of adjustable vanes of aerofoil section. These vanes can be adjusted by means of a regulator, which changes the inlet and outlet angles of the runner vanes to suit the operating conditions. The marking at the outer end of the shaft indicates the amount of opening the vanes. The guide van can be rotated about their axis by means of hand wheel and the position indicated by a pair of dummy guide vanes fixed outside the turbine casing. A rope brake drum is mounted on the turbine shaft to absorb the power developed. Suitable dead weights and a hanger arrangement, a spring balance and cooling water arrangement is provided for the brake drum.

Water under pressure from pump enters through the volute casing and the guiding vanes into the runner while passing through the spiral casing and guide vanes a part of the pressure energy(potential energy) is converted into velocity energy(kinetic energy). Water thus enters the runner at a high velocity and as it passes through the runner vanes, the remaining potential energy is converted into kinetic energy due to curvature of the vanes the kinetic energy is transformed in to mechanical energy, i.e., the water head is converted into mechanical energy and hence the number rotates. The water from the runner is then discharged into the tailrace. Operating guide vane also can regulate the discharge through the runner.

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 vacum gauge. The turbine output torque is determined with the rope brake drum. A tachometer is used to measure the rpm.

SPECIFICATIONS

Rated supply head = 45m.
Rated speed = 1000rpm.
Discharge = 1500 lpm
Weight of rope and hanger = 1kg.
Area ratio = 0.45
Value of k = 3.183 x 10^{-3}
Orifice diameter = 0.10062 m
Size of pump = 0.015 x 0.015 m.

Brake drum diameter = 0.3m
Effective radius of brake drum = 0.165mm
No. of runner blades = 4
Runway speed = 1750rpm.
No of guide vanes = 10.
Size of orificemeter = 0.15 m
value of k = 2.3652 x 10^{-2}

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 them 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 vacum gauge readings
9. Note the orifice meter pressure readings.

Repeat the experiments for other loads

S.no	Pressure Gauge Reading [Hp] Kg\cm	Total Head [H] m of	Venturi meter reading Kg\cm²		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										

VIVA QUESTIONS

1.What is a fluid Machine ?

A fluid machine is a device which converts the energy stored by a fluid in to mechanical energy or work.

2.What are positive displacement machines ?

The machine functioning depend essentially on the change of volume of a certain amount of fluid within the machine. There is a physical displacement of the boundary of certain fluid hence it is called positive displacement machine.

3.Based on the direction of fluid flow how are the fluid machines classified ?

According to the flow direction of fluid, the fluid machines are classified as

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Radial flow machines - The main flow direction is perpendicular to the axis of the machine ie. in radial direction

Mixed flow machines - The fluid enters radially and leaves axially or vice-versa.

4.What is a turbine ?

A turbine converts the energy of the fluid in to mechanical energy which is then utilized in running a generator of a power plant.

5.State the difference between impulse and reaction turbines ?

At the inlet of the turbine the energy available is only kinetic energy, the turbine is known as impulse turbine. If the inlet of the turbine, possesses kinetic energy and pressure energy, the turbine known as reaction turbine

6.Define specific speed based on power.

The specific speed (Ns) of turbine is defined as the speed of some unit of series of such size that it produces unit power with unit head. .

7.Define specific speed based on discharge.

The specific speed (Ns) of the pump is defined as the speed of some unit of the series of such size that it delivers unit discharge at unit speed

8. What is a draft tube ? In which turbine it is mostly used.

The draft tube is a conduit which connects the runner exit to the trail race, when water is being finally discharged from the turbine. In reaction turbine , the draft tube is mostly used.

9. Give an example for a low head turbine , a medium head turbine and a high head turbine.

Low head turbine - Kaplan turbine
Medium head turbine - Francis turbine
High head turbine - Pelton wheel

10. Define specific speed based on power.

The specific speed (Ns) of turbine is defined as the speed of some unit of series of such size that it produces unit power with unit head.

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Rough work

STUDY OF HYDRO POWER PLANT

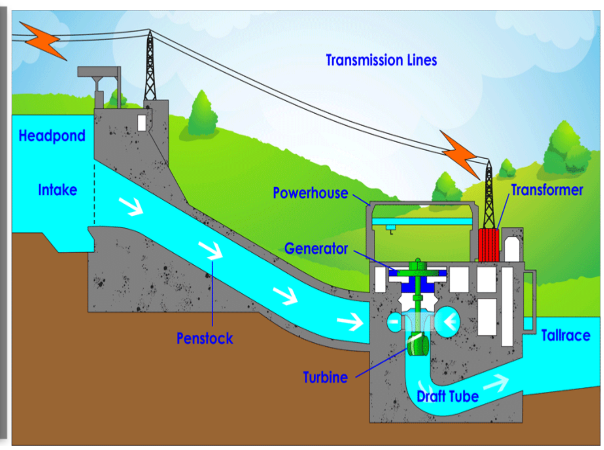
Exp No: 11
Date:

AIM:

To study about hydro powerplant construction, working principle and its history.

Study of Hydro Power Plant

Power system mainly contains three parts namely generation, transmission and distribution. Generation means how to generate electricity from the available source and there are various methods to generate electricity but in this article we only focused on generation of electricity by the means of hydro or water (**hydro power plant**). As we know that the power plant is defined as the place where power is generated from a given source, so here the source is hydro that's why we called it **hydro power plant**.



In **hydro power plant** we use gravitational force of fluid water to run the turbine which is coupled with electric generator to produce electricity. This power plant plays an important role to protect our fossil fuel which is limited, because the generated electricity in hydro power station is the use of water which is renewable source of energy and available in lots of amount without any cost.

The big advantage of hydro power is the water which the main stuff to produce electricity in **hydro power plant** is free, it not contain any type of pollution and after generated electricity the price of electricity is average not too much high.

Construction and Working of Hydro Power Plant

Fundamental parts of hydro power plant are

1. Area
2. Dam
3. Reservoir
4. Penstock
5. Storage tank
6. Turbines and generators
7. Switchgear and protection

For **construction of hydro power plant** first we choose the area where the water is sufficient to reserve and no any crisis of water and suitable to build a dam, then we construct the dam. The main function of dam is to stop the flow of water and reserve the water in reservoir. Mainly dam is situated at a good height to increase the force of water. Reservoir stocks up lots of water which is employed to generate power by means of turbines. After that Penstock, the pipe which is connected between dam and turbine blades and most important purpose of the penstock is to enlarge the kinetic energy of water that's why this pipe is made up of extremely well-built material which carry on the pressure of water. To control the pressure of water means increase or decrease water pressure whenever required, we use a valve. Storage tank comes in picture when the some reason the pressure of water in reservoir is decreases then we use storage tank it is directly connected to penstock and use only in emergency condition. After that we employ turbine and generator. Turbine is the main stuff, when water comes through the penstock with high kinetic energy and falls on turbine blades, turbine rotates at high speed. As we know that the turbine is an engine that transfers energy of fluid into mechanical energy which is coupled with generator and generator converts mechanical energy into electrical energy which we utilize at the end. In hydro power plant we also add switchgears and protections which control and protect the whole process inside the plant. The control equipments consists control circuits, control devices, warning, instrumentation etc and connect to main control board. After generating electricity at low voltage, we use step up transformer to enlarge the level of voltage (generally 132 KV, 220 KV, 400 KV and above) as per our requirement. After that we transmit the electric power to the load center, and then we step down the voltage for industrial and large consumer and then again we step down the voltage to distribute electricity at domestic level which we used at home. This is the whole process of generating electricity by the means of hydro (hydro power plant) and then transmitting and distributing electricity.

History of Hydro Power Plant

First hydro power is used by the Greekins to spin water wheels for crushing wheat into flour before more than 2000 years ago. In the 1700's, hydropower was generally used for pumping irrigation (non-natural use of water on the way to the land) water. We start to generate electricity from hydro power in 1882 when United States (U S) establishes a first hydro power station which generate 12.5 kilowatts (KW) of power. The rapid growth of hydro power comes in 1900’s when hydraulic reaction turbine comes in picture as a result in 1900’s hydro power plants fulfill the requirement of 40% of total United States' electricity. In between 1905-1911 largest hydro power station (Roosevelt Dam) is built by the united state and its generated capacity is increased from 4500kW to 36,000kW.In 1914 S.J. Zowski developed the high specific speed reaction (Francis) turbine runner for low head applications. 1922 the first time a hydroelectric plant was built specifically for crest power. In 1933 Hoover Dam, Arizona generated electricity first time. In 1940 over 1500 hydro power plants generate about one third of the United States' electrical energy.

If we compare the countries on the basis of generated electricity by the means of hydro power, Canada on the top after that United State then Brazil then Russia then China then Norway and at 7th number India is present. India fulfills the 3.5 % power to the total world power through hydro power plants. In India scope of hydro power is very good, first hydro power station, capacity of 130kW establishes in Asia at mounts of Darjeeling in 1898 and after that in 1902 Shimsh (Shivanasamudra) is established and both located in India. Now a day in India the leading hydro power plant is located of river Naptha Jhakri hydro project of 1500MW in Himachal Pradesh. In India main boost come in the field of hydro power in august 1998 when the Government of India publicized a plan on ‘Hydro Power Development’ after that in November 2008 once again Indian government announced this plan and as a result India become leading country list to produce hydro power. This a general idea about hydro power plant.

Result:

Thus we studied about hydro powerplant construction, working principle and its history.

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Rough Work

CONTENT BEYOND SYLLABUS

BERNOULLI'S THEOREM VERIFICATION APPARATUS

Exp No: 12
Date:

AIM:

To verify Bernolli's theorem using Bernoulli's apparatus.

Apparattus required:

Bernoulli's apparatus.

Formulae required:

$$H_{total} = \frac{P}{\rho g} + \frac{V^2}{2g} + Z$$

Where,

H_{total} = Total head

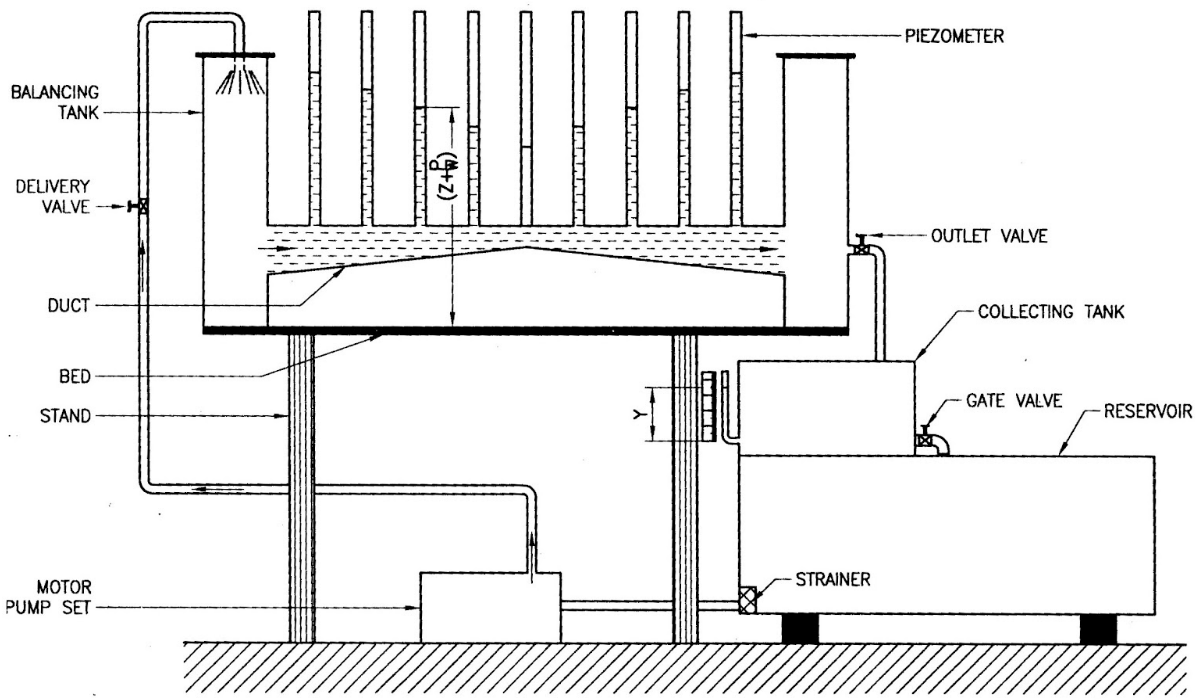
$\frac{V^2}{2g} = Velocity\ head$

$\frac{P}{\rho g} = Pressure\ head$

Z = Datum head

Procedure:

1. The electric motor is started and water is allowed to flow in the given apparatus.
2. The outlet valve of the apparatus is adjusted and maintain a constant head.
3. There should not be any air bubble in the piezometric tubes and the apparatus.
4. Thus pressure head and the various section of conduit are maintained.
5. Notedown the manometric readings.
6. Measure the time taken for 10 cm raise in collecting tank.
7. Using Bernoulli's equation, calculate the total head.



Tabulation:

C/S area m^2	Time for 10 cm raise (sec)	Discharge Q x 10^{-3} m^3 / sec	Velocity (V) m/s	Velocity head $V^2/2g$ (m)	p/ρg (m)	Datum head (m)	Total head

Result:

Thus the Bernoulli's equation is verified by using Bernoulli's apparatus, and the total head is __________________.

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