EINSTEIN

COLLEGE OF ENGINEERING

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Department of Mechanical Engineering

ME38-Fluid Mechanics and Machinery Laboratory

Name : ………………………………………

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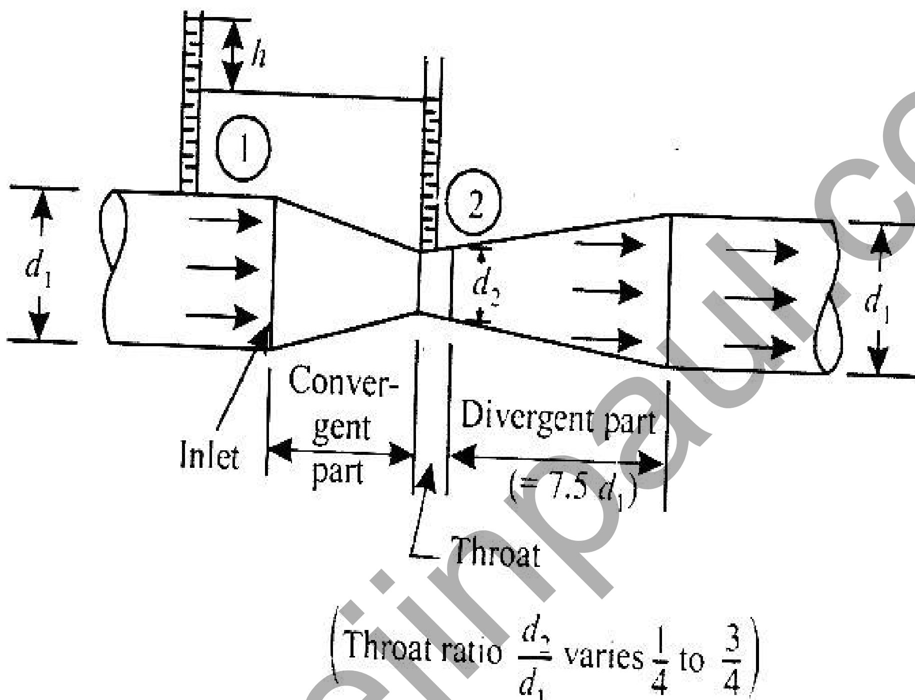


SCHEMATIC DIAGRAM OF VENTURIMETER

Ex.No.1 **FLOW THROUGH VENTURIMETER**

Date:

AIM:

To determine the coefficient of discharge of the venturimeter.

APPARATUS REQUIRED:

A venturimeter, Differential U-Tube manometer, collecting tank fitted with piezometer and control valve, stop watch and meter scale.

THEORY:

A venturimeter is one of the most important practical applications of Bernoulli's theorem. It is an instrument used to measure the rate of discharge in a pipe line and is often fixed permanently at different sections of the pipe line to know the discharges there. A venturimeter has been named after the 18th century Italian ENGINEER VENTURI.

FORMULA USED:

1. Coefficient of discharge $C_d = Q_a / Q_t$ Where

Q_a – actual discharge and Q_t – theoretical discharge

2. Theoretical discharge $Q_t = \dfrac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ in m^3/sec

Where, a_1 is the area of inlet in m^2

a_2 is the area of outlet in m^2

h is the differential head in meter of water

g is the acceleration due to gravity m/sec^2

$a_1 = \dfrac{\pi}{4} d_1^2$, where d_1 = diameter of the inlet (m)

$a_2 = \dfrac{\pi}{4} d_2^2$, where d_2 = diameter of outlet (m)

Differential head $h = (h_1 - h_2) \cdot \dfrac{(S_m - S_l)}{S_l}$ in m

$$\frac{(S_m - S_l)}{S_l} = \frac{13.6 - 1}{13.6} = 12.6$$

S_m = specific gravity of the manometric liquid

S_l = specific gravity of the flowing liquid

3. Actual discharge $Q_a = \frac{AH}{t} \quad \left(m^3/s\right)$

A = area of the collecting tank (m)

H = rise of water in the capillary tube (m)

t = time taken for H meter rise of water in the capillary tube (s)

PROCEDURE:

1. The diameter of the inlet and outlet are recorded and the dimensions of the collecting tank are measured
2. Priming is done
3. The inlet valve is opened slightly and the manometer heads on both the h_1, h_2 are noted.
4. The outlet valve of the collecting tank is closed tightly and the time taken for 'H' m rise of water in the collecting tank is observed.
5. The above procedure is repeated by gradually increasing the flow and observing the required readings.
6. The observations are tabulated and the coefficient of discharge of the venturimeter was computed

OBSERVATIONS:

- Diameter of pipe = 40mm, 24mm
- Diameter of throat = 25mm, 15mm
- Area of the collecting tank= 0.5m×0.5m

OBSERVATION AND TABULATION:

For 40mm pipe dia and 25 mm throat dia venturimeter

S. No.	Manometer reading				Time for 0.1m rise of water in the capillary tube	Actual discharge	Theoretical discharge	Coefficient of discharge
	h_1	h_2	h_m	h	t	Q_a	Q_t	C_d
	cm	cm	cm	m	sec	$\left(m^3/s\right)$	$\left(m^3/s\right)$	
1								
2								
3								
4								
5								

For 24mm pipe dia and 15 mm throat dia venturimeter

S. No.	Manometer reading				Time for 0.1m rise of water in the capillary tube	Actual discharge	Theoretical discharge	Coefficient of discharge
	h_1	h_2	h_m	h	**t**	Q_a	Q_t	C_d
	cm	cm	cm	m	**sec**	$\left(m^3/s\right)$	$\left(m^3/s\right)$	
1								
2								
3								
4								
5								

GRAPH:

- Actual discharge (Q_a) Vs head (h)

Answer the following:

1. What is peizometer?

2. Define the following terms.

   - Fluid.
   - Specific volume
   - Specific gravity.
   - Viscosity.
   - Compressibility.
   - Vapour pressure.
   - Capillarity.
   - Surface tension.

3. Differentiate the following terms.

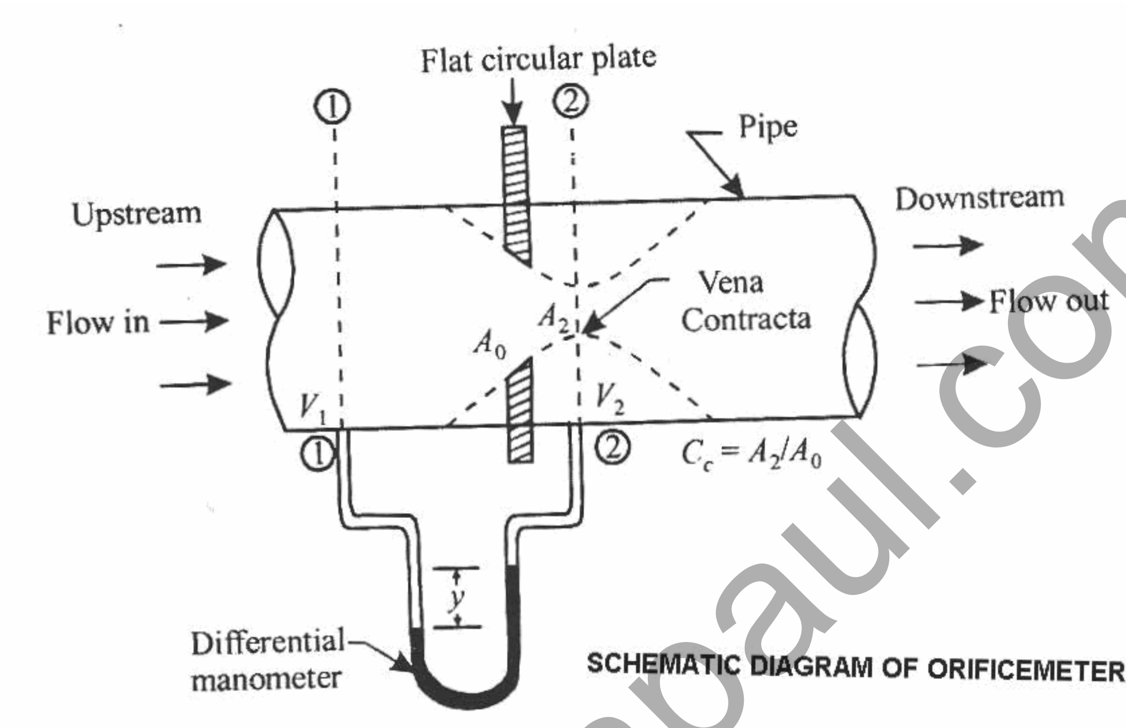
   - Fluid and solid.
   - Newtonian and non Newtonian fluid.
   - Ideal and real fluid.

4. Derive continuity equation for compressible and incompressible fluid.

5. Differentiate between Absolute and gauge pressures

RESULT:

Thus the coefficient of discharge of venturimeter is determined.



SCHEMATIC DIAGRAM OF ORIFICEMETER

Ex.No.2 **FLOW THROUGH ORIFICEMETER**

Date:

AIM:

To determine the coefficient of discharge of the orificemeter.

APPARATUS REQUIRED:

Orificemeter, Differential U-Tube manometer, collecting tank fitted with piezometer and control valve, stop watch and meter scale.

THEORY:

An orifice is an opening in the wall or base of a vessel through which the fluid flows. The top edge of the orifice is always below the free surface. Orifices are used to measure the discharge. An orifice is termed small when its dimensions are small compared to the head causing flow. The variation in the velocity from the top to the bottom edge is considerable. According to shape there are circular orifices, rectangular orifices, square orifices, Triangular orifices.

FORMULA USED:

1. Coefficient of discharge $C_d = Q_a / Q_t$

Where Q_a – actual discharge and Q_t – theoretical discharge

2. Theoretical discharge $Q_t = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ in m^3/sec

where a_1 is the area of inlet in m^2

a_2 is the area of outlet in m^2

h is the differential head in meter of water

g is the acceleration due to gravity m/sec^2

$a_1 = \frac{\pi}{4} d_1^2$, where d_1 = diameter of the inlet (m)

$a_2 = \frac{\pi}{4} d_2^2$, where d_2 = diameter of outlet (m)

Differential head $h = (h_1 - h_2) \cdot \frac{(S_m - S_l)}{S_l}$ in m

$$\frac{(S_m - S_l)}{S_l} = \frac{13.6 - 1}{13.6} = 12.6$$

S_m = specific gravity of the manometric liquid

S_l = specific gravity of the flowing liquid

3. Actual discharge $Q_a = \frac{AH}{t} \quad \left(m^3/s\right)$

A = area of the collecting tank (m)

H = rise of water in the piezometer tube (m)

t = time taken for H meter rise of water in the piezometer tube (s)

PROCEDURE:

7. The diameter of the inlet and outlet are recorded and the dimensions of the collecting tank are measured
8. Priming is done
9. The inlet valve is opened slightly and the manometer heads on both the h_1, h_2 are noted.
10. The outlet valve of the collecting tank is closed tightly and the time taken for 'H' m rise of water in the collecting tank is observed.
11. The above procedure is repeated by gradually increasing the flow and observing the required readings.
12. The observations are tabulated and the coefficient of discharge of the venturimeter was computed

OBSERVATIONS:

Diameter of pipe = 40mm, 25mm

Diameter of throat = 20mm, 15mm

Area of the collecting tank = 0.5m×0.5m

OBSERVATION AND TABULATION:

For 40mm pipe dia and 20 mm throat dia venturimeter

S. No.	Manometer reading				Time for 0.1m rise of water in the capillary tube	Actual discharge	Theoretical discharge	Coefficient of discharge
	h_1	h_2	h_m	h	t	Q_a	Q_t	C_d
	cm	cm	cm	m	sec	$\left(m^3/s\right)$	$\left(m^3/s\right)$	
1								
2								
3								
4								
5								

For 25mm pipe dia and 15 mm throat dia venturimeter

S. No.	Manometer reading				Time for 0.1m rise of water in the capillary tube	Actual discharge	Theoretical discharge	Coefficient of discharge
	h_1	h_2	h_m	h	t	Q_a	Q_t	C_d
	cm	cm	cm	m	sec	$\left(m^3/s\right)$	$\left(m^3/s\right)$	
1								
2								
3								
4								
5								

GRAPHS TO PLOT:

- Actual discharge (Q_a) Vs head (h)

Answer the following:

1. Mention two pressure measuring instruments

2. How manometers are classified

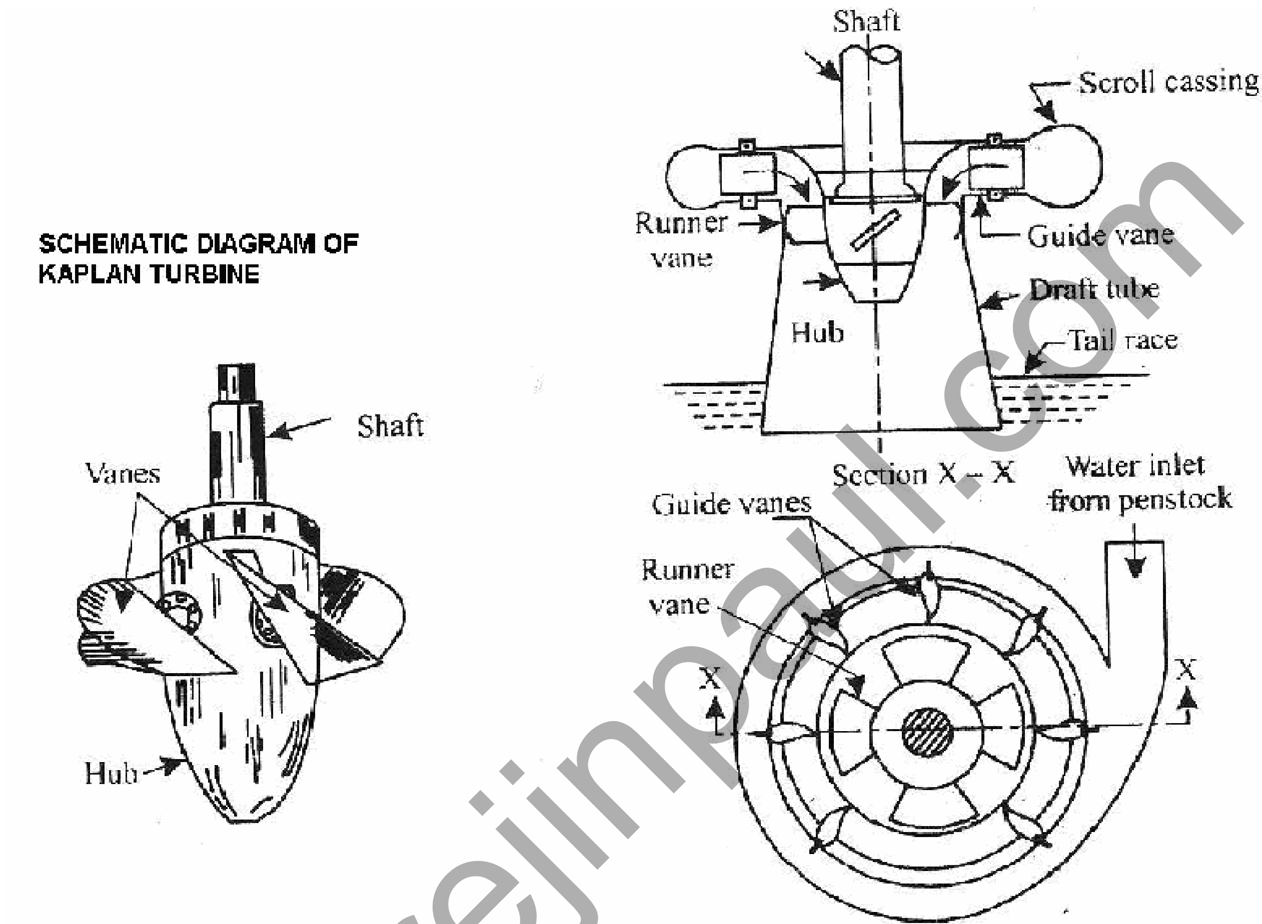
3. State Newton's law of viscosity

4. Define stream line.

5. Define path line.

RESULT:

Thus, the coefficient of discharge of orificemeter is determined.


SCHEMATIC DIAGRAM OF
KAPLAN TURBINE
Shaft
Vanes
Hub
Shaft
Scroll cassing
Runner vane
Guide vane
Draft tube
Hub
Tail race
Section X – X
Water inlet from penstock
Guide vanes
Runner vane
X
X

Ex.No. 3 PERFORMANCE TEST ON KAPLAN TURBINE

Date:

AIM:

To conduct the performance test on the Kaplan turbine.

APPARATUS REQUIRED:

i)Kaplan turbine

ii)Tachometer

THEORY:

Kaplan turbine is one of the types of axial flow turbine. Usually, it has 4 to 6 blades having no outside rim. It is also known as variable pitch propeller turbine. The Kaplan turbine behaves as a propeller turbine at full load conditions. In Kaplan turbine runner blades are adjustable and can be rotated about pivots fixed to the boss of the runner. The blades are adjusted automatically by servo mechanism so that at all loads the flow enters them without shock. Thus, a high efficiency is maintained even at part load.

OBSERVATIONS:

- Rated supply head = 8m
- Discharge = 2500 lpm
- Rated speed = 1200 Rpm
- Runner outside diameter= 140mm
- Hub diameter = 70mm
- Hub ratio = 0.5
- No of runner blades = 4
- No of guide vanes = 12
- Brake drum diameter = 300mm
- Diameter of the pipe (d_1) = 0.13m
- Diameter of the throat of venturimeter (d_2) = 0.078 m

FORMULAE:

1. Rate of flow of water (Q) = $[(a_1 \times a_2) \times \sqrt{(2gh)}] / [\sqrt{(a_1^2 - a_2^2)} \times 0.9]$ in m^3/sec

- a1=area of inlet of the venturimeter= $(\Pi \times d_1^2)/4$
- a2=area of throat of venturimeter= $(\Pi \times d_2^2)/4$
- h=$[(S_m/S_l)-1] \times (h_1-h_2)$ in m

  S_m- Specific gravity of mercury=13.6

  S_l - Specific gravity of water=1

2. Output power = $2\Pi NT/60$ Watts

- N is speed in rpm
- T is torque in Nm = radius of drum x (T_1-T_2)x g

3. Input power = $\rho Qgh/1000$ kw

4. Efficiency = (Output power P_0/Input power P_i) x100

PROCEDURE:

1. Open the gate valve slowly and make it as fully open.
2. Now at full open and at no load, note the reading of manometer, pressure Gauge.
3. Then, load the turbine by adjusting the screw rod connected to the belt which Is on the brake drum and tighten the lock and the speed get reduced.
4. Now, note the readings of manometer, pressure gauge and spring balance.
5. Thus, for various loads with gate valve fully opened note the above said Readings.

OBSERVATION TABULAR COLUMN:

S.No	Gate opening	Pressure Gauge reading	Manometer readings		Speed Of rotation	Spring balance reading	
			h_1	h_2		T_1	T_2
Unit		Kg/m^2	m	m	rpm	kg	kg
1.							
2.							
3.							
4.							

CALCULATION TABULAR COLUMN:

S.No.	Net supply head (h)	Actual discharge (Q)	Input power (P_i)	Output power (P_0)	Efficiency
	m	m^3/s	Kw	Kw	·/.
1.					
2.					
3.					
4.					

GRAPH:

- Speed Vs Efficiency
- Speed Vs Output power
- Speed Vs Discharge

Answer the following:

1. What is the difference between propeller and Kaplan turbine?

2. Mention the parts of Kaplan turbine.

3. Differentiate between inward and outward flow reaction turbine.

4. Define impulse turbine.

5. Define reaction turbine

RESULT:

Thus performance tests are conducted on the Kaplan turbine and characteristics curves are drawn.

Ex.No.4 **FLOW THROUGH PIPE**

Date:

AIM:

To determine the coefficient of friction, when water is flowing through a pipe.

APPARATUS REQUIRED:

- Pipe friction apparatus
- Manometer
- Stop watch
- Collecting tank
- Sump tank

THEORY:

When water is flowing in a pipe, it experiences some resistance to its motion. It effects in the reduction of the velocity and the head of the water available. There are many types of losses, but the major loss causes due to frictional resistance of the pipe only. The minor losses are so small as compared to friction losses. The minor losses are such as loss of head at entrance and loss of head due to velocity of water at outlet.

OBSERVATIONS:

Length of the collecting tank (L) = 50cm

Breadth of the collecting tank (B) = 50 cm

Distance between the pressure tapping on the pipe line (l) = 2m

Diameter of the I pipe (d_1) = 15 mm

Diameter of the II pipe (d_2) = 20 mm

Diameter of the III pipe (d_3) = 25 mm

FORMULAE USED FOR CALCULATIONS:

1. Coefficient of friction (f) = $(2\times g\times h_f\times d)/(l\times V^2)$

- Distance between the pressure tapping on the pipe line (l) = 2m
- Loss of head due to friction (h_f)= $(h_1-h_2)\times[(S_m-S_1)/S_1]$ in mm

S_m- Specific gravity of Mercury= 13.6

S1- Specific gravity of water=1

2. V, Velocity of water in tube = Q_a /a in mm/s

- Area of the I pipe, II pipe, III pipe (a_1, a_2, a_3) = $(\Pi\times d^2)/4$ in mm^2

3. Actual discharge (Q_a) = $(A \times H)/t$ in mm^3/sec

- A (area of the collecting tank) = $L \times B$ in m^2
- H= Height of water in collecting tank
- t = time taken for collection for H rise in the collecting tank. (In sec).

PROCEDURE:

- The diameter of the pipe is measured and the initial plan dimensions of the collecting tank and the length of the pipe line between the two pressure tapping cocks are measured.
- Keeping the outlet valve fully closed the inlet valve is opened completely.
- The outlet valve is slightly opened and manometric heads in both the limbs (h1 and h2) are measured.
- The outlet valve of the collecting tank is tightly closed and the time‘t’ required for ‘H’ rise of water in the collecting tank is observed by using a stop watch.
- The above procedure is repeated by gradually increasing the flow and observing the corresponding readings.
- The observations are tabulated and the friction factor computed.

OBSERVATION TABULAR COLUMN:

For 15mm diameter pipe:

S.No.	Manometer readings (mm of Hg)			Time taken for water collection for H rise in the collecting tank (t) (in sec)
	h_1	h_2	h_1-h_2	
1				
2				
3				
4				
5				

For 20mm diameter pipe:

<table>
<tr><td rowspan="2">S.No.</td><td colspan="3">Manometer readings (mm of Hg)</td><td rowspan="2">Time taken for water collection for H rise in the collecting tank (t) (in sec)</td></tr>
<tr><td>h_1</td><td>h_2</td><td>$h_1 - h_2$</td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td></tr>
</table>

CALCULATION TABULAR COLUMN: (For 15mm diameter pipe)

S.No.	Loss of head $h_f =$ $(h_1-h_2) \times [(S_m-S_1)/S_1]$ in mm	Actual discharge $(Q_a) = (A \times H)/t$ in mm^3/sec	Velocity of water in tube $= Q_a /a$ in mm/s (V)	V^2 $(mm/s)^2$	Friction factor $f =$ $(2 \times g \times h_f \times d)/(l \times V^2)$

Mean Value of 'f'=

For 20mm diameter pipe:

S.No.	Loss of head $h_f =$ $(h_1-h_2) \times [(S_m-S_1)/S_1]$ in mm	Actual discharge $(Q_a) = (A \times H)/t$ in mm^3/sec	Velocity of water in tube = Q_a /a in mm/s (V)	V^2 $(mm/s)^2$	Friction factor f = $(2 \times g \times h_f \times d)/(l \times V^2)$

Mean Value of 'f'=

GRAPHS TO PLOT:

‘h’ Vs ‘V^2’

Answer the following:

1. What do you mean by major energy loss?
2. List down the type of minor energy losses.
3. What is compound pipe?
4. What do you mean by equivalent pipe
5. Derive Darcy -weisback's equation.

RESULT:

Thus, the coefficient of friction of the two pipes 20mm and 15mm determined and the values are given below

Coefficient of friction (f) for 15mm diameter pipe =

Coefficient of friction (f) for 20mm diameter pipe =

Ex.No:5 **PERFORMANCE TEST ON GEAR PUMP**

Date:

AIM:

To conduct a performance test on gear pump.

APPARATUS REQUIRED:

1. Gear Pump test rig
2. Stopwatch
3. Meter Scale
4. Plumb Bob

THEORY:

The gear pump test rig consisting of a gear pump coupled to an induction motor through flexible coupling. The pump is mounted on an oil sump and a suction pipe with suction gauge, delivery pipe with delivery gauge, discharge control valve etc provided. This being a positive displacement pumps full closing of the delivery control valve should be avoided.

A collecting tank with gauge glass and scale fittings with drain valve fittings provided to measure the pump discharge and to drain back the oil to the sump.

A panel with switch, starter and energy meter provided to note the input power. The gear 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 o the wheels is keyed to the driving shaft and the other revolves as a driven wheel.

The pump is first filled with the liquid before it is started, as the gear rotate; the liquid 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 liquid into the delivery pipe. Each tooth of gear acts like a piston of a reciprocating pump to force liquid into the discharge line.

FORMULA:

1. Area of the collecting tank (A) = l× b

l =40 cm

b= 40 cm

Energy meter constant (N_e) = 100 rev/Kw-hr

Datum level difference (x) = 0.3m

2. Actual discharge (Q_a) = Ah/t

- h- 10cm rise of oil level
- t- time taken for 10cm rise of oil level in collecting tank in seconds

3. Total head (H) = H_s+H_d+x

4. Input power (P_i) = $[(3600 \times N_r) / (N_e \times t)] \times 1000$ watt

- N_r – No. of revolutions of energy meter disc= 10
- t- Time taken for 10 revolutions of energy meter disc.

5. Output power (P_0) = $(\rho_{oil} \times g \times Q_a \times H)/ 1000$ Kw

$\rho_{oil} = 850$ Kg/ m^3

6. Efficiency of the pump = P_0 / P_i in %

1 Kg/ Cm^2 = 12 m of oil column

PROCEDURE:

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

OBSERVATION TABULAR COLUMN:

S.No.	Pressure gauge reading Kg/ Cm2	Vacuum Gauge reading mm of Hg	Time taken for 10 cm rise In sec	Time taken for 10 revolutions in energy meter	Delivery head H_d	Suction head H_s	Correction head X
1.							
2.							
3.							
4.							

CALCULATIONS TABULAR COLUMN:

S.No.	Total head	Actual Discharge Q_a	Input power (P_i)	Output Power (P_0)	Efficiency %
1.					
2.					
3.					
4.					

GRAPHS TO PLOT:

Plot graphs for

Discharge Vs Total Head

Output Power Vs Total Head

Efficiency Vs Total Head

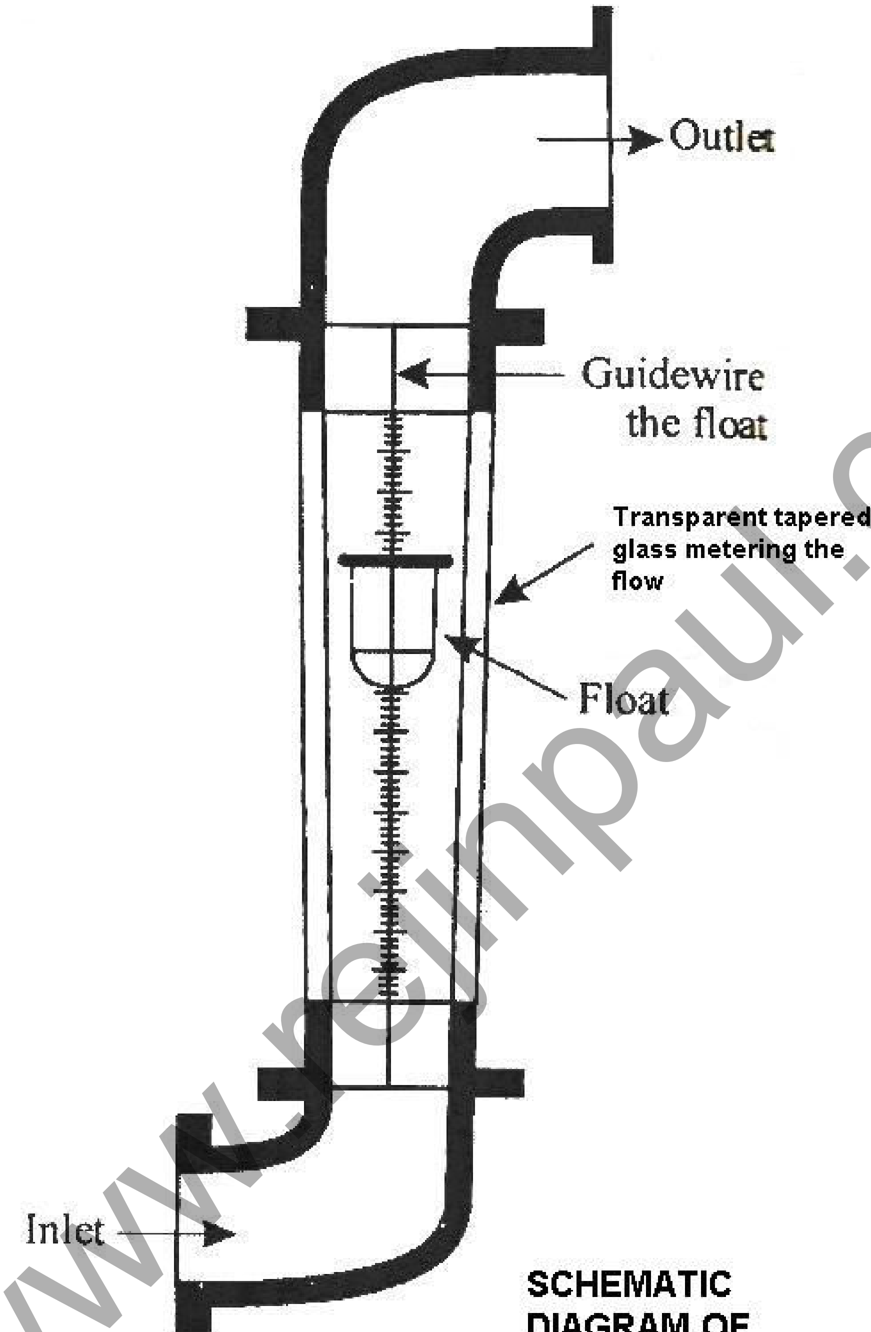
Answer the following:

1. Briefly explain Gear pump.
2. Differentiate between internal gear pump and external gear pump.
3. Briefly explain vane pump.
4. What is rotary pump?
5. How performance characteristic curves are drawn for pump

RESULT:

Maximum Efficiency of the pump = ……………………..

Total head of maximum Efficiency = ……………………



SCHEMATIC DIAGRAM OF ROTAMETER

Ex.No. 6 **PERFORMANCE TEST ON ROTAMETER**

Date:

AIM:

To determine the coefficient of discharge of the rotometer.

APPARATUS REQUIRED:

A rotometer having 0 – 30LPM range, single phase 0.5 HP 1440 rpm monoblock pump, reservoir tank arrangement, piping system, stopwatch and meter scale.

THEORY:

When the rate of flow increases the float rises in the tube and consequently there is an increase in the annular area between the float and the tube. Thus, the float rides higher or lower dephending on the rate of flow.

FORMULA USED:

1.Actual discharge $Q_a = \frac{AH}{t} \times 60{,}000$ LPM

A = area of the collecting tank (m)

H = rise of water in the capillary tube (m)

t = time taken for H meter rise of water in the capillary tube (s)

2. Coefficient of discharge $C_d = Q_a / Q_R$

Q_a – actual discharge (LPM) and Q_R – Rotometer discharge (LPM)

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 rotometer 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 rotometer is compared.

<u>OBSERVATION AND TABULATION:</u>

Sl. No.	Rotometer discharge		Time for 0.1m rise of water in the capillary tube	Actual discharge		Coefficient of discharge
	Q_R		t	Q_a		C_d
	(LPM)	m^3/sec	(Sec)	(LPM)	m^3/sec	
1						
2						
3						
4						
5						

Area of collecting tank = 50cm x 50cm

Answer the following:

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

RESULT:

Thus, the coefficient of discharge (C_d) of rotometer is determined.

Ex.No. 7 PERFORMANCE STUDY OF CONSTANT SPEED CENTRIFUGAL PUMP

Date:

AIM: To find the efficiency of the centrifugal pump.

APPARATUS REQUIRED

Centrifugal pump setup, metre scale, stop watch.

THEORY:

The radial flow type pumps are commonly called as Centrifugal pumps. It has flow in relative direction through the impeller. The flow takes place from the low pressure towards the high pressure. The head of the centrifugal pump may be expressed in the following ways as static head, Manometric head and total or effective head. When a centrifugal pump operates the various losses such as hydraulic losses, Mechanical losses and leakage loss occurs.

FORMULAE USED TO CALCULATE:

1. $\eta = \frac{\text{Output power}}{\text{Input power}}$

2. Output power $P_0 = \frac{w \times Q_{act} \times H_T}{1000} kW$

- Specific weight of water w = 9810 N/m^3
- Q_{act} – actual discharge
- H_T – Total head

3. $Q_{act} = \frac{AH}{t} \quad m^3/s$

- Q_{act} – Actual discharge of water in m^3/s
- A – area of the tank in m^2
- H – level of rise of water in meter in the collecting tank (10 cm)
- t – time for 10 cm rise of water

H_T = Pressure head (G) + Vacuum head (V) + Datum head (Z)

4. Input Power $P_i = \frac{n \times 3600 \times \eta_m}{N \times T}$ Kw

- n – No. of revolution of energy meter
- η_m - Pre determined efficiency (0.55)
- N – Energy meter constant
- T – Time taken for N revolution

PROCEDURE:

1. Open the outlet valve until it is fully open.
2. Priming of the centrifugal pump
3. Switch on the centrifugal pump
4. By closing the outlet value the delivery pipe, the required pressure in the pressure gauge reading was set.
5. Pressure gauge reading was noted.
6. Vacuum gauge reading was noted
7. Time taken for 5 revolution of disc in the energy meter was observed and noted.
8. Energy meter constant from energy meter was noted
9. Time taken for the 10cm rise of water in the collecting tank was noted down.
10. Repeat the steps 4 to 9 for the required number of times.
11. Area of the collecting tank and datum head was measured.

OBSERVATION TABULAR COLUMN:

S. No	Pressure gauge Reading		Pressure head (m of water) G	Vacuum gauge Reading (mm of Hg)	Vacuum head (m of water) V	Datum head (m of water) Z	Time for 10cm rise of water (sec)	Time for 5 revolution Of disc in energy meter (sec)
	Kg/cm^2	N/m^2						
1.								
2.								
3.								
4.								

CALCULATION TABULAR COLUMN:

S.No.	Total Head $H_T = G+V+Z$	Actual Discharge $Q_{act} = \frac{AH}{t}$ m^3/s	Input power P_i Kw	Output power P_0 Kw	Efficiency P_0 / P_i
1.					
2.					
3.					
4.					
5.					

GRAPHS TO PLOT:

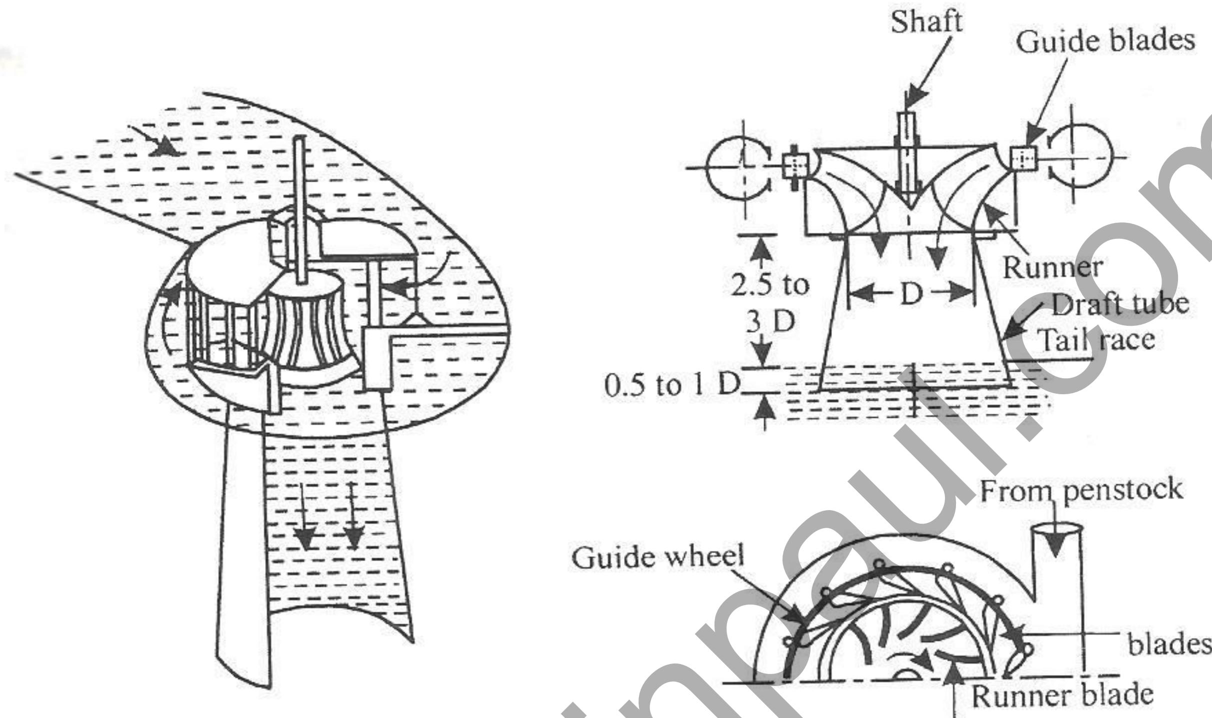
- Input power Vs Q_{act}
- Efficiency Vs Q_{act}
- Total head Vs Q_{act}
- Output power Vs Q_{act}

Answer the following:

1. Define Positive displacement pump.
2. Differentiate between Roto-dynamic and positive displacement pump.
3. Define cavitation in pump.
4. What is the need for priming in pump?
5. Mention the type of casing used in centrifugal pump

RESULT:

Thus, the efficiency of the centrifugal pump has been determined by conducting the performance test.



SCHEMATIC DIAGRAM OF FRANCIS TURBINE

Ex.No. 8 PERFORMANCE TEST ON FRANCIS TURBINE

Date:

AIM: To conduct the performance test on Francis turbine.

APPARATUS REQUIRED:

i) Francis turbine setup
ii) Tachometer

THEORY:

The modern Francis Turbine is an inward mixed flow reaction turbine. Here the water pressure enters the runner from the guide vanes towards the centre in radial direction and discharges out of the runner axially. The Francis Turbine operates under medium heads and requires medium quantity of water. Francis turbine has been installed in Bhakra nangal project, Punjab across the river Sutlej River.

OBSERVATIONS:

- Rated supply head = 1.2m
- Discharge = 2000 lpm
- Rated speed = 1250 Rpm
- Runner diameter = 180mm
- Power output = 3HP
- No of guide vanes = 8
- Brake drum diameter = 300mm
- Diameter of the pipe (d_1) = 0.13m
- Diameter of the throat of venturimeter (d_2) = 0.078m

FORMULAE USED FOR CALCULATION:

1. Rate of flow of water (Q) = $[(a_1 \times a_2) \times \sqrt{(2gh)}] / [\sqrt{(a_1^2 - a_2^2)} \times 0.9]$ in m^3/sec.

- a_1=area of inlet of venturimeter= $(\Pi \times d_1^2)/4$
- a_2=area of throat of venturimeter = $(\Pi \times d_2^2)/4$

2. h= $[(S_m / S_l)-1)] \times (h_1-h_2)$ in m

- S_m- Specific gravity of mercury=13.6
- S_l - Specific gravity of water=1

3. Output power (P_0) = $2\Pi NT/60$ Watts

- N is speed in rpm
- T is torque in Nm = radius of drum x (T_1-T_2)x g

4. Input power (P_i) = (ρ_w x Q x g x h)/1000 kw

5. Efficiency = (Output power (P_0)/Input power (P_i)) x100

PROCEDURE:

1. Open the gate valve slowly so that the turbine at 1200 Rpm (at no load).
2. Apply the load adjusting the screw rod connected to the belt for loading the Brakes drum and tighten the locknut and the speed gets reduced.
3. Now note the readings of manometer, pressure gauge and spring balance.
4. Open the gate valve to an extent such that the speed is 1200 rpm.
5. Now note the manometer, pressure gauge readings and spring balance Readings.
6. For various loads note the above said readings.

OBSERVATION TABULAR COLUMN:

S.No	Pressure Gauge reading	Manometer readings		Speed Of rotation (N)	Spring balance reading	
		h_1	h_2		T_1	T_2
Unit	Kg/cm^2	cm	cm	rpm	kg	kg
1.						
2.						
3.						

CALCULATION TABULAR COLUMN:

S.No.	Net supply head (h)	Actual discharge (Q) m^3/sec	Input power (P_i) kw	Output power (P_0) Watts	Efficiency %

GRAPH:

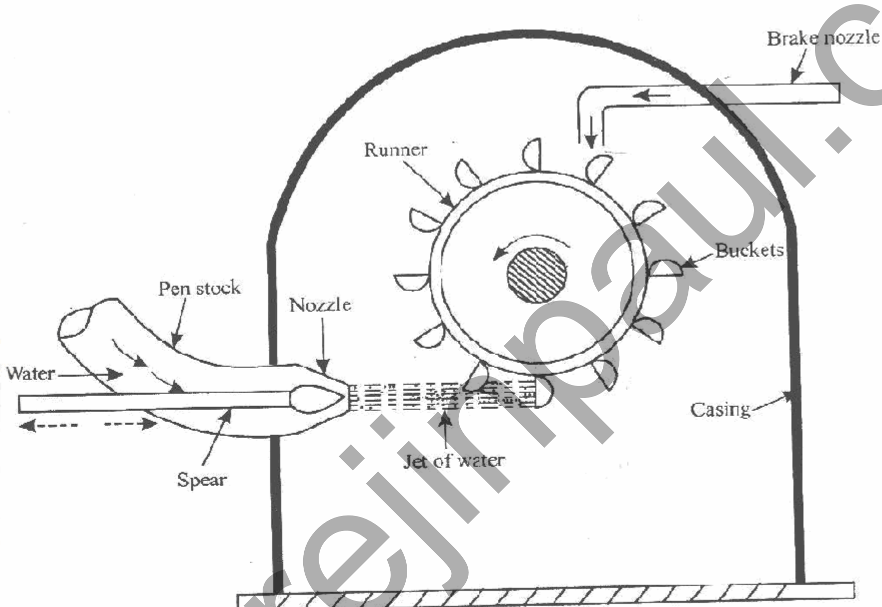
- Speed Vs Efficiency
- Speed Vs Output power
- Speed Vs Discharge

Answer the following:

1. What is the difference between Francis turbine and Modern Francis turbine?
2. What is the difference between outward and inward flow turbine?
3. What is mixed flow reaction turbine? Give an example.
4. Why draft tube is not required in impulse turbine?
5. How turbines are classified based on head. Give example.

RESULT:

Thus performance tests are conducted on the Francis turbine and characteristic curves are drawn.



SCHEMATIC DIAGRAM OF PELTON WHEEL TURBINE

Ex.No. 9 PERFORMANCE TEST ON PELTON WHEEL TURBINE

Date:

AIM: To study the performance of the given Pelton wheel turbine to draw the characteristic curves.

APPARATUS REQUIRED:

i)Pelton wheel turbine

ii)Tachometer

THEORY:

Pelton wheel turbine is named after American Engineer Lester Allen Pelton. It is an impulse turbine. The pressure energy of the water is converted in to kinetic energy when passed through the nozzle and forms the high velocity jet of water. The formed water jet is used for driving the wheel. The pelton wheel turbine is a tangential flow impulse turbine.

OBSERVATIONS:

- Rated supply head = 1.2m
- Discharge = 660 lpm
- Rated speed = 800 Rpm
- Runner outside diameter = 300mm
- No of pelton cups = 20 nos.
- Brake drum diameter = 300 mm
- Size of the venturimeter = 65 mm
- Diameter of the throat of venturimeter = 39 mm

FORMULAE:

1.Rate of flow of water (Q) = $[[(a_1 \times a_2) \sqrt{(2gh)}] / \sqrt{(a1^2 - a2^2)} \times 0.9]$ in m^3/sec

Where a1=area of input pipe

a2=area of throat of venturimeter

$h = [(S_m/S_l) - 1] (h_1 - h_2)$ in m

- S_m- Specific gravity of mercury=13.6
- S_l - Specific gravity of water=1

2. Output power (P_0) = $2\Pi NT/60$ Watts

- N is speed in rpm
- T is torque in Nm = radius of drum x $(T_1 - T_2)$x g

3. Input power (P_i) = $(\rho_w \times Q \times g \times h)/1000$ kw

4. Efficiency = (Output power (P_0)/Input power (P_i)) x100

OBSERVATION TABULAR COLUMN:

S.No	Nozzle opening	Pressure Gauge reading	Manometer readings		Speed Of rotation N	Spring balance reading	
			h_1	h_2		T_1	T_2
Unit		Kg/m^2	m	m	rpm	kg	kg

PROCEDURE:

1. Gradually, open the delivery valve of the pump.
2. Adjust the nozzle for half open by operating the needle valve by hand wheel.
3. The head should be maintained by operating the delivery valve and at Constant value.
4. Observe the speed of wheel using tachometer.
5. Observe the reading h_1 &h_2 in the two manometer limbs which are connected to the venturimeter.

CALCULATION TABULAR COLUMN:

Net supply head (h) in m	Actual discharge (Q)	Input power (P_i)	Output power (P_0)	Efficiency
m	m^3/s	kw	kw	%

GRAPH:

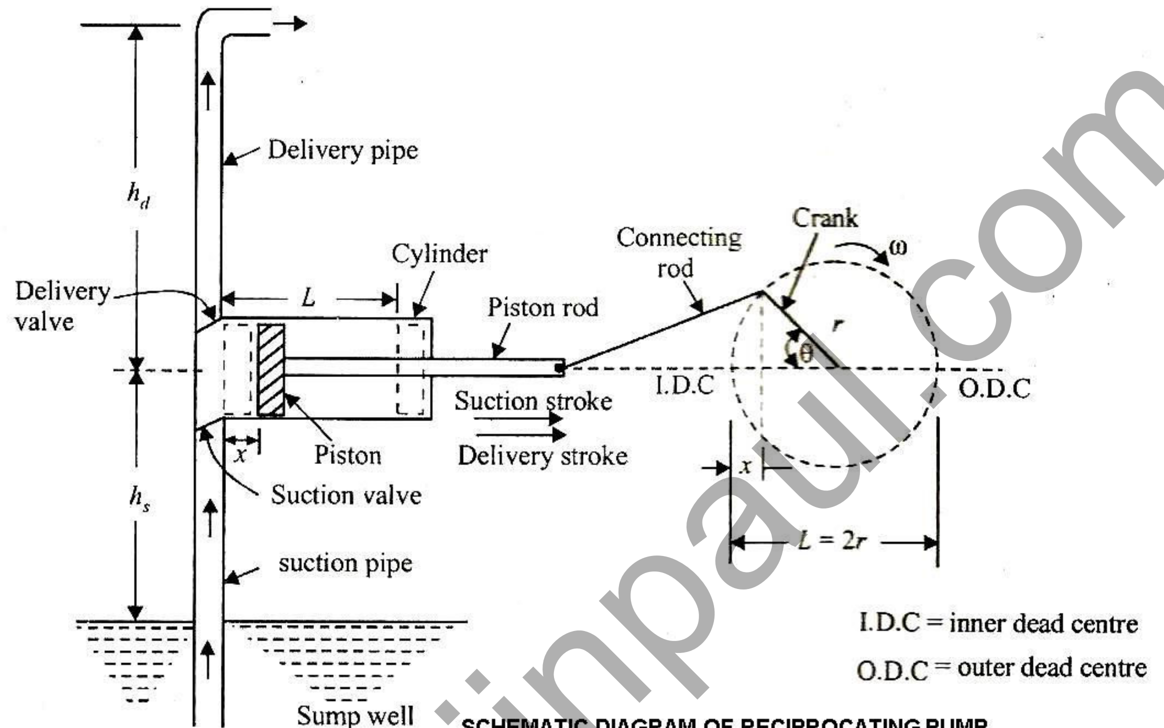
- Speed Vs Efficiency
- Speed Vs Output power
- Speed Vs Discharge

Answer the following:

1. What are the main parameters in designing a Pelton wheel turbine?
2. What is breaking jet in Pelton wheel turbine?
3. What is the function of casing in Pelton turbine
4. Draw a simple sketch of Pelton wheel bucket.
5. What is the function of surge tank fixed to penstock in Pelton turbine?

RESULT:

Thus performance tests are conducted on the Pelton wheel turbine and characteristic curves are drawn.



SCHEMATIC DIAGRAM OF RECIPROCATING PUMP

Ex.No.10 **PERFORMANCE TEST IN RECIPROCATING PUMP**

Date:

AIM:

To conduct performance test in a reciprocating pump.

APPARATUS REQUIRED:

- Reciprocating test rig
- Stop watch
- Meter scale
- Pump

THEORY:

Reciprocating pumps are also classified as positive displacement pumps. Here definite volume of liquid is trapped in a chamber which is alternatively filled from the inlet and emptied at a higher pressure through the discharge. Most piston pumps are acting with liquid admitted alternatively on each side of the piston so that one part of the cylinder is being filled where as the other being emptied to minimize fluctuations in the discharge.

OBSERVATIONS:

Energy meter constant (N_e) = 100 rev/ KW-hr

Stroke length of the pump (L) = 0.045m

Bore (d) = 0.04m

Area of the collecting tank (a) = 0.25 m^2

FORMULAE USED FOR CALCULATION:

1. Piston area (A) = $(\Pi/4) \times L^2$ in m^2
2. Percentage of slip= $[(Q_t - Q_a)/ Q_t] \times 100$ in%
3. Theoretical discharge (Q_t) = $(2 \times L \times A \times N)/ 60$ m^3/sec
4. Actual discharge (Q_a) = $[(A\times H)/ t]$ (in m^3/sec)

   t- Time taken for 10cm rise in water level.

   H= suction head (h_s) + Delivery head (h_d) in meters of water.

5. Over all Efficiency (η_O) = $(P_0/P_i) \times 100$ in %
6. Output power (P_0) = $(3600/ N_e) \times (10/t_e)$ in Kw
7. Input power (P_i) = $(\rho \times g \times Q_a \times H) / 1000$ in Kw

   ρ- Density of water = 1000 Kg/ m^3

PROCEDURE:

a) Keep the delivery valve open and switch on the pump. Slowly close the delivery valve and maintain a constant head.
b) Note the delivery and suction gauge reading.
c) Note the time for 10 rev of energy meter.
d) Note the time for 10cm rise in water level in the collecting tank.
e) Note the speed of the pump (N) Rpm.
f) Repeat the procedure for various openings of the delivery valve.

OBSERVATION TABULAR COLUMN:

S.No.	Pressure gauge reading (Kg/cm^2)	Vacuum gauge reading (mm of Hg)	Time for 10 rev in energy meter (t_e) (in sec)	Time taken for 10cm rise in water level (t) (in sec)	Delivery head (h_d) (in m)	Suction Head (h_s) (in m)
1.						
2.						
3.						
4.						
5.						

CALCULATION TABULAR COLUMN:

S.No.	Total Head (H) (in m)	Actual discharge (Q_a) (in m^3/sec)	Theoretical Discharge (Q_s) (in m^3/sec)	Percentage of Slip in %	Input power (in Kw) P_i	Output power (in Kw) P_0	Overall efficiency η_O
1.							
2.							
3.							
4.							
5.							

GRAPHS TO PLOT:

- Total head (H) Vs Actual Discharge (Q_a)
- Total head (H) Vs Output power (P_0)
- Total head (H) Vs Over all Efficiency (η_O)

Answer the following:

1. What is separation in reciprocating pump?
2. How separation occurs in reciprocating pump?
3. Write down the equation for loss of head due to acceleration in reciprocating pump.
4. Write down the equation for loss of head due to friction in reciprocating pump.
5. Differentiate single acting and double acting reciprocating pump.

RESULT:

Thus, the performance test in a reciprocating pump has been conducted successfully with the following values

1. Maximum efficiency of the pump =
2. Maximum head of the pump =

Ex.No.11 **PERFORMANCE TEST IN SUBMERSIBLE PUMP**

Date:

AIM:

To conduct performance test in a submersible pump.

APPARATUS REQUIRED:

- SUBMERSIBLE PUMP test rig
- Stop watch
- Meter scale
- Plump bob

FORMULAE USED FOR CALCULATION:

1. Discharge, $Q = a_1 \times a_2 \sqrt{(g \times h)} / \sqrt{(a_1^2 - a_2^2)}$ in m^3/ sec.

a_1= inlet area of venturimeter

a_2= throat area of venturimeter

$h = (h_1 - h_2) \times [(s_m/s_w) - 1]$ in m

g is the acceleration due to gravity m/sec^2

$a_1 = \frac{\pi}{4} d_1^2$, where d_1 = diameter of the inlet (m)

$a_2 = \frac{\pi}{4} d_2^2$, where d_2 = diameter of outlet (m)

S_m = specific gravity of the manometric liquid = 13.6

S_l = specific gravity of the flowing liquid = 1

2. Output power, $P_o = (\rho \times g \times Q \times H_d)/ 1000$ Kw

The total efficiency head H in meters of water column = H_d

(The delivery pressure is in Kg/ cm^2; the total head developed in the pump has to be converted in metres of water column).

3. Input power, $P_i = (3600 \times 10)/ (N_e \times t)$ Kw

4. Efficiency of the pump = P_o / P_i in %

PROCEDURE:

1. The following observations have to be made before starting the experiment.

- Size of the collecting tank
- Energy meter constant

2. Delivery valve is kept full open

3. The pump is operated by switching on the motor.

4. The following observations are made

- Pressure gauge reading (Kg/cm2).
- Vacuum gauge reading (mm of Hg).
- Time taken for 10 revolutions of energy meter disc (t) seconds.
- Time taken for 10cm rise of water level in collecting tank.

5. The procedure is repeated for various pressure heads by adjusting the pressure valve.

6. It is very important that the pressure valve should not be closed fully.

OBSERVATION TABULAR COLUMN:

S.No.	Manometer reading In m			Time taken for 10 cm rise of water in the collecting tank	Delivery gauge reading	
	h_1	h_2	h		Kg/cm2	m of water
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

CALCULATION TABULAR COLUMN:

S.No.	Discharge Q In mm^3/sec	Output power in Kw	Input power In Kw	Efficiency
1				
2				
3				
4				
5				
6				
7				
8				

GRAPH TO PLOT:

- Discharge Vs Power
- Discharge Vs Head
- Discharge Vs Efficiency

Answer the following:

1. Explain with neat sketch the working principle of rotary pump(Gear / Vane pump)
2. Derive the efficiencies in centrifugal pump
3. Derive the amount of work saved by air vessel in reciprocating pump.

RESULT:

Thus, the performance test in a submersible pump has been conducted successfully with the following values

Maximum efficiency of the pump =