SRI SHANMUGHA COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Affiliated to Anna University and Accredited by NAAC & NBA (ECE)

Pullipalayam, Morur (P.O), Sankari (T.k), Salem (D.T) – 637 304

DEPARTMENT OF MECHANICAL ENGINEERING

CE8381 - Fluid Mechanics and Machinery Laboratory

SRI SHANMUGHA COLLEGE OF ENGINEERING AND TECHNOLOGY

Pullipalayam, Morur (P.O), Sankari (T.K), Salem (D.T) - 637304**.**

DEPARTMENT OF MECHANICAL ENGINEERING

Connects Life & Learning

Name :

Branch :

Semester :

Register no :

Certified that this is the bona-fide record of work done by the above student in the CE8381-Fluid Mechanics and Machinery Laboratory during the semester April/May 2020

Staff in-charge **Head of the Department**

INSTRUCTION TO THE STUDENTS

Students are instructed to

1. Wear the Overcoats and Shoes, before entering into the laboratory.
2. Operate the equipment's/instruments only in the presence of Lab Technician/Lab In charge.
3. Have a clear idea about the experiment, before doing the same.
4. Come with the observation results of the previous experiments get signed by the lab in charge, well in advance. Those students who have not got the signature for the previous experiment will not be allowed to do the next experiment.
5. Put their signature in the register before getting taking required instruments for doing the experiment.

Vision and Mission of the Department

VISION

To prepare competent mechanical engineers capable of working in an interdisciplinary environment contributing to society through innovation, leadership and entrepreneurship

MISSION

M1: To offer quality education which enables them in professional practice and career

M2: To provide learning opportunities in the state-of-the-art research facilities to create, interpret, apply and disseminate knowledge in their profession

M3: To prepare the students as professional engineers in the society with an awareness of environmental and ethical values

PROGRAMOUTCOMES (POs):

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health, safety, cultural, societal and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis, and interpretation of data and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, apply appropriate techniques, resources, modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal, environmental contexts, demonstrate the knowledge and need for sustainable development.

PO8 Ethics: Apply ethical principles, commit to professional ethics, responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, as a member or leader in diverse teams and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community with society at large being able to comprehend, write effective reports, design documentation, make effective presentations and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge, understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need, ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1 Manufacturing: Modelling, Simulation and Analysis in the field of Manufacturing.

PSO2 Design: Develop and implement new ideas on product design with help of modern CAD tools.

CE8381- FLUID MECHANICS AND MACHINES LABORATORY

COURSE OUTCOME:

COs	Course Outcomes
C204.1	Apply mathematical knowledge to predict the properties and characteristics of a fluid.
C204.2	Analyze and calculate major and minor losses associated with pipe flow in piping networks.
C204.3	mathematically predict the nature of physical quantities
C204.4	Analyze and evaluate the performance of pumps
C204.5	Analyze and evaluate the performance of turbines.

Course Outcomes	Program Outcomes													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C204.1	3	3	3			1	1	1			1	2		
C204.2	3	3	3	2	2	2		1			1	2	2	2
C204.3	3	3	3	2	2	1					2	2	2	2
C204.4	3	3	3	2	2	2	1	2				2	1	2
C204.5	3	3	3	2	2	2	2	2				2	1	2
C204	**3.00**	**3.00**	**3.00**	**2.00**	**2.00**	**1.60**	**1.30**	**1.50**			**1.30**	**2.00**	**1.50**	**2.00**

LIST OF EXPERIEMNTS

CE8381- FLUID MECHANICS AND MACHINES LABORATORY

Course Outcomes		Upon the completion of this course the students will be able to **CO1** Calculate the coefficient of discharge for orifice meter and venturimeter. **CO2** Calibrate the Rota meter and Estimate the friction factor for flow through pipes. **CO3** Predict performance characteristics of centrifugal pump and submergible pump. **CO4** Predict performance characteristics of reciprocating pump and gear pump. **CO5** Predict performance characteristics of turbines.	
Sl. No	**K Level**	**Name of the Experiment**	**Relevance to COs**
1	K4	Determination of the Coefficient of discharge of given orifice meter.	CO1
2	K4	Determination of the Coefficient of discharge of given venturi meter.	CO1
3	K4	Calculation of the rate of flow using Rotameter.	CO2
4	K4	Determination of friction factor for a given set of pipes.	CO2
5	K4	Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pump	CO3
6	K4	Conducting experiments and drawing the characteristic curves of reciprocating pump.	CO4
7	K4	Conducting experiments and drawing the characteristic curves of gear pump.	CO4
8	K4	Conducting experiments and drawing the characteristic curves of Pelton wheel.	CO5
9	K4	Conducting experiments and drawing the characteristics curves of Francis turbine.	CO5
10	K4	Conducting experiments and drawing the characteristic curves of Kaplan turbine.	CO5
		Content Beyond the Syllabus	
1	K4	Investigate the validity of Bernoulli’s theorem to flow of water	CO1
2	K4	Performance test on jet pump	CO3

CONTENTS

S.No	Date	Name of the Experiment	Page No	Marks	Signature

Pre – laboratory Test

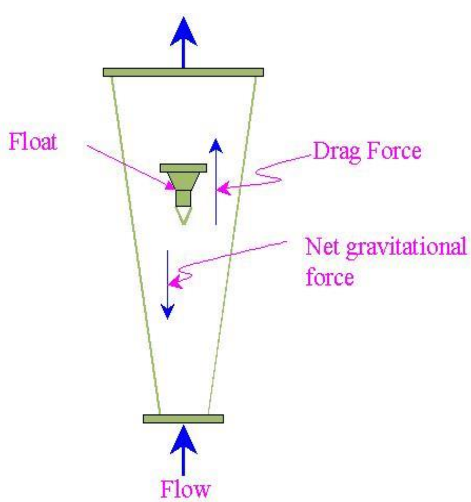
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Calibration of Rotameters
Purpose : To find the rate of flow of liquid

Application

- It uses only the inherent properties of the fluid, along with gravity, to measure flow rate.
- Portable Rotameter can also be constructed to measure the flow rate of large bodies of liquid or gas, such as rivers, oceans, streams, as well as the atmosphere.

Questions

1. Mention few discharge measuring devices
2. Mention the advantage of Rotameter
3. Discuss few disadvantages of Rotameter
4. Write down Bernoulli's equation of motion for ideal and real fluid
5. List the types of rotameter



Calibration of Rotameter Exp.: 1

Aim:

To measure the rate of flow of liquid using Rotameter

Apparatus Required:

1. Rotameter having 0 – 30LPM range
2. Single phase 0.5 HP 1440 rpm
3. Monoblock pump
4. Reservoir tank arrangement
5. Piping system
6. Stopwatch
7. Meter scale

Formula:

Actual discharge

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

Where:

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

Percentage of Error = $(Q_{act} - Q_{the}) / Q_{act} * 100$

Observation and Computation:

Area of collecting tank =

TABULATION FOR ROTAMETRE

S.No	Rotameter discharge		Time for 10 cm rise of water in the capillary tube	Actual discharge		Percentage of Error
	Q_R		**t**	**Q_a**		**%**
	LPM	m^3/ Sec	Sec	LPM	m^3/ Sec	
1						
2						
3						
4						
5						
6						
					Average	

Model calculation:

Procedure:

1. Priming is done first for venting air from the pipes.
2. The inlet valve is opened slightly such that the discharge on the rotameter is noted.
3. The outlet valve of the collecting tank is closed tightly and the time taken for 'H' meter Rise of water in the collecting tank is observed.
4. The above procedure is repeated by gradually increasing the flow and observing the Required readings.
5. The observations are tabulated and the coefficient of discharge of rotameter is compared. Each set of reading should be taken within 2 to 3 minutes

Gate and IES Questions:

1. Mention few discharge measuring devices
2. Derive an expression for discharge in Venturimeter
3. Derive an expression for discharge in orifice meter Write down Euler's equation of motion.
4. Write down Bernoulli's equation of motion for ideal and real fluid

Graph:

Actual Discharge Versus Percentage of Error (Q_{act} in X-aixs & % of Error in Y-axis)

Result:

Thus, the Percentage of Error of rotameter is determined =

Assessment

<table>
<tr><th>Scale</th><th>Score</th><th>Remarks</th><td rowspan="10">Signature of the CI with Date</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Pre – laboratory Test

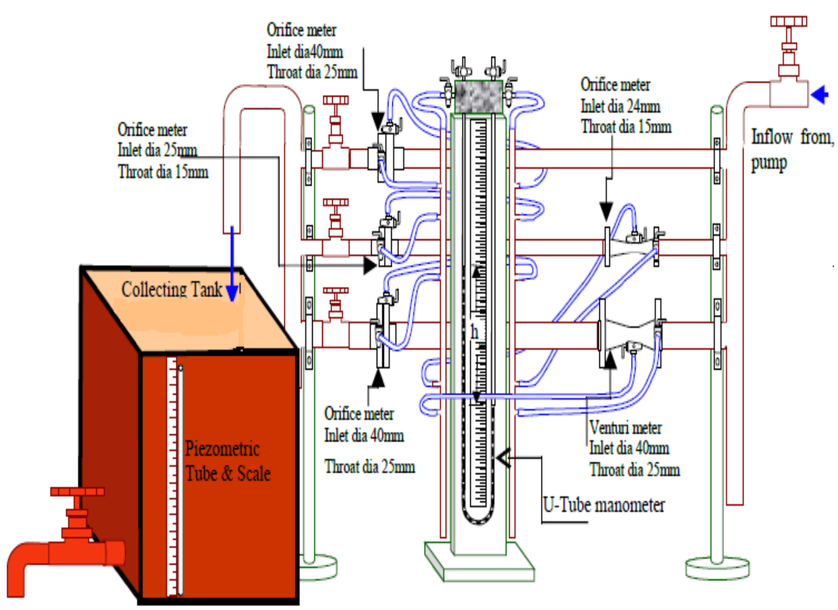
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Flow through Venturimeter
Purpose : To find the rate of flow of liquid

Application

- Venturies and Orifice plates are widely used in industries to measure the flow rate of gases and liquids. The working principle is simple and flow is measured using the differential pressure principle.
- The Venturi meter which has long been used in hydraulics is here applied to the measurement of volume flow of blood through vessels.

Questions

1. List the difference between orifice and venturimeter
2. What is the purpose of throat?
3. What is the purpose of manometer?
4. List few types of manometer
5. Define converging area part?
6. Define diverging part?



Orifice meters and Venturi meter setup

Flow through Venturimeter Exp.: 2

Aim:
To determine the coefficient of discharge of the Venturimeter for a given pipe size

Apparatus Required:

1. Venturimeter fitted with the pipeline
2. Collecting tank with piezometer.
3. Stopwatch
4. Meter scale/measuring tape

Formula:

Actual discharge (Q_a)

$Q_a = Ax/t$ m^3/s

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

x = rise if water level in collecting tank (m)

t = time for ‘x’ m rise (sec)

Head over the Venturimeter

$H = h(S_m - S_w/S_w)$ m

h = difference in manometer reading (h_1-h_2)

S_m = Specific gravity of mercury (13.6)

S_w = Specific gravity of water (1).

Theoretical discharge (Q_t)

$Q_t = a_1 a_2 \sqrt{(2gH)} / \sqrt{a_1^2 -- a_2^2}$ m^3/s

a_1 = area of the pipe (m^2) $a_1 = (\pi d_1^2/4)$

a_2 = area of throat in venturimeter (m^2) $a_2 = (\pi d_2^2/4)$

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

H = head over the venturimeter (m)

d_1 = diameter of the pipe (m)

d_2 = diameter of the throat = d_1 x diameter ratio (m)

Observation and Computation:

Diameter of inlet pipe (d_1) =
Diameter of throat (d_2) =
Area of collecting tank =

TABULATION FOR VENTURI METER

S.No	Manometer Readings				Drop in Pressure Head	Time for 10 cm rise	$\sqrt{H}$	Discharge		Coefficient of discharge
								Actual	Theoretical	
	(h_1) cm	(h_1) m	(h_2) cm	(h_2) m	H (m)	t (sec)	(m)	Q_a (m^3/s)	Q_t (m^3/s)	$Cd=Q_a/Q_t$
1.										
2.										
3.										
4.										
5.										
6.										

Graph:

Readings observed during the experiments were used in this graph.

Head ($\sqrt{H}$) in x axis Vs Actual discharge (Q_a) in y axis

Model calculation:

Procedure:

1. The diameter of the pipe and internal cross section area of collecting tank are noted down
2. Close all the cocks except manometer cocks.
3. Then open the corresponding cocks of a given pipe size.
4. Start the motor and adjust the gate valve at exit to maintain steady flow for desired head.
5. Note the manometer readings and note the time for ‘h’ cm rise of water level in collecting tank.
6. Repeat the above procedure for different manometer heads by adjusting the gate valve

Result:

The coefficient of discharge of the venturimeter for a given pipe size

1) From observation ---------

Gate and IES questions:

1. What is meant by calibration?
2. What is meant by coefficient of discharge?
3. What is the use of Venturimeter?
4. In a venturimeter, the divergent cone is kept
   a) Shorter than convergent cone **b)** equal to convergent cone **c)** longer than convergent cone **d)** none of these.

Assessment

<table>
<tr><th>Scale</th><th>Score</th><th>Remarks</th><td rowspan="10">Signature of the CI with Date</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Pre – laboratory Test

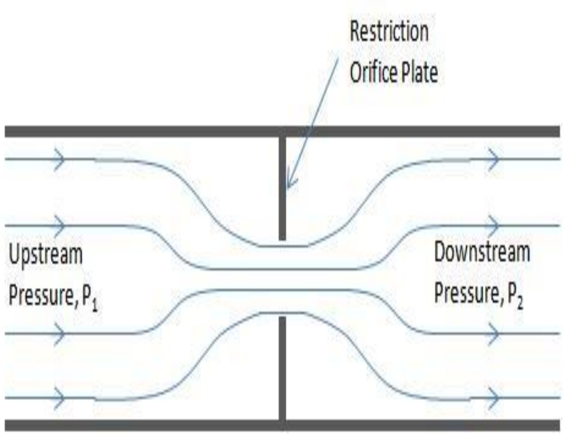
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Flow through Orifice meter
Purpose : To find the rate of flow of liquid

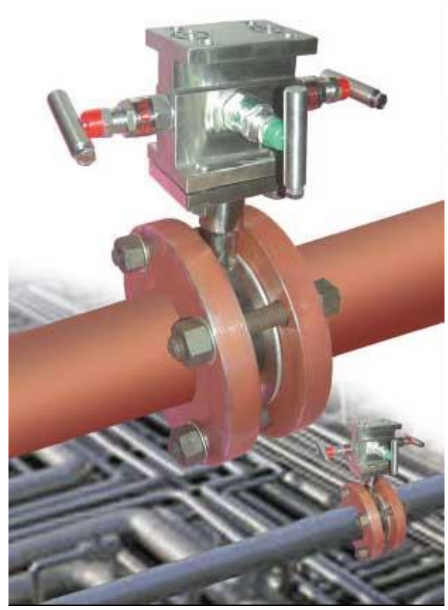
Application

- Venturies and Orifice plates are widely used in industries to measure the flow rate of gases and liquids. The working principle is simple and flow is measured using the differential pressure principle.
- Orifices generate a differential pressure which if integrated with time, can then be used to convert into any engineering parameter like flow rate, quantity, speed etc. and can be used in any industrial, automotive, aeronautical, and domestic or just about any field.

Questions

1. What is the purpose orifice meter is used? Define it?
2. Why is co-efficient of discharge of venturimeter is more than coefficient of discharge of orifice meter?
3. Orifice meter are used for flow measuring. How?
4. What is coefficient of discharge?





Flow through Orifice meter Exp.: 3

Aim:

To determine the coefficient of discharge of the orifice meter for a given pipe size.

Apparatus Required:

1. Orifice meter fitted with the pipeline
2. Collecting tank with piezometer.
3. Stopwatch
4. Meter scale/measuring tape

Formula:

Actual discharge (Q_a)

$$Q_a = Ax/t \quad m^3/s$$

A = Area of the collecting tank (m^2)
x = rise if water level in collecting tank (m)
t = time for 'x' m rise (sec)

Head over the orifice meter

$$H = h\,(S_m\text{-}S_w/S_w)\ m$$

h = difference in manometer reading (h_1-h_2)
S_m = Specific gravity of mercury (13.6)
S_w = Specific gravity of water (1).

Theoretical discharge (Q_t)

$$Q_t = a_1 a_2 \sqrt{(2gH)} \,/\, \sqrt{a_1^2 \text{--}\ a_2^2} \quad m^3/s$$

a_1 = area of the pipe (m^2) $a_1 = (\pi\ d_1^2/4)$
a_2 = area of throat in venturimeter (m^2) $a_2 = (\pi\ d_2^2/4)$
g = acceleration due to gravity (m/s^2)
H = head over the venturimeter (m)
d_1 = diameter of the pipe (m)
d_2 = diameter of the throat = d_1x diameter ratio (m)

Observation and computation:

Diameter of inlet pipe (d_1) =
Diameter of orifice meter =
Area of collecting tank =

TABULATION FOR ORIFICE METER

S.No	Manometer Readings				Drop in Pressure Head	Time for 10 cm rise	$\sqrt{H}$	Discharge		Coefficient of discharge
								Actual	Theoretical	
	(h_1) cm	(h_1) m	(h_2) cm	(h_2) m	H (m)	t (sec)	(m)	Q_a (m^3/s)	Q_t (m^3/s)	$Cd=Q_a/Q_t$
1.										
2.										
3.										
4.										
5.										
6.										

Graph:

Readings observed during the experiments were used in this graph.

Head ($\sqrt{H}$) in x axis Vs Actual discharge (Q_a) in y axis

Model Calculation:

Procedure:

1. The diameter of the pipe and internal cross section area of collecting tank are noted down
2. Close all the cocks except manometer cocks.
3. Then open the corresponding cocks of a given pipe size.
4. Start the motor and adjust the gate valve at exit to maintain steady flow for desired head.
5. Note the manometer readings and note the time for ‘h’ cm rise of water level in collecting tank.
6. Repeat the above procedure for different manometer heads by adjusting the gate valve

Result:

The coefficient of discharge of an orifice meter for a given pipe size

1) From observation ---------

Gate and IES Questions:

1. Orifice-meter is used to measure

   a) Discharge **b)** pressure at the point **c)** average speed **d)** velocity

2. Explain the concept of vena contracta.
3. How does C_d vary with diameter ratio?
4. What is the difference between a device and an instrument?
5. Explain the difference between the Orifice meter and Rotameter.
6. Explain the reason for Coefficient of discharge for the Orifice meter is very less compared with Venturimeter.
7. What are the effects on flow of liquid due to sudden contraction in a flow passage?

Assessment

Scale	**Score**	**Remarks**	
			Signature of the CI with Date

Pre – laboratory Test

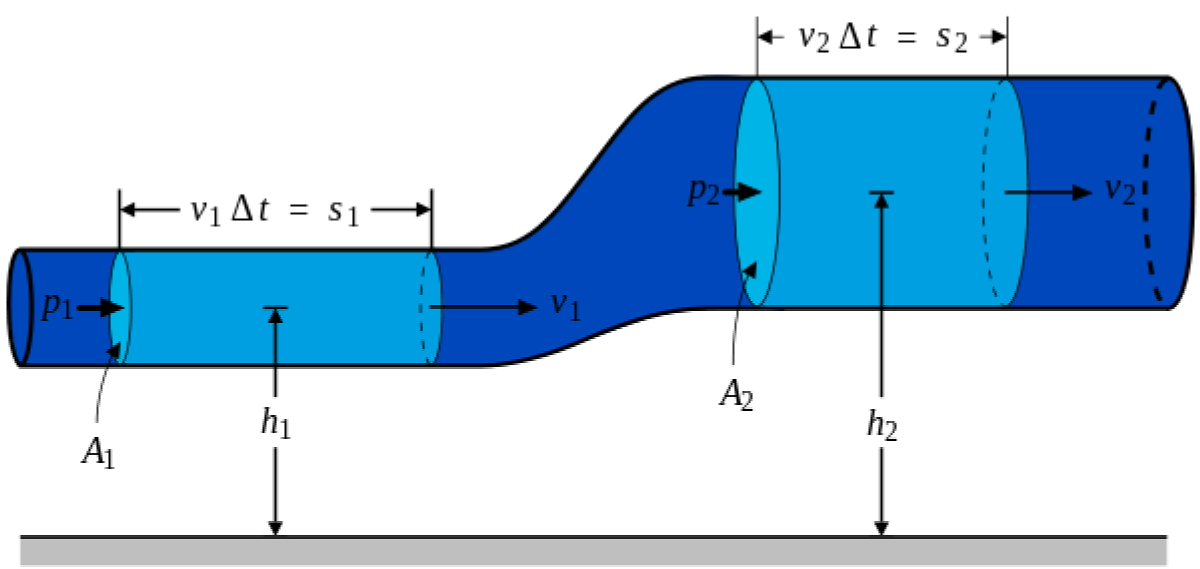
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Flow through variable duct area - Bernoulli's Experiment
Purpose : To find the rate of flow of liquid

Application

- Venturimeter , orifice meter , pilot tube
- Bernoulli's equation considers only pressure and gravitational force acting on the fluid particles.
- Bernoulli's equation can be applied when syphoning fluid between two reservoirs. Another useful application of the Bernoulli equation is in the derivation of Torricelli's law for flow out of a sharp edged hole in a reservoir
- One of the most common everyday applications of Bernoulli's principle is in air flight. The main way that Bernoulli's principle works in air flight has to do with the architecture of the wings of the plane.
- Bernoulli's principle is also the governing theory that is behind sailing.

Questions

1. State Bernoulli's theorem.
2. Write the limitation of Bernoulli's equation?
3. What is the relation between c_c, c_d & c_v?
4. State the potential head



Bernoulli's Experiment Exp.: 4

Aim:

To investigate the validity of Bernoulli's theorem as applied to the flow of water in a tapering circular duct.

Apparatus Required:

1. Bernoulli's set up
2. Stopwatch
3. Meter scale

Formula:

Considering flow at two sections in a pipe, Bernoulli's equation may be written as:

$$H_1 = Z_1 + p_1/w + V_1^2/2g$$

$$H_2 = Z_2 + p_2/w + V_2^2/2g$$

For this apparatus Z1 = Z2 = elevation (or) Datum head

p/w = Pressure head

$V^2/2g$ = Kinetic head

TABULATION FOR BERNOULLI'S EQUATION

S.No	Cross section area (m^2)	Time for H = 0.1 m rise	Discharge Q = Ax/t (m^3/sec)	Velocity V = Q/A (m/sec)	Velocity head $V^2/2g$	Piezometer reading pressure head in m	Total head $p/w + V^2/2g + Z$
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

Model calculation:

Procedure:

1. Priming is done first for venting air from the pipes.
2. Open the inlet slowly and allow the water to flow from the supply tank.
3. Under this condition the pressure head will become constant in the piezometer tubes
4. Note down the quantity of water collected in the measuring tank for a given interval of time
5. Compute the area of cross – section under the piezometer tube.
6. Compute the area of cross – section under the tube.
7. Change the inlet and outlet supply and note the reading.
8. Take at least three reading as described in the above steps.

Graph:

Readings observed during the experiments were used in this graph.

(i) Area (A) in x axis Vs Pressure Head in y axis

(ii) Area (A) in x axis Vs Velocity Head in y axis

Result:

The total head decreases gradually due to increase in various losses. The total head remains the same at all sections

Gate and IES Questions:

1. List out the limitations of Bernoulli Equation.
2. Why do you level the experiment section (tube)?
3. Draw graph for the positions of manometer Vs. EGL and HGL for three different flow rates.
4. Describe the different slope obtained in the graph.
5. What is dynamic pressure and static pressure?
6. Bernoulli's equation assumes that.

a) Fluid is non-viscous **b)** fluid is homogeneous **c)** flow is steady **d)** flow is along the stream line **e)** all the above.

Assessment

Scale	**Score**	**Remarks**	**Signature of the CI with Date**

Pre – laboratory Test

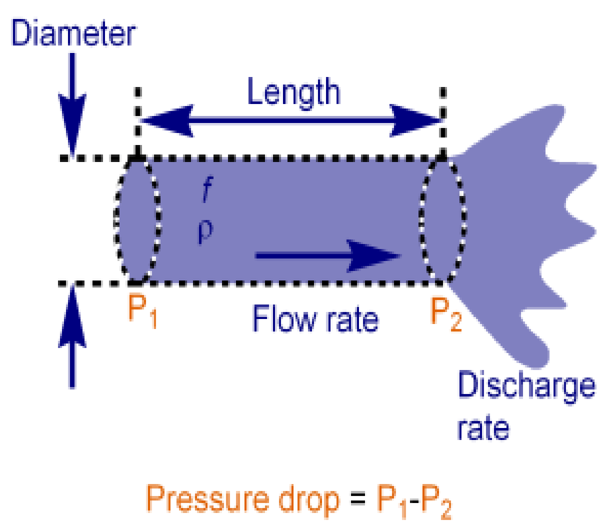
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : To determine the friction factor for a given pipe size
Purpose : To find the friction factor for a given pipe size

Application

- To define the kind of flow in liquid
- To measure the head loss in fluids
- To determine the velocity of liquid

Questions

1. Define the terms major energy loss and minor energy loss in pipe?
2. How will you determine the major energy loss by using (i) Darcy formula and (ii) Chezy's formula? And define head loss co-efficient
3. What is the other name for friction factor?
4. What is an equivalent pipe?
5. Under what conditions does a minor loss become a major loss?
6. Define major loss in pipe?



Determination friction coefficient in pipe Exp.: 5

Aim:

To determine the friction factor for a given pipe size

Apparatus Required:

1. Collecting tank with piezometer.
2. Stopwatch
3. Meter scale/measuring tape
4. Differential U-tube mercury manometer
5. Major loss set up

Formula:

Actual discharge (Q_a)

$Q_a = Ax/t \quad m^3/s$

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

x= rise if water level in collecting tank (m)

t = time for ‘x’ m rise (sec)

Head loss due to friction (h_f)

$h = h_1 - h_2$

h_1 & h_2 = Manometer reading (m)

Darcy’s friction factor (f)

$h_f = flv^2 / 2gd$

$f = h_f.2.g.d / l\, v^2$

$h_f = h\,(S_m - S_w/S_w)$ m

d = diameter of pipe (m)

l = length of the pipe (m)

v = velocity of the liquid (**$v = Q_a / a \quad m/s$**)

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

a = area of the pipe (m^2) $\quad a = (\pi\, d^2)/4$

Observation and Computation:

1. Length of the pipe =
2. Diameter of the pipe =
3. Area of collecting tank =

TABULATION FOR FINDING FRICTION FACTOR

S. No	Pipe dia	Manometer reading				Head loss h	Time for 10 cm rise of water	Q	Velocity V	V^2	Friction Factor 'f'
		h_1		h_2							
	(mm)	(cm)	(m)	(cm)	(m)	(m)	(t) sec	(m^3/s)	(m/s)	(m/s)	
1	25										
2	25										
3	25										

S. No	Pipe dia	Manometer reading				Head loss h	Time for 15 cm rise of water	Q	Velocity V	V^2	Friction Factor 'f'
		h_1		h_2							
	(mm)	(cm)	(m)	(cm)	(m)	(m)	(t) sec	(m^3/s)	(m/s)	(m/s)	
1	15										
2	15										
3	15										

Graph:

Readings observed during the experiments were used in this graph.

1. Head loss (H) Vs Velocity of flow in m/s (V)

Model calculation:

Procedure:

1. The diameter of the pipe and internal cross section area of collecting tank are noted down.
2. Close all the cocks except manometer cocks.
3. Then open the corresponding cocks of a given pipe size.
4. Start the motor and adjust the gate valve at exit to maintain steady flow for desired head.
5. Note the manometer readings and note the time for 'h' cm rise of water level in collecting tank.
6. Repeat the above procedure for different manometer heads by adjusting the gate valve.

Inference:

Head loss due to friction is increased when diameter of pipe is decreased.

The friction factor almost remains constant for varying Reynolds number in a pipeline.

Result:

Friction factor for a given pipe size-------------

Gate and IES questions:

1. Define water hammer in Pipes
2. If H_g is the gross or total head and h_f is the head lost due to friction, then net or effective head (H) is given by
$H = H_g/h_f$ **b)** $H = H_g \times h_f$ **c)** $H = H_g + h_f$ **d)** $H = H_g - h_f$
3. Manning's formula is used for
a) Flow in open channels **b)** head loss due to friction in open channels **c)** head loss due to friction in pipes flowing full **d)** flow in pipes.
4. An ideal fluid is
a)Incompressible **b)** compressible **c)** compressible and non-viscous **d)** slightly affected by surface torque.
5. In an inclined pipe, the pressure difference at its two ends is due to
a) Sudden head drop at inlet **b)** exit head drop **c)** frictional loss head **d)** elevation head
6. The dimensionless parameter not applicable to flowing liquids, is
a) Reynold number **b)** Weber number **c)** Pressure coefficient **d)** Kinematic viscosity
e) Friction factor.

Assessment

Scale	**Score**	**Remarks**	
			Signature of the CI with Date

Pre – laboratory Test

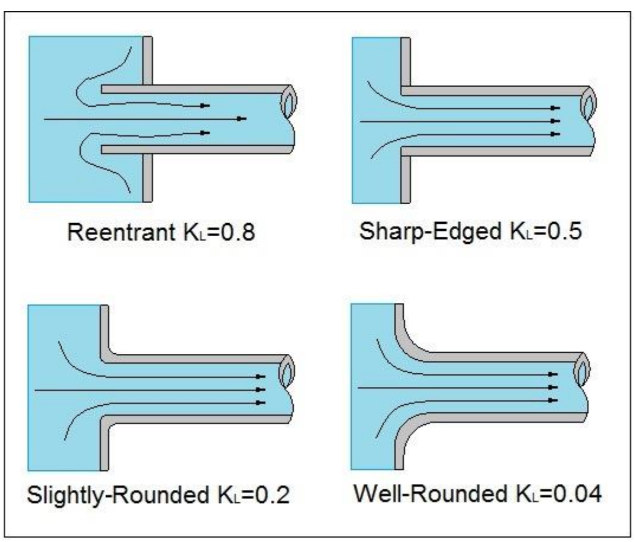
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Determination of loss coefficients for pipe fittings
Purpose : To find loss coefficients for pipe fittings

Application

- To measure the head loss in fluids
- To determine the velocity of liquid

Questions

1. Define hydraulic gradient and total energy lines?
2. Define eddy loss?
3. Define sudden contraction?
4. Define sudden enlargement?



Determination of loss coefficients for pipe fittings Exp.: 6

Aim:

To determine the value of the loss-coefficient (K_L) by conducting the test in the pipe fittings for a given pipe size.

Apparatus Required:

1. Collecting tank with piezometer
2. Stop watch.
3. Measuring tape/meter scale.
4. U-tube manometer.

Formula:

Actual discharge (Q_a)

$$Q_a = Ax/t \quad m^3/s$$

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

x = rise if water level in collecting tank (m)

t = time for ‘x’ cm rise (sec)

Head loss due to bend (h)

$$h = k_L v^2 / 2g$$

$$k_L = (2g. h) / v^2$$

h = Head loss (m)

g = Acceleration due to gravity (m^3 / s)

Loss coefficient for contraction (k_L)

$$h = k_L v_1^2/2g$$

$$k_L = (2g. h)/v_1^2$$

V_1 = velocity of water in smaller pipe ($v_1 = Q_a/a_1$)

h = Head loss (m)

a_1 = area of the smaller pipe ($a_1 = (\pi d_1^2/4)$)

g = Acceleration due to gravity (m^3 / s)

Loss coefficient for expansion (k_E)

$$\mathbf{h = k_L(v_1-v_2)^2/2g}$$

$$\mathbf{k_L = hg/(v_1-v_2)^2}$$

K_L = Loss coefficient

V_1 = velocity of water in smaller pipe ($v_1 = Q_a/a_1$)

v_2 = velocity of water in bigger pipe ($v_2 = Q_a/a_2$)

a_2 = area of bigger pipe (m^2) $a_2 = (\pi\, d_2^2/4)$

d_1 & d_2 diameter of smaller & bigger pipes.

Observation and computation:

Diameter of the smaller pipe (d_1) =

Diameter of the bigger pipe (d_2) =

Area of collecting tank (A) =

TABULATION FOR MINOR LOSSES

S.No	Type of loss	Pipe dia	Manometer Reading				$H_f = h\ (S_m - f_w) / S_w$	Time 10cm rise of Water	Discharge Q	Velocity		Velocity head $(V_1 - V_2)^2 / 2g$	Loss Coefficient K_L
			h_1	h_1	h_2	h_2				V_1	V_2		
		mm	cm	m	cm	m	m	(t) (sec)	(m^3/s)	(m/s)	(m/s)	m	
1	Expansion												
2													
3													

S.No	Type of loss	Pipe dia	Manometer Reading				Time 10 cm rise of Water	Discharge Q	Velocity		Velocity head ($0.5V_2^2$)/ 2g	Loss Coefficient K_L
			h_1	h_1	h_2	h_2			V_1	V_2		
		mm	cm	m	cm	m	(t) (sec)	(m^3/s)	(m/s)	(m/s)	m	
1	Contraction											
2												
3												

S.No	Type of loss	Pipe dia	Manometer Reading				Time 10 cm rise of Water	Discharge Q	Velocity	Velocity head (V $)^2$ / 2g	Loss Coefficient K_L
			h_1	h_1	h_2	h_2			V		
		mm	cm	m	cm	m	(t) (sec)	(m^3/s)	(m/s)	m	
1	Bend										
2											
3											

Model calculation:

Procedure:

1. The diameter of the pipe and internal cross section area of collecting tank are noted down
2. Close all the cocks except manometer cocks.
3. Then open the corresponding cocks of a given pipe size.
4. Start the motor and adjust the gate valve at exit to maintain steady flow for desired head.
5. Note the manometer readings and note the time for ‘h’ cm rise of water level in collecting tank.
6. Repeat the above procedure for different manometer heads by adjusting the gate valve.

Graph:

Readings observed during the experiments were used in this graph.

1. Discharge (Q) in X-Axis Vs Head loss (H_f) in Y-Axis in Expansion
2. Discharge (Q) in X-Axis Vs Velocity (v) in Y-Axis in Contraction
3. Discharge (Q) in X-Axis Vs Velocity (v) in Y-Axis in Bend

Inference:

Head loss due to friction is increased when diameter of pipe is decreased.
The friction factor almost remains constant for varying Reynolds number in a pipeline.

Result:

The value of ‘K’ for a given pipe size
1. Bend =
2. Contraction =
3. Expansion =

Gate and IES questions:

1. If velocities of fluid particles vary from point to point in magnitude and direction, as well as from instant to instant, the flow is said to be
   a)Laminar **b)** turbulent flow **c)** uniform flow **d)** non-uniform flow.
2. To measure very low pressure, we use
   a)Barometers **b)** Piezometers **c)**Manometers **d)** differential manometers.
3. Chezy's formula is used to determine
   a) Head loss due to friction in pipe **b)** velocity of flow in pipe **c)** velocity of flow in open channels **d)** none of these
4. Frictional loss of head includes the loss of energy due to
   a)Viscosity **b)**Turbulence **c)**both (a) and (b) **d)**none of these
5. Pick up the correct statement regarding convergent divergent mouth piece from the following:
   a)It converges upto Venacontracta and then diverges
   b) In this mouth piece there is no loss of energy due to sudden enlargement
   c) The coefficient of discharge is unity
   d) All the above.

Assessment

Scale	Score	Remarks	Signature of the CI with Date

Pre – laboratory Test

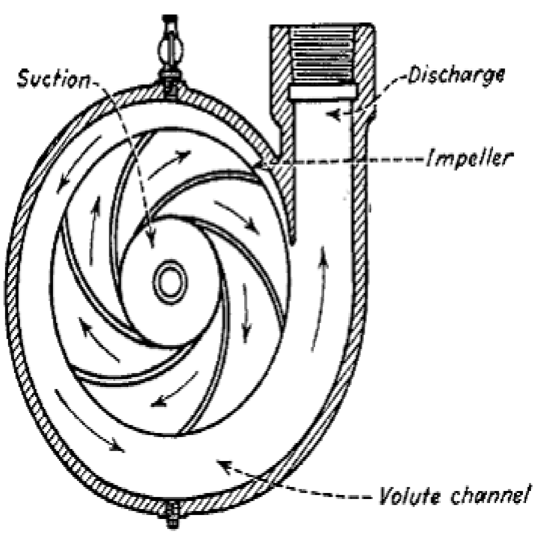
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Characteristics of single stage Centrifugal pumps
Purpose : To find the discharge of the pump

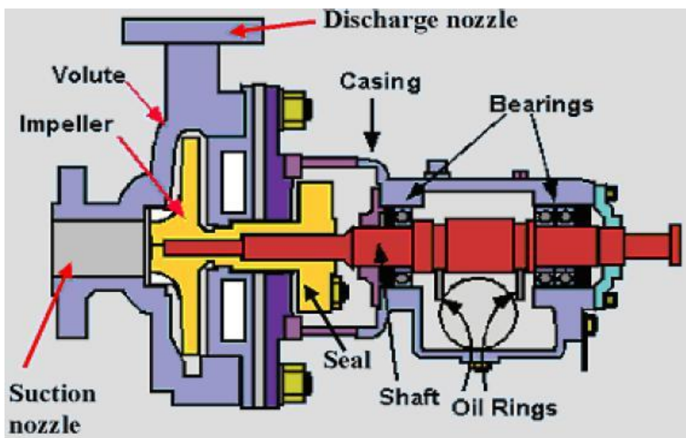
Application

- Building Services - pressure boosting, heating installations, fire protection sprinkler systems, drainage, air conditioning
- Industry and Water engineering - boiler feed applications, water supply (municipal, industrial), wastewater management and irrigation, sprinkling, drainage and flood protection
- The Chemical and Process Industries - paints, chemicals, hydrocarbons, pharmaceuticals, cellulose, petro-chemicals, sugar refining, food and beverage production
- Secondary systems - coolant recirculation, condensate transport, cryogenics, refrigerants

Questions

1. List out the various components of a centrifugal pump.
2. What is the role of a volute chamber of a centrifugal pump?
3. List the types of impeller and casings for a centrifugal pump.
4. What is meant by priming of pumps?
5. Define Manometric heads
6. What is the maximum theoretical suction head possible for a centrifugal pump?





Centrifugal Pump

Characteristics of Centrifugal pump-Single stage Exp.: 7

Aim:

To conduct the performance test on the given Single stage centrifugal pump and determine the efficiency and to draw the characteristic curves.

Apparatus Required:

1. Vacuum gauge for measuring the suction pressure.
2. Pressure gauge for measuring the delivery pressure.
3. Energy meter for measuring input power.
4. Collecting tank of known cross section with piezometer and stop watch to measure the flow rate.
5. Measuring tape or scale to find the difference in height of pressure and vacuum gauges.
6. Single stage centrifugal pump set up.

Formula:

1. Discharge (Q)

$Q = Ax/t$ - m^3/s

A = internal cross sectional area of collecting tank (m^2)

x = rise of water level in collecting tank (m)

t = time taken for x-m rise. (Sec)

2. Total head (H)

$H = H_s + H_d + X$

H_s = vacuum (suction) head

H_d = pressure (delivery) head

X = difference in level of pressure & vacuum gauges.

Pressure gauge reading = P x 9.81 m of water

Vacuum gauge reading = V x (13.6/1000) m of water

3. Output Power (P_o)

P_o = WQH X 1000

W-specific weight of water (kN/m^2)

Q-discharge of water (m^3/s)

H-total head (m)

4. Input Power (P_i)

P_i = (3600 x N x 1000) / (Ec x T)

N_r = No. of revolutions in energy meter disc

T = time taken for N revolution (sec)

Ec = energy meter constant (revolution/ Kw hr)

5. Efficiency (η)

$\eta = Po/P_i$ X 100

P_o = Power output (w)

P_i = Power input (w)

Observation and computation:

Energy meter constant (Ec) =
Difference in level of pressure
& vacuum gauges (X) =
Area of collecting tank =
Efficiency of motor (η_m) =

TABULATION FOR SINGLE STAGE CENTRIFUGAL PUMP

S.No	Suction head 'H_s' (V)		Delivery head 'H_d' (P)		Time(t) for 10 Cm rise of water (Sec)	Total Head $H = H_s + H_d + x$	Time for N = 5 (S) Revolution of energy meter disc	Discharge Q m^3/s	Output power P_o (w)	Input Power P_i (w)	Efficiency $\eta = P_o/P_i$
	Vacuum gauge 'mm' as Hg	(m) water	Pressure gauge (Kg/cm^2)	(m) of water							
1											
2											
3											
4											
5											
6											

Model calculation:

Procedure:

1. Prime the pump if necessary.
2. Keep the delivery valve in close condition.
3. Start the motor and adjust the gate valve to required pressure.
4. Note the following reading.
    - pressure gauge reading (H_s)-kg/cm^2
    - Vacuum gauge reading (H_c) -mm of Hg.
    - Time for x-m rise of water level in collecting tank-t sec.
    - Time of N revolution in energy meter T-sec.
    - Difference in level between pressure & vacuum gauges.

The above procedure is repeated for different delivery valve openings and tabulated the readings.

Graph:

Taking speed (N) in x-axis and Efficiency (η), Input power (Pi) & Discharge (Q) in y-axis

1. Discharge (Q) Vs. Efficiency (η)
2. Discharge (Q) Vs. Input power (P_i)
3. Discharge (Q) Vs. Total head (H)

Result:

Thus the performance test on single stage centrifugal pump is conducted and characteristic curves are plotted.

Maximum efficiency (η_m) =

Discharge (Q) =

Total Head (H) =

Input power (P_i) =

Gate and IES questions:

1. Power required to drive a centrifugal pump is directly proportional to ___________ of its impeller.
   a) Diameter **b)** square of diameter **c)** cube of diameter **d)** fourth power of diameter
2. Discharge of a centrifugal pump is
   a) Directly proportional to diameter of its impeller
   b) Inversely proportional to diameter of its impeller
   c) Directly proportional to (diameter) 2 of its impeller
   d) Inversely proportional to (diameter) 2 of its impeller
3. The static head of a centrifugal pump is equal to the ___________ of suction head and delivery head.
   a) Product **b)** difference c**)** sum

Assessment

Scale	**Score**	**Remarks**	
			Signature of the CI with Date

Pre – laboratory Test

Name of the Laboratory	: Fluid Mechanics and Machinery Laboratory
Name of the Experiment	: Characteristics of Multi stage Centrifugal pumps
Purpose	: To find the discharge of the pump

Application

- Building Services - pressure boosting, heating installations, fire protection sprinkler systems, drainage, air conditioning
- Industry and Water engineering - boiler feed applications, water supply (municipal, industrial), wastewater management and irrigation, sprinkling, drainage and flood protection
- The Chemical and Process Industries - paints, chemicals, hydrocarbons, pharmaceuticals, cellulose, petro-chemicals, sugar refining, food and beverage production
- Secondary systems - coolant recirculation, condensate transport, cryogenics, refrigerants

Questions

1. List out the various components of a centrifugal pump.
2. What is the role of a volute chamber of a centrifugal pump?
3. List the types of impeller and casings for a centrifugal pump.
4. What is meant by priming of pumps?
5. Define Manometric heads
6. What is the maximum theoretical suction head possible for a centrifugal pump?

Characteristics of Centrifugal pump-Multi Stage Exp.: 8

Aim:

To conduct the performance test of the given multistage centrifugal pump and to determine the efficiency and to draw characteristic curves.

Apparatus Required:

1. Vacuum gauge for measuring the suction pressure.
2. Pressure gauge for measuring the delivery pressure.
3. Multistage centrifugal pump.
4. Collecting tank of known cross section with piezometer and stop watch to measure the flow rate. Measuring tape or scale to find the difference in level of pressure and vaccum gauges.
5. Energy meter

Formula:

1. Discharge (Q)

Q= Ax/t - m^3/s

A = internal cross sectional area of collecting tank (m^2)

x = rise of water level in collecting tank (m)

t = time taken for x-m rise. (Sec)

2. Total head (H)

$H = H_s + H_d + X$

H_s = vacuum (suction) head

H_d = pressure (delivery) head

X = difference in level of pressure & vacuum gauges.

Pressure gauge reading = P x 9.81 m of water

Vacuum gauge reading = V x (13.6/1000) m of water

3. Output Power (P_o)

P_o = WQH X 1000

W-specific weight of water (kN/m^2)

Q-discharge of water (m^3/s)

H-total head (m)

4. Input Power (P_i)

P_i = (3600 x N x 1000) / (Ec x T)

N_r = No. of revolutions in energy meter disc

T = time taken for N revolution (sec)

Ec = energy meter constant (revolution/ Kw hr)

5. Efficiency (η)

η = Po/P_i X 100

P_o = Power output (w)

P_i = Power input (w)

Observation and computation:

Energy meter constant (Ec) =
Difference in level of pressure
& vacuum gauges (X) =
Area of collecting tank =

TABULATION FOR MULTI STAGE CENTRIFUGAL PUMP

S.No	Vacuum gauge reading		Pressure head			Total Head H (m)	Time for N=2 revolution of energy disc (T) sec	Time(t) for 10 cm rise of water	Discharge Q m^3/s	Output power P_o (Kw)	Input Power P_i (Kw)	Efficiency $\eta = P_o/P_i$
	mm of Hg	m of water	P1	P2	m of water							
1												
2												
3												
4												
5												
6												

Model calculation:

Procedure:

1. Prime the pump if necessary.
2. Keep the delivery valve in close condition.
3. Start the motor and adjust the gate valve to required pressure.
4. Note the following reading.
    - pressure gauge reading (H_s)-kg/cm^2
    - Vacuum gauge reading (H_c) -mm of Hg.
    - Time for x-m rise of water level in collecting tank-t sec.
    - Time of N revolution in energy meter T-sec.
    - Difference in level between pressure & vacuum gauges.

The above procedure is repeated for different delivery valve openings and tabulated the readings.

Graph:

Taking speed (N) in x-axis and Efficiency (η), Input power (Pi) & Discharge (Q) in y-axis
1. Discharge (Q) Vs. Efficiency (η)
2. Discharge (Q) Vs. Input power (P_i)
3. Discharge (Q) Vs. Total head (H)

Result:

Thus the performance test on multi stage centrifugal pump is conducted and characteristic curves are plotted.

Maximum efficiency (η_m)	=
Discharge (Q)	=
Total Head (H)	=
Input power (P_i)	=

Gate and IES questions:

1. Power required to drive a centrifugal pump is directly proportional to ___________ of its impeller.
   a) Diameter **b)** square of diameter **c)** cube of diameter **d)** fourth power of diameter
2. Discharge of a centrifugal pump is
   a) Directly proportional to diameter of its impeller
   b) Inversely proportional to diameter of its impeller
   c) Directly proportional to (diameter) 2 of its impeller
   d) Inversely proportional to (diameter) 2 of its impeller
3. The static head of a centrifugal pump is equal to the ___________ of suction head and delivery head.
   a) Product **b)** difference c**)** sum

Assessment

Scale	Score	Remarks	
			Signature of the CI with Date

Pre – laboratory Test

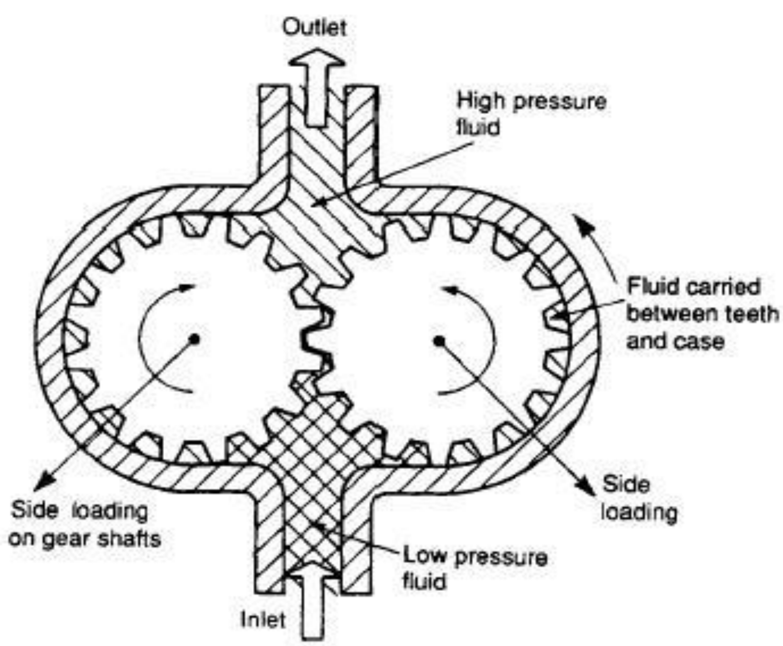
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Characteristics of Gear pump
Purpose : To find the rate of flow of liquid

Application

- Various fuel oils and lube oils
- Chemical additive and polymer metering
- Chemical mixing and blending (double pump)
- Industrial and mobile hydraulic applications (log splitters, lifts, etc.)
- Acids and caustic (stainless steel or composite construction)
- Low volume transfer or application

Questions

1. What is meant by pump?
2. What is meant by priming of pumps?
3. What are the advantages and disadvantages of gear pump?
4. What are the parameters of gear pump?



Characteristics of Gear pump Exp.: 9

Aim:

To study the construction details of gear pump and draw its characteristic curve.

Apparatus Required:

1. Meter scale
2. Stop watch
3. Gear oil pump
4. Driving unit
5. Piezometer
6. Energy meter
7. Pressure gauge
8. Vacuum gauge

Formula:

1. **Discharge (Q)**

Area of collecting tank = L * B in m^2

Discharge (Q) = Volume / Time (m^3/sec)

= Ax/t

Where,

t = Time taken for 10 cm rise of water in seconds

x = Rising head in m of water

2. **Input power**

Input power = Nx3600x1000 / T x E_c

Where,

N = Number of revolutions of energy meter disc

T = Time taken for 'N' revolutions

η_m = Efficiency of motor

E_c= Energy meter constant

3. **Output power**

Output power = wQH (Watts)

Where,

w = specific weight of water in N/m^3

4. **Total head**

Vacuum gauge reading = v X 13.6 /1000 m of water

5. **Efficiency**

η= Po/P_i X 100

Observation and Computation:

Energy meter constant E_c = 750 rev / Kw hr

Difference in level between the centers of vacuum and pressure gauges x =

Internal plan dimensions of collecting tank length l = , breadth b =

TABULATION FOR GEAR PUMP

S.No	Suction head Hs		Delivery head H_d		Total head $h=H_s+H_d+x$	Time for N revolution of energy meter disc	Discharge Q (m^3/s)	Power input P_o (kw)	Power output Pi (kw)	Efficiency $\eta = P_o/P_i$
	vacuum gauge reading (mm of Hg)	V x 10^{-3} x 13.6 / (780) in m	Pressure gauge reading (mm of Hg)	m of water						
1										
2										
3										
4										
5										
6										

Model calculation:

Procedure:

1. The supply tank is filled with oil to required height
2. The delivery valve is opened fully
3. By regulating the delivery valve, the discharge and delivery head are varied.
4. For each positions of delivery valve the following observations are made :
    - vacuum gauge reading
    - Pressure gauge reading
    - Time taken for N revolutions of energy meter disc
    - Time taken for a particular rise (h) of water level in collecting tank, keeping the outlet valve completely closed
5. The above observations for different delivery valve opening are calculated.

Result:

The characteristic curves are drawn and best driving conditions are determined

Efficiency η =

Discharge Q =

Total head (H) =

Input power P =

Gate and IES Questions:

1. Define working of rotary pump.
2. Which type of pump is mostly used in cooling water?

Assessment

Scale	Score	Remarks	
			Signature of the CI with Date

Pre – laboratory Test

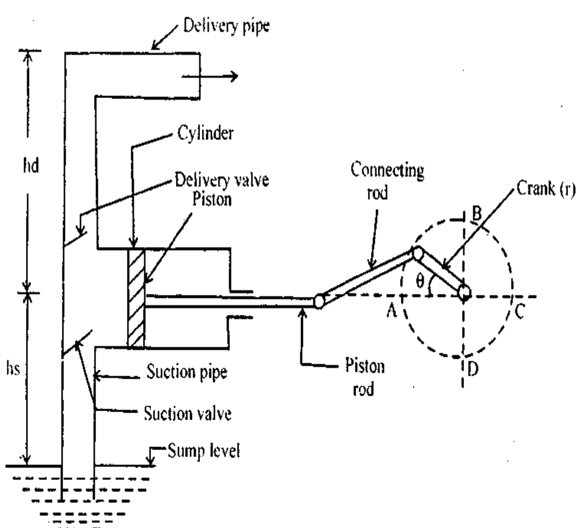
Name of the Laboratory	: Fluid Mechanics and Machinery Laboratory
Name of the Experiment	: Characteristics of Reciprocating pump
Purpose	: To find discharge of Reciprocating pump

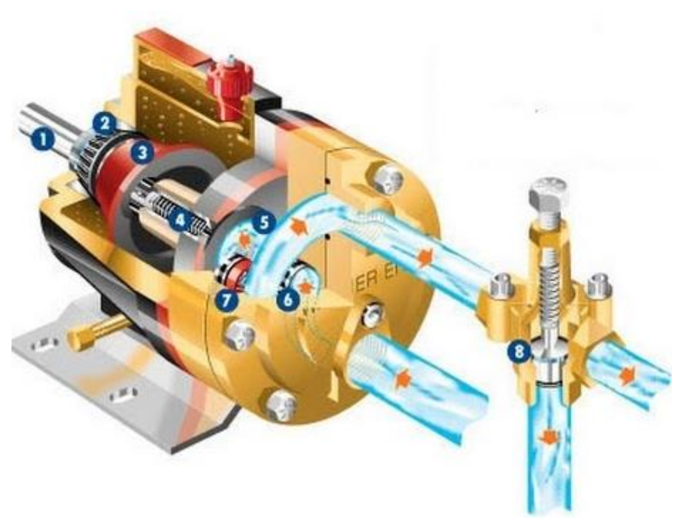
Application

- Oil and gas industries
- Power plants
- Petrochemicals and refineries
- Sugar industries
- Soap and detergent industries
- Food and beverage
- Water treatment plants

Questions

1. Mention the main components of reciprocating pump
2. Distinguish between centrifugal pump and reciprocating pump.
3. Define the “slip” of reciprocating pump. When does the negative slip occur?
4. What is an air vessel? States its functions.
5. What are the advantages of fitting an air-vessel in reciprocating pump?
6. When will select the reciprocating pump?
7. Give an example of rotary pumps?





Characteristics of Reciprocating pump — Exp.: 10

Aim:

To determine the efficiency of the reciprocating pump.

Apparatus Required:

1. Vacuum gauge for measuring the suction pressure.
2. Pressure gauge for measuring the delivery pressure.
3. Single phase energy meter for measuring input power.
4. Collecting tank of known cross section with piezometer and stop watch to measure the flow rate.
5. Measuring tape or scale to find the difference in height of pressure and vacuum gauges.
6. Reciprocating pump.

Formula:

1. Discharge (Q)

Q= Ax/t - m^3/s

A = internal cross sectional area of collecting tank (m^2)

x= rise of water level in collecting tank (m)

t = time taken for x-m rise. (Sec)

2. Total head (H)

$H = H_s + H_d + X$

H_s = vacuum (suction) head

H_d = pressure (delivery) head

X = difference in level of pressure & vacuum gauges.

Pressure gauge reading = P x 9.81 m of water

Vacuum gauge reading = V x (13.6/1000) m of water

3. Output Power (P_o)

P_o = WQH X 1000

W = specific weight of water (kN/m^2)

Q = discharge of water (m^3/s)

H = total head

4. Power Input (P_i)

$P_i = (3600 \times N \times 1000 \times \eta_m) / (Ec \times T)$

N_r = No.of revolutions in energy meter disc.

T = time taken for N revolution (sec)

Ec = energy meter constant (revolution/ Kwhr)

5. Efficiency (η)

$\eta = Po/P_i \times 100$

P_o-Power output (w)

P_i- Power input (w)

Observation and Computation:

Difference in level of pressure
& vacuum gauges (X) =
Area of collecting tank =
Efficiency of motor (η_m) =
Number of revolution in energy meter =

TABULATION FOR RECIPROCATING PUMP

S.No	Suction head 'H_s' (V)		Delivery head 'H_d' (P)		Time(t) for 'x' m rise of water (Sec)	Total Head $H = H_s + H_d + x$	Time for N = 5 (S) Revolution of energy meter disc	Discharge Q m^3/s	Output power P_o (w)	Input Power P_i (w)	Efficiency $\eta = P_o/P_i$
	Vacuum gauge 'mm' as Hg	water	Pressure gauge (kg/cm^2)	water							
1											
2											
3											
4											
5											

Model calculation:

Procedure:

1. Prime the pump if necessary.
2. Keep the delivery valve in open condition.
3. Start the motor and adjust the gate valve to required pressure.
4. Note the following reading.
    - pressure gauge reading P-kg/cm^2
    - Vacuum gauge reading V-mm of Hg.
    - Time for h-m rise of water level in collecting tank-t sec.
    - Time of N_r revolution in energy meter T-sec.
    - Difference in level between pressure & vacuum gauges.

Take minimum 6 set of readings by varying the head from 0 to 3 kg/cm^2
The above procedure is repeated for different delivery valve openings and tabulated the readings.

Graph:

Taking total head (H) in x-axis and Efficiency (η), Input power (Pi) & Discharge (Q) in y-axis
1. Total Head vs. Efficiency
2. Total Head vs. Input power
3. Total Head vs. Discharge.

Result:

Thus the performance test on a double acting reciprocating pump is conducted and characteristic curves are plotted.

Maximum efficiency (η_{max}) =
Discharge (Q) =
Total Head (H) =
Input power (P_i) =

Gate and IES Questions:

1. Mention few discharge measuring devices
2. Which of the following pump is preferred for flood control and irrigation applications?
   a) Centrifugal pump **b)** Axial flow pump **c)** Mixed flow pump **d)** Reciprocating pump
3. Slip of a reciprocating pump is defined as the
   a) ratio of actual discharge to the theoretical discharge
   b) sum of actual discharge and the theoretical discharge
   c) difference of theoretical discharge and the actual discharge
   d) product of theoretical discharge and the actual discharge

Assessment

Scale	Score	Remarks	
			Signature of the CI with Date

Pre – laboratory Test

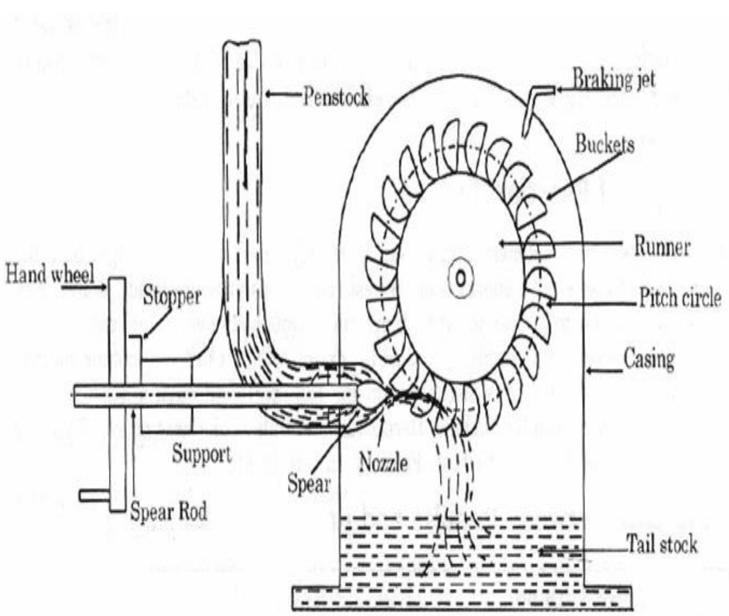
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Characteristics of Pelton wheel turbine
Purpose : To study the characteristics of Pelton wheel turbine.

Application

- Pelton wheels are the preferred turbine for hydro-power, when the available water source has relatively high hydraulic head at low flow rates, where the Pelton wheel is most efficient.

Questions

1. What do you mean by turbine?
2. What is meant by wetted perimeter?
3. Define cavitations.
4. Explain impulse turbine.
5. Write the function of draft tube in turbine outlet.
6. Define the specific speed of turbine



Characteristics of Pelton wheel turbine — Exp.: 11

Aim:

To study the characteristics of Pelton wheel turbine

Apparatus Required:

1. Vacuum gauge for measuring the suction pressure.
2. Pressure gauge for measuring the delivery pressure.
3. Single phase energy meter for measuring input power.
4. Collecting tank of known cross section with piezometer and stop watch to measure the flow rate.
5. Measuring tape or scale to find the difference in height of pressure and vacuum gauges.
6. Reciprocating pump.

Formula:

1) Discharge. (Q)

$$Q = 0.0055\sqrt{h}$$

h = Venturimeter head

2) Input Power (Pi)

$$P_i = 9.81 \times Q \times H \quad (Kw)$$

Q = Discharge (m^3/s)

H = Total head

3) Output power (P_o)

$$P_o = \pi DNT / (102 \times 60)$$

Where $T = (T_1 - T_2) + T_0$

T_1= Load applied in kg

T_2= Spring Balance weight in kg

T_0= Hanger weight in kg

N= Speed of turbine in rpm

D = Equivalent drum diameter in m

D = (d_1+d_2) m

d_1= break drum diameter in m

d_2= Rope Diameter in m

4) Efficiency (η)

$$\eta = P_o/P_i \times 100$$

P_o-Power output (w)

P_i- Power input (w)

Observation and Computation:

Brake drum diameter (D) =
Radius of drum (R_e) =
Diameter of rope (t) =
Weight of rope of hanger =

TABULATION FOR PELTON WHEEL TURBINE

S.No	Pressure gauge reading P		Manometer readings		Venturimeter head h	Flow rate Q	Wt. On Hanger T_1	Spring Balance weight T_2	Net weight T	Speed N	Output power P_o	Input Power P_i	Efficiency $\eta = P_o/P_i$
	kg/cm^2	m of water	V_1	V_2	m	m^3/s	kg	kg	kg	rpm	(Kw)	(Kw)	
1													
2													
3													
4													
5													
6													

Model calculation:

Procedure:

1. Keep the nozzle opening at required opening
2. Prime the pump if necessary.
3. Close the sluice and start the pump.
4. The start button should be kept pressed for 5-10 seconds and then released.
5. Open the delivery valve for required pressure.
6. Load the turbine by adding the weight to the hanger.
7. Note the load on the hanger, spring balance load, venturimeter pressure gauge reading, speed & inlet pressure gauge reading.
8. Repeat the experiment for various loads.

Graph:

Taking total head (H) in x-axis and Efficiency (η), Input power (Pi) & Discharge (Q) in y-axis
1. Total Head vs. Efficiency
2. Total Head vs. Input power
3. Total Head vs. Discharge.

Result:

Maximum efficiency =
Speed =
Discharge =
Input power =
Output power =

Gate and IES Questions:

1. The efficiency of a Pelton wheel working under constant head ___________ with the increase in power.
   a) Remains same **b)** increases **c)** decreases
2. Which of the following turbine is preferred for 0 to 25 m head of water?
   a) Pelton wheel **b)** Kaplan turbine **c)** Francis turbine **d)** none of these
3. Work done by a turbine ___________ upon the weight of water flowing per second.
   a) Depends **b)** does not depend

Assessment

Scale	**Score**	**Remarks**	
			Signature of the CI with Date

Pre – laboratory Test

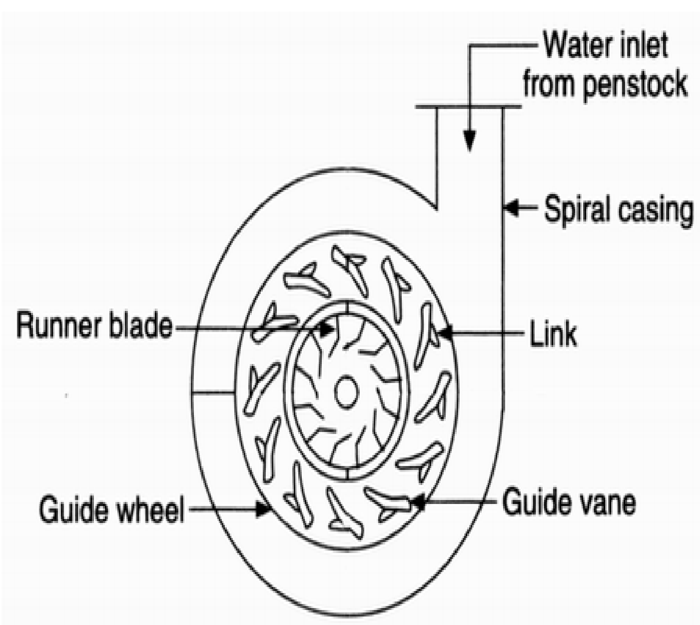
Name of the Laboratory : Fluid Mechanics and Machinery Laboratory
Name of the Experiment : Characteristics of Francis turbine
Purpose : To study the characteristics of Francis turbine.

Application

- Francis turbines may be designed for a wide range of heads and flows. This, along with their high efficiency, has made them the most widely used turbine in the world.
- In addition to electrical production, they may also be used for pumped storage

Questions

What is the other name for Francis Turbine?
1. Classify turbines according to flow.
2. Explain about characteristic curves of a hydraulic turbine.
3. What is specific speed of the turbine?
4. What are the types of characteristic curves?
5. What are the classification of turbine and give some suitable examples?
6. Give an example for a low head turbine, a medium head turbine and a high head turbine.
What are reaction turbines? Give examples



Characteristics of Francis turbine — Exp.: 12

Aim:

To study the characteristics of Francis turbine

Apparatus Required:

1. Francis turbine coupled with mechanical break drum.
2. Venturimeter fitted with pressure gauge in a pipeline for measuring flow rate.
3. Rope brake dynamometer
4. Spring balance
5. Weights
6. Orifice meter

Formula:

1) Discharge. (Q)

$$Q = 0.0131 \sqrt{h}$$

h = venturimeter head

2) Input Power (Pi)

$$P_i = 9.81 \times Q \times H \quad (Kw)$$

Q = discharge (m^3/s)

h = total head

3) Output power (P_o)

$$P_o = \pi DNT / (102 \times 60)$$

Where $T = (T_1 - T_2) + T_0$

T_1= Load applied in kg

T_2= Spring Balance weight in kg

T_0= Hanger weight in kg

N= Speed of turbine in rpm

D = Equivalent drum diameter in m

$D = (d_1+d_2)$ m

d_1= break drum diameter in m

d_2= Rope Diameter in m

4) Total head

$$\mathbf{H = H_s + H_d + X}$$

H_s = vacuum head in m of water

H_d = delivery head in m of water

X = difference in level difference the centers of Vaccum & pressure gauge

5) Efficiency (η)

$$\boldsymbol{\eta = (Po/Pi) \times 100}$$

P_o-Power output (w)

P_i- Power input (w)

Observation and Computation:

Weight of hanger (T_0) =
Diameter of brake drum (D) =
Rope thickness =

TABULATION FOR FRANCIS TURBINE

S. no	Delivery head		Vacuum gauge reading		Orifice reading			Orifice Head m of water	Flow rate Q	Speed N	Weight of Hanger T1	Spring Balance weight T2	Net weight T	Output power P_o	Input Power P_i	Efficiency $\eta = P_o/P_i$
	Pressure gauge	water	mm of hg	water	v_1	v_2	$h_m = (v_1 - v_2)$	H	m^3/s	rpm	Kg	Kg	kg	(kw)	(kw)	%
	(kg/cm^2)	m		m												
1																
2																
3																
4																
5																

Model calculation:

Procedure:

1. Keep the guide vane opening at required openings.
2. Prime the pump if necessary.
3. Close the sluice and start the pump.
4. The start button should be kept pressed for 5-10 seconds and then released.
5. Open the delivery valve for required pressure.
6. Load the turbine by adding the weight to the hanger.
7. Note the load on the hanger, spring balance load, Venturimeter pressure gauge reading, speed & inlet pressure gauge reading.
8. Repeat the experiment for various loads.

Graph:

Taking speed (N) in x-axis and Efficiency (η), Input power (Pi) & Discharge (Q) in y-axis
1. Speed (N) Vs. Efficiency (η)
2. Speed (N) Vs. Input power (Pi)
3. Speed (N) Vs. Discharge (Q)

Result:

Maximum efficiency =
Discharge =
Input power =
Output power =

Gate and IES Questions:

1. The ratio of actual work available at the turbine to the energy imparted to the wheel is known as ___________ efficiency
   a) Hydraulic **b)** Mechanical c) overall
2. The speed of a turbine runner is
   a) Directly proportional to $H^{1/2}$ **b)** inversely proportional to $H^{1/2}$
   c) Directly proportional to $H^{3/2}$ **d)** inversely proportional to $H^{3/2}$
3. H_e overall efficiency of a reaction turbine is the ratio of
   a) Power produced by the turbine to the energy actually supplied by the turbine
   b) Actual work available at the turbine to the energy imparted to the wheel
   c) Work done on the wheel to the energy (or head of water) actually supplied to the turbine
   d) None of the above

Assessment

Scale	**Score**	**Remarks**	
			Signature of the CI with Date

EX.NO PERFORMANCE TEST ON A JET PUMP

AIM:

To study the performance of the pump and to determine the 1.total head 2.discharge 3.power input and 4.efficiency under speed condition

APPARATUS REQUIRED:

- Jet pump
- Collecting tank
- Energy meter
- Pressure gauge

THEORY:

- ✓ A Pump is a device used for lifting liquids from a lower level to a higher level. It converts mechanical energy into pressure energy.
- ✓ A centrifugal pump and reciprocating pump are used when water is to be lifted less than 8m when it is more than 8m jet pump is usable which consist of converged nozzle with can lift the water from 15 to 20m.
- ✓ A Jet pump consist of a conventional radial flow pump with jet nozzle at the suction head this jet helps to increase the suction lift beyond the normal lift of 6m to 8m of water head

WORKING PROCEDURE:

1. When pump is started the water is lifted by the centrifugal action of the pump
2. A stream of high pressure of water from the delivery pipe of the pump is allowed to flow through the suction head.
3. Where the pressure energy of water is converted into K.E due to which a local pressure drop take place.
4. Due to this pressure drop, suction is created and water is sucked from the well. This action ensures the considerably large supply of low pressure water.

FORMULA USED

1. Discharge, Qact = Ah/t in m^3/s

Where,

A = area of collecting tank in m^3/s

h = rise of water level in collecting tank in m

t = time taken for h=0.1m in seconds

2. Input of the motor Pi= 3600xNrx1000 / (Ne X t)

Where,

Ne = energy meter constant

Nr = No of revolutions taken

Let Nr = 5

T = time required to complete Nr=5 revolutions.

3. Output from the pump $P_o = WQH$ in watts

Where,

W = specific weight of water in N/m^3 =9810 N/m^3

Q =displacement in m^3/s

H = Total head in m

$$H = H_S + H_d + X \text{ in m}$$

Where,

H_S = suction head in m

H_d = delivery head in m

X = difference in level of two pressure gauge in m

4. Efficiency $\eta = P_O/P_i X100$

Where,

P_O = input of the motor in watts

P_i = output of the pump in watts

Tabulation

S. No	Pressure gauge reading				Head H=Hs+Hd+X in m	Time for n=0.1m rise in sec	Discharge m^3/sec	Time Nr= 5 in sec	Output Po = WQH in watts	Input Power Pi in watts	$\eta = (P_o/P_i) \times 100$
	Suction Head		Delivery Head								
	kg/cm^2	m	kg/cm^2	m							
1											
2											
3											
4											
5											

PROCEDURE:

1. First prime the pump and start the jet pump. Whole starting close the pressure gauge cock. Then slowly open the delivery valve and along adjust it to the required total head.
2. Discharge is the amount of water the pump delivers over a definite period of time. It is usually expressed in liter per min (LPM). The actual discharge is measured with the help of measuring tank.
3. The power input is the relation between the power input into the pump and power output from the pump. The power output is directly proportional to the total head and discharge.
4. If the total head (H) is measured in meters and the discharge (Q) in l/min. The watt input to the motor is measured with the help of the motor constant stamped on the energy meter.
5. Then the efficiency is calculated by dividing the output power to the input power.

NOTE:-

For converting pressure head P in $Kg/Cm^2$2m of water. The following conversion should be adopted.

$H = P/w = (Kg/Cm^2)/(N/m^3)$

$= 9.81x10^4/9.81x10^3$

$H = 10m$

GRAPH:-

1. Discharge (Q) Vs Total head (H)
2. Discharge (Q) Vs Output power (Po)
3. Discharge (Q) Vs Input power (Ƞ)

Taking discharge on X axis

RESULTS:-

i.	**Discharge**	**Q**	**=**	**m^3/Sec**
ii.	Total head	H	=	m
iii.	Output power Po		=	watts
iv.	Efficiency under Ƞ		=	

Speed condition

EX.NO PERFORMANCE TEST ON KAPLAN TURBINE

AIM:

To study characteristics of Kaplan turbine

APPARATUS:

- ✓ Kaplan turbine unit
- ✓ Pressure gauge
- ✓ Spring balance
- ✓ Weights

THEORY:

Kaplan turbine is an axial flow reaction turbine used in dams and reservoirs of low height to convert hydraulic energy into mechanical energy. They are best suited for low heads say 10 to 15m. This specific speed ranges from 200 to 1000.

Water under pressure from the pump enter through the volute casing and guide vanes into the runner. While passing through the spiral casing and guide vanes a portion of pressure energy (ie) potential energy is converted into velocity energy (ie). Kinetic energy water thus enters the runner at a high velocity and it passes through the runner vanes the remaining potential energy is converted into K.E. due to the characteristic of the vanes, the K.E is transform into mechanical energy (ie) the water head is converted into mechanical energy and hence runner rotates. The water from the runner is discharged into the tail race, the discharge through runner can be regulated by the operating guide vanes also.

FORMULA USED

1. **Discharge,Q =0.089√h in m^3/s**

Where is the head

2. **Total head, H= (P) + (V) in m**

Where, P is the pressure gauge reading in Kg/cm^2

V is the vacuum gauge reading in mm of Hg

3. **Inputpower Pi=WQH in watts**

Where,

W = specific weight of water in N/m^3 =9810 N/m^3

Q =displacement in m^3/s

H = Total head in m

4. **Output power Po = ΠDNT/(102x60) Kw**

Where $T = (T_1-T_2) +T_0$

T_1 = Load applied in Kg

T_2=spring balance weight in Kg

T_o = hanger weight in Kg

N = speed of turbine in rpm

D = equivalent drum diameter in m

D = (d_1 + d_2)

d_1 = break drum diameter in m

d_2 = rope diameter in m

5. Efficiency $\eta = P_O/P_i X100$

Where,

P_O = input of the motor in watts

P_i = output of the pump in watts

Observation and Computation:

Brake drum diameter (D) =

Radius of drum (R_e) =

Diameter of rope (t) =

Weight of rope of hanger =

TABULATION FOR KAPLAN WHEEL TURBINE

S.No	Pressure Gauge		Vacuum Gauge Reading		H=P+V in "m"	Orificemeter Manometer Reading			Flow rate Q m^3 /Sec	Speed N in rpm	Wt on hang To in Kg	Spring Wt in Kg	Net Wt "T" in Kg	Po KW	P_i in KW	$\eta = (P_o/P_I) X 100$
	Kg/cm^2	m	kg/cm^2	m		H1	H2	H								

PROCEDURE:

1. Keep the guide vane opening as required
2. Prime the pump is necessary
3. Close the gate valve for required pressure
4. Load the turbine by adding the weight to the hanger
5. Note the load on the hanger, spring balance load, manometer reading, speed, pressure and vacuumgauge reading.
6. Repeat the experiment for various loads.

GRAPH:-

1. Speed (N) Vs Efficiency (η)
2. speed (N) Vs Discharge (Q)
3. Speed (N) Vs Input power (P_i)
4. Speed (N) Vs Output power (Po)

Taking Speed (N) on X axis

RESULTS:-

i. Maximum efficiency η = %
ii. Speed at best efficiency point N = rpm
iii. Discharge at best efficiency point Q = m^3/s
iv. Input power at best efficiency point P_i = Kw
v. Output power at best efficiency point P_o= Kw