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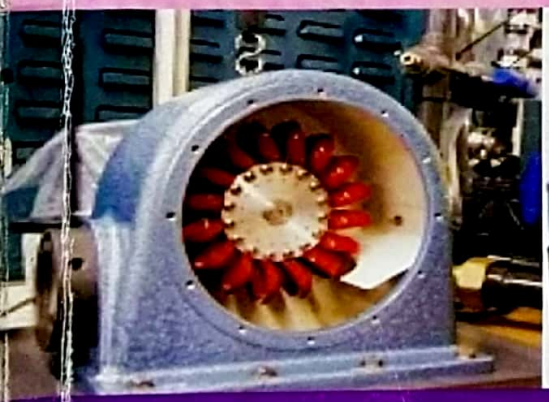
Name Chirag Rajiv Thakur

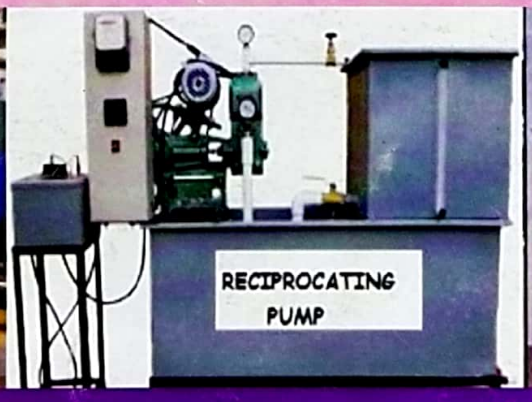
Roll No. 23 Year 20 19 20 20

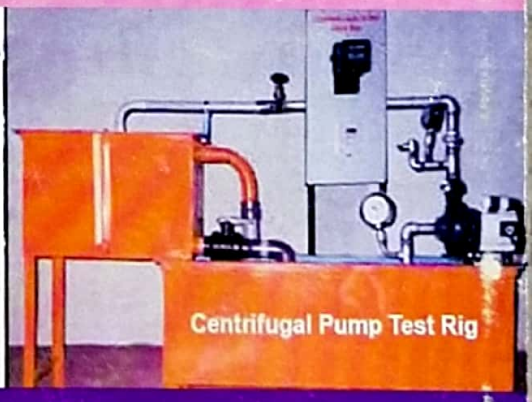
Exam Seat No.

MECHANICAL GROUP | SEMESTER - IV | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL FOR FLUID MECHANICS AND MACHINERY (22445)







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Certificate

This is to certify that Mr. / ~~Ms~~ Chirag Rajiv Thakur

Roll No. 23 of Fourth Semester of Diploma in Mechanical Engineering of Institute V.E.S. Polytechnic, Chembur

(Code 0004) has completed the term work satisfactorily in course Fluid Mechanics and Machinery **(22445)** for the academic year 20.19 to 20.20 as prescribed in the curriculum.

Place Chembur
Date:

Enrollment No. 1800040362
Exam Seat No. 104606

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Content Page

List of Practical and Progressive Assessment Sheet

S. No	Practical Outcome	Page No.	Date of performance	Date of submission	Assessment marks(25)	Dated sign. of teacher	Remarks (if any)
1.	Use Bourdon's pressure gauge and U-tube Manometer to measure water pressure also Measure discharge of water using measuring tank and stop watch.*	1	14/12/19	28/12/19	24	AP 28/12	
2.	Measure Total Energy available at different sections of a pipe layout	11	28/12/19	4/1/20	23	AP 04/01	
3.	Use Venturimeter to measure discharge through a pipe*	22	4/1/20	11/1/20	24	AP 11/01	
4.	Use Sharp edged circular orifice to measure discharge through a pipe	31	11/1/20	25/1/20	24	AP 25/01	
5.	Estimate Darcy's friction factor 'f' in pipes of three different diameters for four different discharges	42					
6.	Determine frictional losses in sudden expansion and sudden contraction in pipe.*	51	25/01/20	29/02/20	25	AP 29/02	
7.	Determine frictional losses in bend in pipe.						
8.	Determine frictional losses in elbow in pipe.						
9.	Determine the force exerted by a jet on flat plate	62					
10.	Use Pelton wheel test rig to determine overall efficiency	70					
11.	Dismantle a Centrifugal pump. *	79	15/2/20	29/2/20	25	AP	
12.	Assemble a Centrifugal pump.*					29/02	
13.	Determine overall efficiency of Centrifugal Pump	88					
14.	Dismantle a Reciprocating pump *	98	7/3/20	7/3/20	24	AP 07/03/20	
15.	Assemble a Reciprocating pump*				24	AP 07/03/20	

Practical No.1: Measure water Pressure using Bourdon's pressure gauge and U-tube Manometer and discharge of water using measuring tank and stop watch.

I Practical Significance

Pressure measurement is the analysis of an applied force by a fluid on a surface. Pressure is typically measured in units of force per unit of surface area. Many techniques have been developed for the measurement of pressure. Instruments used to measure and display pressure in an integral unit are called pressure gauges.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use Bourdon's pressure gauge, Manometer & Discharge measurement instrument'**

IV Relevant Course Outcome(s)

1. Use Manometers and Bourden's gauge to measure pressure.

V Practical Outcome

- Use Bourdon's pressure gauge and U-tube Manometer to measure water pressure.
- Measure discharge of water using measuring tank and stopwatch

VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

Bourdon pressure gauge is used to measure pressure . The pressure to be measured is applied to a curved tube, oval in cross section. Pressure applied to the tube tends to cause the tube to strengthen out .The deflection of the tube is communicated through a system of levers to a recording needle

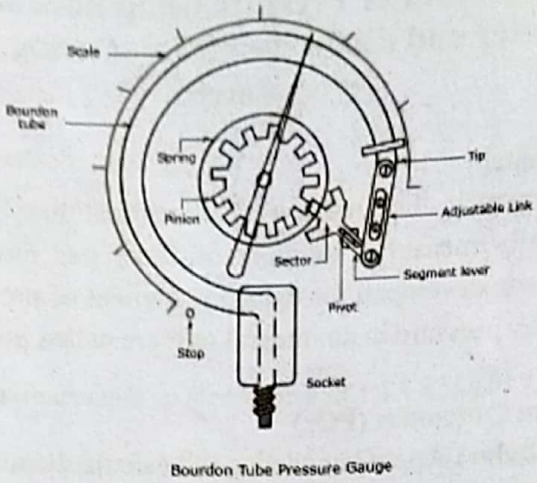


Figure 1- Construction of Bourdons pressure Gauge

U Tube Manometer: A manometer works on the principle of hydrostatic equilibrium and is used for measuring the pressure exerted by a liquid . Hydrostatic equilibrium states that the pressure at any point in a fluid at rest is equal, and its value is just the weight of the overlying fluid. In its simplest form, a manometer is a U-shaped tube consisting of an incompressible fluid like water or mercury. It is inexpensive and does not need calibration.

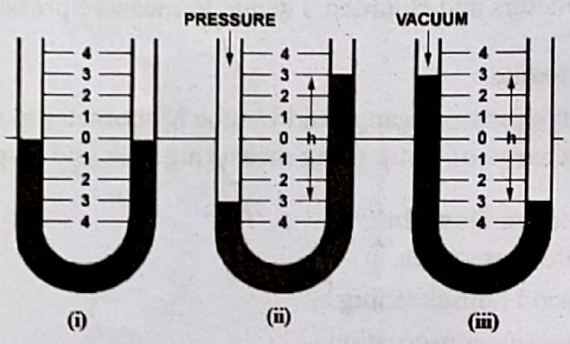


Figure 2- U Tube Manometers

Measurement of Discharge: Discharge is the volumetric flow rate of water. It is commonly expressed in cubic meter per second. Simplest method to measure the discharge of water is with the help of measuring tank.

VIII Experimental setup

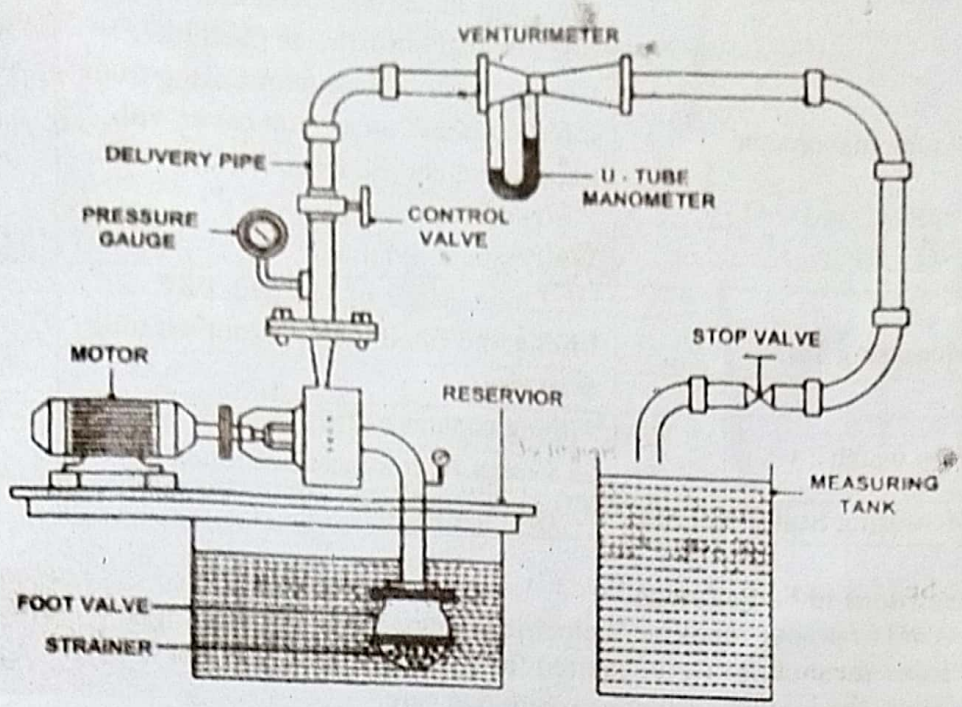


Figure 3 Experimental Set up

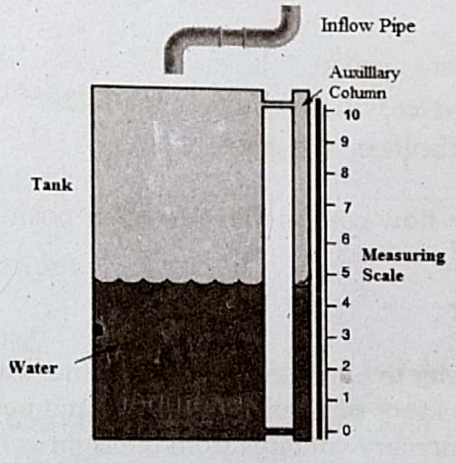


Figure 4: Measuring Tank for discharge Measurement.

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Centrifugal Pump Test Rig along with necessary pipe fitting & Accessories.	**Pump :** 1HP Centrifugal Pump.**DC motor :** 1HP. **Supply Tank :** 80 Ltrs. Made of MS with FRP Lining. **Piping :** GI/PVC	1
2	Bourdon pressure gauge	Range 0 to 12 bar	1

3	Venturimeter	Venturi-meter - 13 mm (Mild Steel)	1
4	U tube manometer	Metering Tube : Special uniform bare thick walled borosilicate glass tube Casing : M.S. /Aluminum Casing from three sides and aluminum cover with transparent acrylic front Zero adjustment scale Wall / Stand mounted	1
5	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
6	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
7	Measuring Scale/steel rule	Range upto 60 cms	1

X Precautions to be Followed

1. Avoid improper handling of electrical connections of Centrifugal pump.
2. Please ensure Priming is required for centrifugal pump or not.
3. Handle the U- tube manometer with due care.
4. Handle the venurimeter pipes with due care.
5. Handle Stop watch carefully.

XI Procedure

For Bourdon Tube Pressure gauge

1. Start the pump and water will flow in the pipe line.
2. Record the indicated units on the gauge.
3. Record the pressure.
4. Adjust & change the flow control valve to other position and record the reading of pressure gauge.

For U Tube Manometer

1. Connect the manometer to pipe through which fluid/water the is flowing
2. Remove air from the limbs of U tube mercury manometer.
3. Note the heights of mercury columns from the right and left limbs
4. Calculate the difference of above two mercury columns
5. Calculate the head in meters of water, meters of liquid and in N/m^2.
6. Repeat step 6 to 9 by adjusting flow control valve/flow rates.

For Discharge Measurement with Measuring Tank

1. Measure the dimensions for calculating cross sectional area of measuring tank
2. Start the pump.
3. Collect the flow of water in the measuring tank similar to tank as shown in the figure 4.
4. Start the stop watch when you start to collect flow of water in the measuring tank.
5. Note the height of water in the tank after pre-decided time.
6. Stop collecting water in the tank

7. Stop the pump.
8. Calculate volume of water collected in the tank
9. Calculate the discharge of water = Volume of Water /Time = cm^3/sec.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.	Bourden pressure gauge		Range - 0 to 6 bars	01	
2.	Venturimeter		Venturimeter - 13 mm MS	01	
3.	U-tube Manometer			01	
4.	Measuring tank		40 lts	01	
5.	Measuring scale		Upto 60 cms	01	

XIII Actual Procedure Followed

Refer XI

XIV Precautions Followed

① Avoid improper handling of electrical components of centrifugal pump.
② Handle the U-tube manometer with due care
③ Handle Stopwatch carefully.

XV Observations and Calculations.

1. Pressure Gauge reading

Sr No	Pressure Reading In Kg_f / cm^2	Pressure Reading in N/m^2
1	40	392.4×10^4
2	45	441.45×10^4
3		
4		

2. U Tube Manometer reading

S_1= Specific gravity of liquid flowing through pipe (water) = 1

S_2= Specific gravity of manometer fluid (mercury) = 13.6

Reading for finding differential head:

Sr. No.	Height of Hg in cm the left Limb	Height of Hg in cm the left Limb	Difference In meters	Differential head in the meters of water	Differential head in N/m^2
	h_1	h_2	$x = (h_1 - h_2)/100$	$H = x(S_2 - S_1)/S_1$	P
1	16.7	12.2	0.045	0.567	5562.27
2	16.1	12.8	0.033	0.4158	4078.998
3	17.4	11.6	0.058	0.7308	7169.148

Calculation of Manometer reading:

For x= 4.5 cms = 0.045 meters.

Differential head in meters of water, $H = \frac{x(S1-S2)}{S1}, = \frac{0.045(13.6-1)}{1} = 0.567$ meters of water

H= 0.567 meters.

Pressure Intensity = (P) =W *H

Whrer, W= specific weight of water = 9810 N/m^2

P = 9810 * 0.567 P = 5562.27 N/m^2

2. Discharge Measurement reading–

(a) Measuring tank Dimension= Width **W** = 36 cms,

(b) Breadth, **B** = 26 cms

Sr No	Initial Auxiliary tube reading (I_1) in cm	Final Auxiliary tube reading (I_2) in cm	Height of Water in Auxiliary tube $H_1 = I_2 - I_1$ cm.	Time Required for collecting Water sec.	Discharge Q m^3/s
1	5	15	10	21	4.457×10^{-4}
2	5	15	10	25	3.744×10^{-4}

3	5	15	10	20	4.68×10^{-4}

Calculation of Discharge Measurement reading.

Volume of Water collected in the tank, $V = W * B * H_1$

$V = 0.936$ $cm^3 = 0.00936 m^3$

Time (t) = 25 seconds

Discharge, $Q = \frac{\text{Volume of Water collected}}{\text{Time}}$

$$Q = \frac{V}{t} = \frac{0.00936}{25} = 3.744 \times 10^{-4} \frac{m^3}{sec}$$

XVI Results

Pressure intensity for first flow rate

(i) For Bourdon tube pressure Gauge: - 5 N/m^2

(ii) For Manometer Reading: - 5562.27 N/m^2

(iii) Discharge of water :- 3.744×10^{-4} m^3/sec

XVII Interpretation of Results

1. Bourden tube pressure gauge.
2. For Manometer Reading = 5562.27 N/m^2.
3. Discharge of water = 3.744×10^{-4} m^3/sec.

XVIII Conclusions

Hence, we measured water pressure using Bourden's pressure gauge and U-tube manometer and discharge of water using measuring tank & stop watch.

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. A different pressure gauges show following sets of reading
   (i) 50 psi
   (ii) 100 kg_f/cm^2
   15 bar
   Convert it into N/mm^2 & N/m^2.

2. Convert the following reading
   (i) -30 mm of Hg into KPa
   (ii) 10 PSI into bar.
3. Calculate pressure of liquid in a pipe of specific gravity 0.8 with the help of simple manometer. Manometer contains mercury (take sp.gravity of Hg =13.6). From common datum ,the reading in the left limb is 0.06m & right limb which is open to atmosphere is 0.15 m.

[Space for Answer]

1] (i) a) 50 psi = 0.345 N/mm^2 ... (Dividing by 145)

b) 50 PSI = 34408 N/m^2 ... (multiply by 689)

(ii) a) 100 kg/cm^2 = 9.8067 N/mm^2 ... (Divide by 10.19)

b) 100 kg/cm^2 = 9.8067 N/m^2 ($\times 10^6$)

2] (ii) a) 30 mm of Hg = 3.9997 ≈ 4.000 KPa

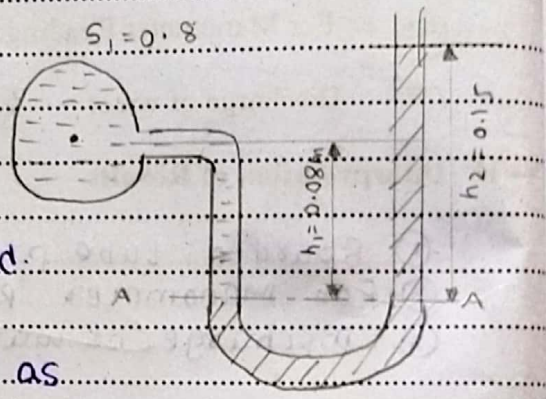
b) 10 PSI = 0.6894 bar ... (Divide by 14.50)

3] Given: $S_1 = 0.8$

$S_2 = 13.6$

$h_1 = 0.06$ m

$h_2 = 0.15$



To find: Pressure of liquid.

Formula: $P_B = \rho g h_B$

Solution: Considering A-A as datum line,

we have,

Pressure head in left limb above A-A

= Pressure in right limb above A-A

$\therefore h_B + S_1 \cdot h_1 = S_2 \cdot h_2$

$\therefore h_B = S_2 h_2 - S_1 \cdot h_1$

$= (13.6 \times 0.15) - (0.8 \times 0.06)$

$= 2.992$ m of water

We have, P_B = Gauge pressure

$= \rho g h_B$

$= 1000 \times 9.81 \times 1.992$

$= 19541.52 \ N/m^2$

$P_B = 0.19542$ Bar

Ans:- Pressure of liquid in a pipe $= 19541.52 \ N/m^2$ or 0.19542 bar

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XX References / Suggestions for Further Reading

1. https://www.slideshare.net/Gauravsingh963/pressure-measuring-devices
2. https://www.youtube.com/watch?v=-9IfpNAESlM
3. https://www.youtube.com/watch?v=HYcuHgSQvyg
4. https://www.youtube.com/watch?v=cq7g3FTsUbY
5. https://www.slideshare.net/hinabhatu/water-measurement-70543237

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	30%
2	Calculation of final readings	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. Amey...Rane.....
2. .Pritem..Parmar
3. .Chirag..Thakur.

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	
15	09	24	AP 28/12

Practical No.2: Measure Total Energy at Different Section of a Pipe Layout.

I Practical Significance

Bernoulli's theorem states " For a perfect and incompressible fluid flowing in a continuous stream ,the total energy of a particle remains same while moving from one point to other".

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.
PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

- This practical is expected to develop the following skills for the industry identified competency **'Maintain hydraulic machinery using knowledge of fluid mechanics'.**

IV Relevant Course Outcome(s)

1. Apply Bernoulli's theorem and Continuity equation to the given discharge measuring device and data.
2. Choose the relevant discharge measuring device for the given application with justification.

V Practical Outcome

- Measure total energy available at various segment pipe-layouts by calculating potential, kinetic & pressure energy at different section.

VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

1. **Energy:** - is defined as the capacity to do work. It exists in various forms and can change from one form to another.
2. **Potential Energy (Potential Head):-** It is the energy possessed by virtue of its position; it is due to configuration or position above some suitable height or datum line. It is denoted by Z.

3. **Kinetic Energy (Velocity Head):** It is energy possessed by a liquid particle by virtue of its motion. It is due to the velocity flowing liquid and is measured as V2/g. Where V is velocity of flow and 'g' is acceleration due to gravity ($g= 9.81 m/s^2$).
4. **Pressure Energy (Pressure Head):-**It is energy possessed by a liquid particle by virtue of its existing pressure. It is due to the pressure of liquid and measured as p /W. Where 'P' is intensity and 'W' is the specific weight of liquid.
5. **Total Energy (Total Head):-** it is the sum of potential energy, kinetic energy and pressure energy. It is denoted by 'E' and mathematically it is expressed as,

   E= Potential Energy+ Kinetic Energy + Pressure Energy

$$E=Z+\frac{V2}{2g}+\frac{P}{W}$$

VIII Experimental setup

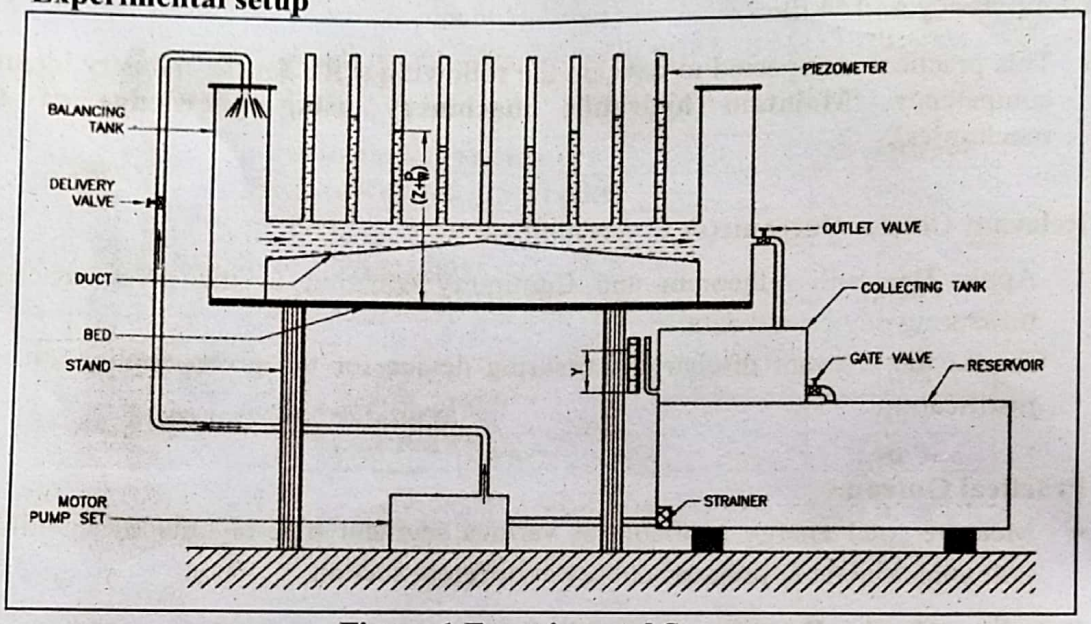


Figure 1 Experimental Set up

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Experimental Set up of Bernoulli's theorem.**	Storage tank: Made up of PVC resist corrosion. Capacity: 100 Ltr. (Approx.), Mono-block pump: 1-phase 1/2 HP, Constant Head Tanks: 2 numbers of suitable size mounted on stand, Differential venturi of 300 mm length made out of Acrylic Square Bar. Multitude Manometer, Material: Aluminum Supporting stand structure for the equipment.	1
2	Pizometer Tubes	Range 0 to 12 bar	1

3	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
4	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
5	Measuring Scale/steel rule	Range up to 60 cms	1

X Precautions to be Followed

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes, note the mean position carefully.
2. Carefully keep some level of fluid in inlet and outlet supply tank.
3. Avoid improper handling of electrical connections of Centrifugal pump.
4. Please ensure Priming is required for centrifugal pump or not.
5. Handle the Pizometer tubes with due care.
6. Handle Stop watch carefully.

XI Procedure

1. Start the pump and water will flow in the pipe line.
2. Open the valve so that the water can enter in the pipe of varying cross section.
3. Open the outlet valve after rising water in piezometer,
4. Maintain level of water .
5. Record head shown in the piezometer.
6. Measure discharge in the measuring tank .
7. Note the time taken for collecting of water by stop-watch.
8. Vary the discharge
9. Repeat the procedure as above. .
10. Plot the following graphs:
    - i) No. of piezometer tube vs. pressure head.
    - ii) No. of piezometer tube vs. velocity head.
    - iii) No. of piezometer tube vs. total head.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.	Piezo-meter tubes	–	Range - 0 - 12 bar	01	

2.	Stopwatch	-	Mechanical or Digital	01	
3.	Steel rule	-	30 cm to 100 cm	01	
4.	Measuring tank	-	W=0.26m B=0.36 m	01	
5.					

XIII Actual Procedure Followed

Refer X

XIV Precautions Followed

1. Handle stopwatch carefully.
2. Handle the Pizometer tubes with due care.
3. Ensure priming is required for Centrifugal pump.

XV Observations and Calculations.

Discharge Measurement reading

Measuring tank Dimension= Width **W** = 0.26 m , Breadth, **B** = 0.36 m

Height of water observed in auxiliary tube H_1= 0.1 m.

Time required for collecting water = 47.67 Seconds.

Calculation of Discharge Measurement reading.

Volume of Water collected in the tank , $V = W * B * H_1$

$V = 9.36 \times 10^{-3}\ m^3$

Time (t) = 47.67 seconds

$$\text{Discharge} = Q_d = \frac{\text{Volume of Water collected}}{\text{Time}}$$

$$Q_d = \frac{V}{t} = \frac{9.36 \times 10^{-3}}{47.67} = \frac{m3}{s}$$

Velocity $V = \frac{Qd}{A}$,

Where A= Area at corresponding tube section

Velocity head at respective point = $V^2/2g$ = 0.194 m.

Pressure Head= P/w = 0.280 m

Potential head = constant (same datum for all tubes)

For Discharge – Q1 = 1.9634×10^{-4} m^3/sec

Tube No.	Cross Sectional Area of the Pipe m^2 ($\times 10^{-4}$)	Velocity 'V' m/sec	Velocity Head $\frac{V^2}{2g}$	Pressure Head $\frac{P}{w}$	Total Head= Velocity Head+ Pressure Head $(V^2/2g)+\frac{P}{w}$
1	3.173	0.0194	0.618	0.280	0.2994
2	2.3778	0.0346	0.276	0.276	0.3046
3	1.6572	0.0719	1.138	0.256	0.3279
4	1.8145	0.0596	1.082	0.225	0.2846
5	2.2431	0.0265	0.722	0.146	0.166
6	2.7171	0.0390	0.875	0.205	0.244 0.2803
7	3.2685	0.0183	0.600	0.232	0.2503
8	3.8359	0.0133	0.511	0.245	0.258
9	4.5239	0.009	0.434	0.253	0.262

For Discharge – Q2 = 1.734×10^{-4} m^3/sec

Tube No.	Cross Sectional Area of the Pipe	Velocity 'V'	Velocity Head	Pressure Head	Total Head= Velocity Head+ Pressure Head
	m^2 $(\times 10^{-4})$	m/sec	$\frac{V^2}{2g}$	$\frac{P}{w}$	$(V^2/2g)+\frac{P}{w}$
1	3.173	0.54	0.014	0.284	0.298
2	2.3778	0.72	0.026	0.275	0.0301
3	1.6572	1.04	0.055	0.264	0.0319
4	1.8145	0.93	0.044	0.238	0.282
5	2.2431	0.77	0.030	0.168	0.198
6	2.2171	0.63	0.020	0.220	0.240
7	3.2685	0.529	0.014	0.243	0.237
8	3.8359	0.451	0.010	0.253	0.263
9	4.5238	0.382	0.007	0.259	0.266

For Discharge – Q3 = 1.9634×10^{-4} m^3/sec

Tube No.	Cross Sectional Area of the Pipe	Velocity 'V'	Velocity Head	Pressure Head	Total Head= Velocity Head+ Pressure Head
	m^2 $(\times 10^{-4})$	m/sec	$\frac{V^2}{2g}$	$\frac{P}{w}$	$(V^2/2g)+\frac{P}{w}$
1	3.173	0.618	0.194	0.294	0.313
2	2.3778	0.825	0.0346	0.291	0.325
3	1.6572	1.18	0.0749	0.290	0.360
4	1.8145	0.65	0.02	0.285	0.31
5	2.2431	0.77	0.03	0.275	0.305
6	2.2171	0.63	0.02	0.280	0.3
7	3.2685	0.529	0.014	0.281	0.294
8	3.8359	0.451	0.01	0.287	0.291
9	4.5238	0.38	0.007	0.290	0.297

XVI Results

(i) Velocity head at respective point = $V^2/2g$ = 0.198 m.

(ii) Pressure Head= P/W = 0.280 m

(iii) Total Head = $V^2/2g + P/w$ = 0.2994 m

Calculations :-

Cross-sectional Area = 3.173×10^{-4} m^2

$Q = 1.9634 \times 10^{-4}$

$Q = AV$

$\therefore V = \frac{Q}{A}$

$= \frac{1.9634 \times 10^{-4}}{3.173 \times 10^{-4}}$

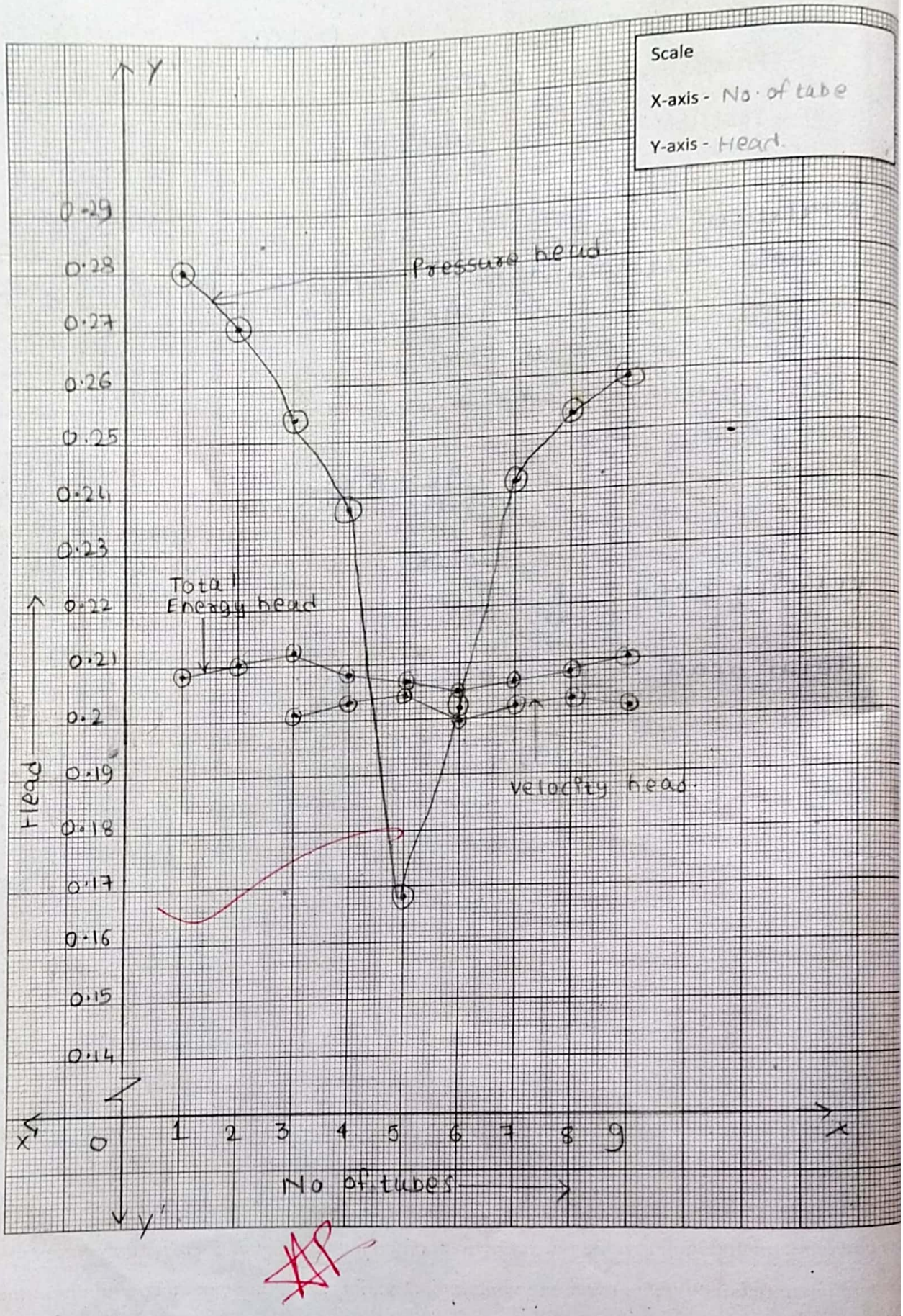
$= 0.68$

Velocity head = $\frac{P}{w}$ = 0.280

Total head = $\frac{P}{w} + 0.280 \cdot \frac{V^2}{2g}$

= 0.2994

(Add Graph)



XVII Interpretation of Results

The total head is the sum of pressure and velocity head.

XVIII Conclusions

Hence, Bernoulli's theorem is verified as the total head at different section is almost done.

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Water is flowing in a fire hose with a velocity of 1.0 m/s and a pressure of 200000 Pa. At the nozzle the pressure decreases to atmospheric pressure (101300 Pa), there is no change in height. Use the Bernoulli equation to calculate the velocity of the water exiting the nozzle. (Hint: The density of water is 9810 N/m^3 and gravity g is 9.8 m/s^2).
2. Water is flowing at a rate of $2m^3/s$ through a tube with a diameter of 1m. If the pressure at this point is 80 kPa, what is the pressure of the water after the tube narrows to a diameter of 0.5m?
3. Suppose that a huge tank 50 m high and filled with water is open to the atmosphere and is hit with a bullet that pierces one side of the tank, allowing water to flow out. The hole is 2m above the ground. If the hole is very small in comparison with the size of the tank, how quickly will the water flow out of the tank?

[Space for Answer]

1)

$V = 1\ m/s$, $P_1 = 2 \times 10^5\ Pa$, $P_2 = 1.013 \times 10^5\ Pa$

By Bernoulli's thm.,

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 \quad \ldots [z_1 = z_2]$$

$$\frac{2 \times 10^5}{g} + \frac{1}{2g} = \frac{1.013 \times 10^5}{g} + \frac{V_2^2}{2g}$$

$$\frac{1 \times 10^5 + 1}{2g} = \frac{V_2^2 + 2.026 \times 10^5}{2g}$$

$$\therefore V_2^2 = 1.974 \times 10^5 + 1 = 197401$$

$$\therefore V_2 = 444.29\ m/s$$

XX References / Suggestions for Further Reading

1. https://study.com/academy/lesson/bernoullis-equation-formula-and-examples.html
2. https://oyc.yale.edu/physics/phys-200/lecture-20
3. https://www.youtube.com/watch?v=QnTt9huzdNU
4. https://www.youtube.com/watch?v=DClKlRZKWWk
5. https://www.slideshare.net/eliseb/bernoullis-principle-465993

XX Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the measuring Instruments	30%
2	Calculation of final readings	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ....Amey Rane.....
2. ..Paiten Parmar
3. ..Chirag Thakur
4. ..Sushil Deshmukh

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	
14	09	23	AP 04/01/20

Practical No.3: Use Venturimeter to Measure Discharge through a Pipe.

I Practical Significance

Venturimeter is a device used for measuring the flow rate. It consists of three parts, Convergent, Throat and divergent cones.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Maintain hydraulic machinery using knowledge of fluid mechanics'.

IV Relevant Course Outcome(s)

1. Apply Bernoulli's theorem and Continuity equation to the given discharge measuring device and data.
2. Describe with sketches the procedure to calculate discharge using the given flow meter.

V Practical Outcome

- Measure flow rate of fluid flowing through the pipe using venturimeter.
- Apply the concept of coefficient of discharge and interpret its important in flow rate calculation.

VI Relative Affective Domain

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

1. **Discharge:** The volume of liquid flowing per unit time through a section of pipe or channel is known as discharge or flow rate.
2. **A venturi meter** is also called a venturi flow meter. It is used to calculate the velocity of fluids flowing through a pipeline.

Experimental setup

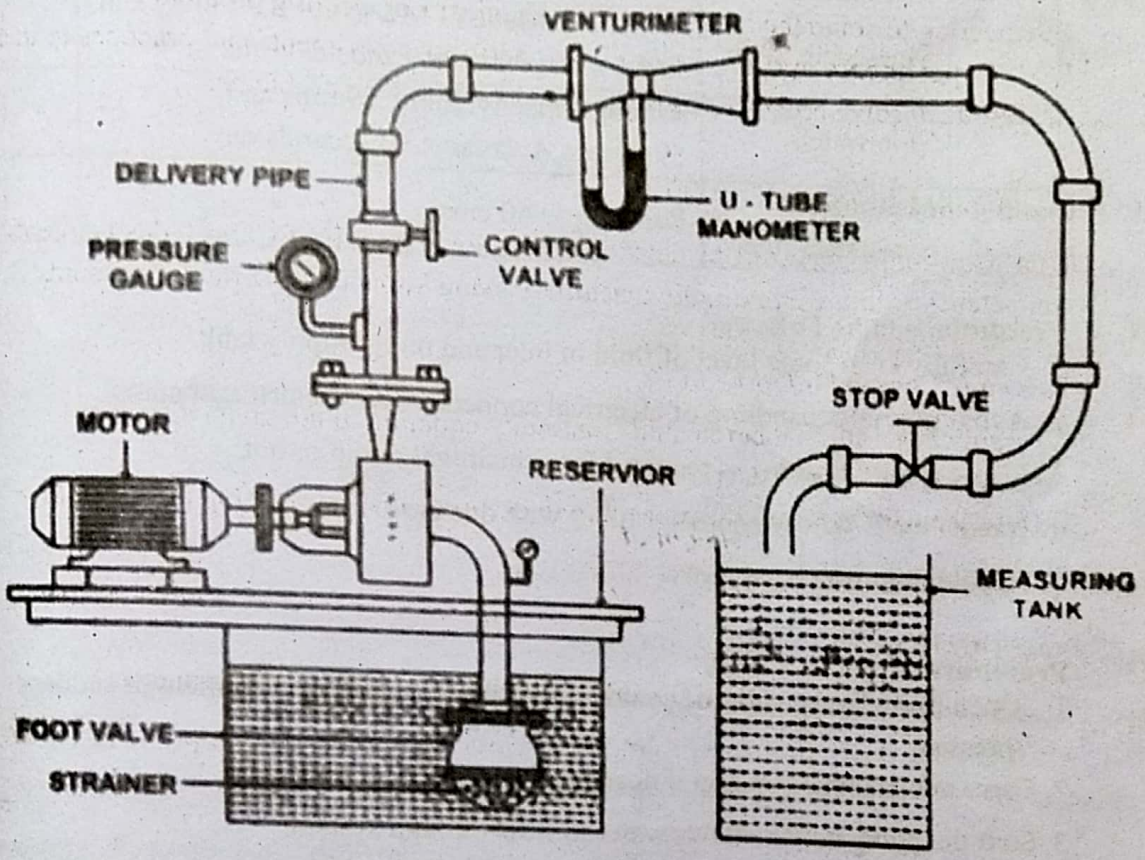


Figure 1 Experimental Set up

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Venturimeter Test Rig consisting of**	**Venturimeter fitted with on the pipe Pump :** 1HP Centrifugal Pump.**DC motor :** 1HP.**Supply Tank :** 80 Ltrs. Made of MS with FRP Lining.**Piping :** GI/PVC.	1
2	U Tube mercury Manometer	It is connected to pipe & Throat section of Venturimeter.	
3	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
4	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
5	Measuring Scale/steel rule	Range upto 60 cms	1

IX Precautions to be Followed

1. Carefully keep some level of fluid in inlet and outlet supply tank.
2. Avoid improper handling of electrical connections of Centrifugal pump.
3. Please ensure Priming is required for centrifugal pump or not.
4. Handle the U tube Manometer tubes with due care.
5. Handle Stop watch carefully.

X Procedure

1. Open the delivery valve of centrifugal pump, to avoid development of sudden pressure.
2. Carry out priming of pump if necessary.
3. Start the pump which allows water to flow through system.
4. Adjust the discharge by control valve.
5. Collect water in a measuring tank to measure the actual discharge.
6. Use stop watch to measure time for collecting water in seconds.
7. Open the two taps simultaneously to connect the venture meter to mercury manometer.
8. Note the height of deflection of mercury column in mercury manometer.
9. Drain the water collected in the measuring tank after each observation.
10. The discharge through the venturimeter can be varied by operating the control valve and repeat the step 4 to 7 for each discharge rate.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.	Venturimeter	Extreme	Pump - 1HP DC motor - 1HP Supply tank 8 OURS	1	
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

Refer Point X

XIII Precautions Followed

1. Carefully keep same level of fluid in inlet and outlet supply tank.
2. Avoid improper handling of electrical connections of centrifugal pump.
3. Please ensure priming is required for centrifugal pump or not.
4. Handle the U-tube manometer tubes with due care.
5. Handle stopwatch carefully.

XIV Observations and Calculations.

Coefficient of Discharge = C_d= 0.98

Reading of calculation of actual discharge

Sr. No.	Rise of water level of Measuring Tank H_1		Deflection of mercury column of the manometer			Converted water columns height (m) $H = H_{hg}(13.6-1)$	Time to collect the water in measuring tank (t)
			H_{throat}	H_{pipe}	$H_{hg}=(H_p-H_t)/100$ $(H_t-H_p)/100$		
	mm	m	cm	Cm	m	m	sec
1	100	0.1	167	122	0.045	0.567	21
2	100	0.1	161	128	0.033	0.415	25
3	100	0.1	174	116	0.058	0.730	20
4							
5							
6							
7							
8							
9							
10							

Discharge Measurement reading– no. 02

Measuring tank Dimension= Width **W** = 0.36 m, Breadth, **B** = 0.26 m

Height of water observed in auxiliary tube H_1= 0.001 m

Time for collecting water in tank t = 25 Seconds.

Calculation of Actual Discharge

Volume of Water collected in the tank, **V= W*B* H_1**

V = 0.00936 m^3

Time (t) = 25 seconds

Diameter of venturimeter at inlet, d1 = 25.4 mm = 0.0254 m

Cross sectional area a_1 = 5.067×10^{-4} m^2

Diameter of venturimeter at throat, d2 = 14.5 mm = 0.0145 m

Cross sectional area a_2 = 1.6513×10^{-4} m^2

Actual Discharge = Q_{act1} = Q = $\frac{\text{Volume of Water collected}}{\text{Time}} = \frac{0.00936}{25}$

$Q = \frac{V}{t} = 0.0003744$ $\frac{\mathbf{m3}}{\mathbf{sec}}$

Qth = Theoretical Discharge = Qth = $\frac{a1a2\sqrt{2gh}}{\sqrt{a1^2 - a2^2}}$ = 4.99×10^{-4} m

Q_{act2}= C_d* Qth = 5.09×10^{-4} m^3/sec

Difference between $Q_{act1} - Q_{act2}$ = 1.346×10^{-4} m^3/sec

XVI Results

Actual Discharge = 3.744×10^{-4} m^3/sec

Qth= Theoretical Discharge = Qth = $\frac{a1a2\sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ = 4.99×10^{-4} m^3/sec

Q_{act2}= C_d* Qth = 5.09×10^{-4} m^3/sec

Difference between $Q_{act1} - Q_{act2}$ = 1.346×10^{-4} m^3/sec

XVII Interpretation of Results

Theoretical Discharge = 4.99×10^{-4} m

Actual Discharge = 3.744×10^{-4} m

XVIII Conclusions

Hence, we performed the venturimeter to measure discharge of fluid.

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State which relevant discharge measuring device is used in following application (i) To measure the speed of the air around the plane.(ii) To measure the fuel and air

distribution in carburetor (iii) volumetric or mass flow rate determination in chemical & petro chemical plants.

2. State Industrial applications of Venturimeter
3. State the use of venturi in carburetor of automobiles?
4. Write down the effect of changing throat diameter on coefficient of discharge.

[Space for Answer]

2) ① To measure speed of air around the plane.
② To measure the fuel distribution in carburator
③ To measure the volume flow of blood through vessels.
④ To measure flow rate of chemical through pipe.

3) Uses of venturi in carburetor of automobiles are as follows.
① It is used to measure airflow in car engine and to ensure that correct amount of fuel is fed to gas combustion engine when needed during during.
② Venturimeter allows carburator to just & calibrate distribution of fuel and air to engine as needed.

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XX Suggestions for Further Reading

1. https://www.youtube.com/watch?v=UNBWI6MV_lY
2. https://www.youtube.com/watch?v=tGQqEZDFVUA
3. https://www.youtube.com/watch?v=YHEPx9m9VXc
4. https://www.youtube.com/watch?v=WvFNqEPNPOc

XXI Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ..Amey..Rane.....
2. ..Chirag..Thakur...
3. ..Priyesh..Mhatre..
4. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
15	09	24	11/01/20.

Practical 4: Use Sharp Edged Circular Orifice for Measuring Discharge

I Practical Significance

An orifice plate is a device used for measuring discharge. Volumetric or mass flow rate may be determined, depending on the calculation associated with the orifice plate.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

IV Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Maintain hydraulic machinery using knowledge of fluid mechanics '.

IV Relevant Course Outcome(s)

1.Use flow meters to measure the rate of flow

V Practical Outcome

- Use Sharp edged circular orifice to measure discharge through a pipe .

VI Relative Affective Domain-

- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

An **orifice plate** is a device used for measuring flow rate, for reducing pressure or for restricting flow.

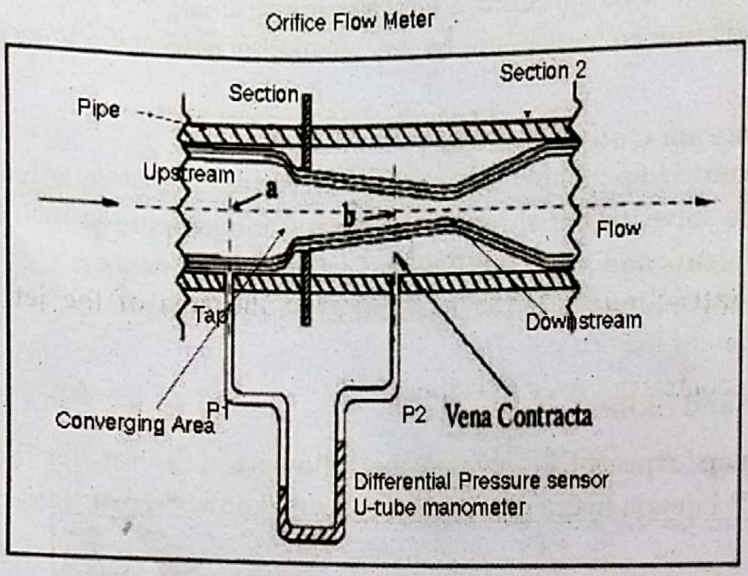

Figure 1: Orifice Meter

1. Vena-contracta:-

Consider an orifice is fitted with a tank. The liquid particles, in order to flow out through the orifice, move towards the orifice from all directions. A few of the particles first move downward, then take a turn to enter into the orifice and then finally flow through it.

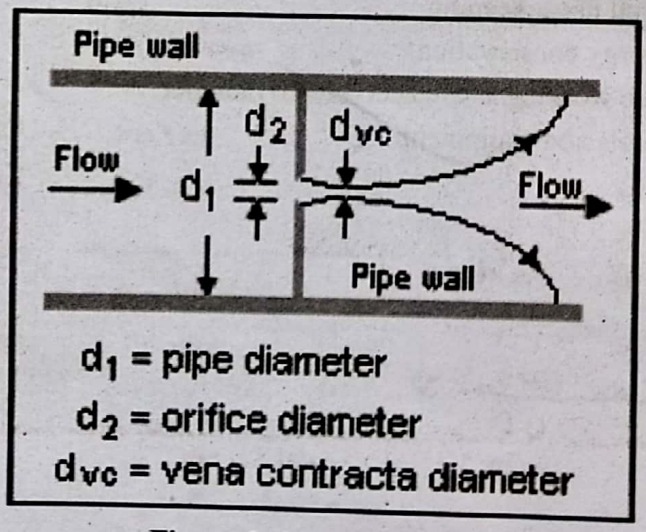

Figure 2: Vena Contracta

2. Coefficient of Discharge:-For an orifice meter, the discharge coefficient (also known as coefficient of discharge) is the ratio of the actual discharge to the theoretical discharge,

3. **Coefficient of Velocity:-**The ratio of actual velocity of the stream at vena-contract to the theoretical velocity is known as the coefficient of velocity

$$C_v = \frac{v_{act}}{v_{th}}$$

$$= \frac{v_{act}}{\sqrt{2gh}}$$

4. **Coefficient of contraction.** It is the ratio between the area of the jet at the vena contracta to the area of the orifice .

C_c = Area at vena contracta / Area of orifice.

5. **Experimental setup**

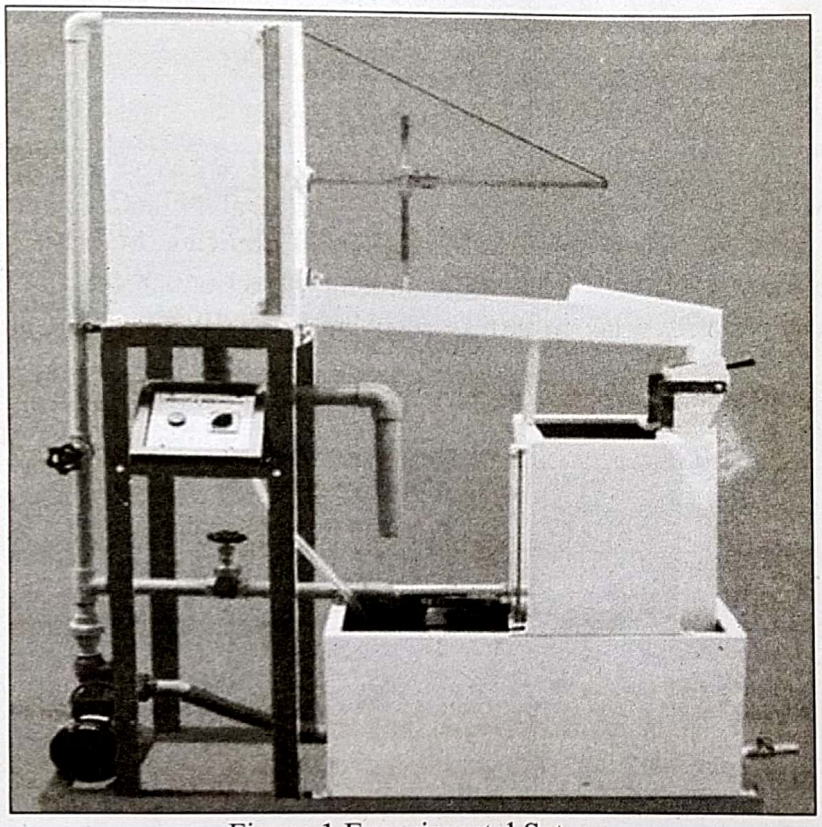

Figure 1 Experimental Set up

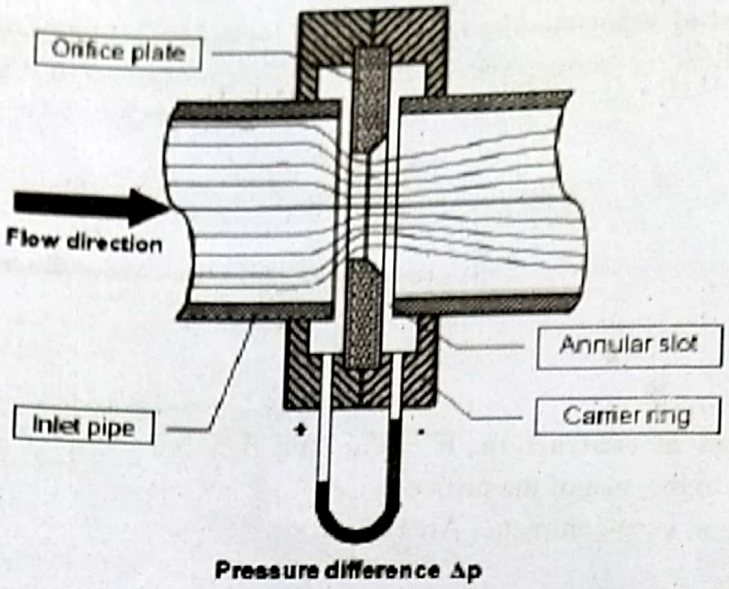

Figure 2- Schematic diagram of Orifice

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Orifice Meter Test Rig**	**Orifice meter fitted with on the pipe Pump :** 1HP Centrifugal Pump.**DC motor :** 1HP.**Supply Tank :** 80 Ltrs. Made of MS with FRP Lining.**Piping :** GI/PVC.	1
2	U Tube mercury Manometer	It is connected to pipe &orificemeter.	
3	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
4	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
5	Measuring Scale/steel rule	Range upto 60 cms	1

6. Precautions to be Followed

1. Carefully keep some level of fluid in inlet and outlet supply tank.
2. Avoid improper handling of electrical connections of Centrifugal pump.
3. Handle the U tube Manometer tubes with due care.
4. Handle Stop watch carefully.

7. Procedure

1.Switch on the power supply to the pump
2.Adjust the delivery flow control valve
3.Note down manometer heads (h1, h2)
4.Note down time taken for collecting 10 cm rise of water in collecting tank (t).
5.Repeat it for different flow rates.
6. Switch off the pump after completely opening the delivery valve.

IX Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.	Orifice meter Test rig	Extreme	Pump- 1 HP DC motor - 1 HP Supply tank - 80 URS	01	
2.					
3.					
4.					
5.					

X Actual Procedure Followed

Refer X

XI Precautions Followed

① Carefully keep same level of fluid in inlet and outlet supply tank.

② Handle the Utube Manometer tubes with due care.

③ Handle stop watch carefully.

XII Observations and Calculations.

Sr. No.	Manometer Reading (cm)			Manometer Head In meters	Time taken for 10 cm rise of water level sec	Actual Discharge m^3/s	Theoretical Discharge m^3/s
	h1	h2	$h_m = h1 - h2$	h_m	t	Q_a	Qt
1	250	35	215	0.215	20	4.68×10^{-4}	3.69×10^{-4}
2	245	45	200	0.200	19.14	4.89×10^{-4}	4.38×10^{-4}
3	250	40	210	0.210	29.52	4.79×10^{-4}	9.88×10^{-4}

Size of pipe : Inlet Dia. d1 = 25 mm , = 0.025 m

Area of pipe = a_1 = 1.962×10^{-3} mm^2

Orifice dia d_2 = 12.5 mm, = 0.0125 m

Area of Orifice = a_2 = 4.90625×10^{-4} mm^2

The actual Discharge , Qa = A x h / t (m3/sec)

Where A = Area of the collecting tank = length x breadth (m^2)

h = Height of water(10 cm) in collecting tank (m),

t = Time taken for 10 cm rise of water (sec) = 20 sec

The Theoretical discharge through orifice meter,

$Qt = (a_1 a_2 \sqrt{2g H}) / \sqrt{(a1^2 - a2^2)}$ m3/sec

Where, H = Differential head of manometer in m of water

= 12.6 x hm m

g = Acceleration due to gravity (9.81m/sec^2)

Inlet Area of orifice meter in m^2 , $a_1 = \pi d1^2/4$,

Area of the throat or orifice in m^2 , $a_2 = \pi d2^2/4$

Draw graph Qa Vs Qt .

XIII Interpretation of Results

Actual discharge $(Q_A) = \frac{A \times h}{t}$

$= \frac{0.26 \times 0.36 \times 0.1}{20}$

$= 4.89 \times 10^{-4}$ m^3/s

Size of pipe, $d_1 = 25$ mm $= 0.025$

$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4} \times (0.25)^2$

$= 4.9 \times 10^{-4}$ m^2

$d_2 = 12.5\ mm = 0.0125\ m$

$A_2 = \frac{\pi}{4} d_2^2$

$= 1.227 \times 10^{-3}\ m^2$

Theoretical Discharge,

$$Q_t = \frac{a_1 a_2 \sqrt{2gH}}{\sqrt{(a_1^2 - a_2^2)}}$$

$$= \frac{4.9 \times 10^{-4} \times 1.227 \times 10^{-4} \times \sqrt{2 \times 9.81 \times 2.52}}{\sqrt{(4.90 \times 10^{-4})^2 - (1.227 \times 10^{-4})^2}}$$

$$= \frac{210.164 \times 10^{-8}}{\sqrt{22.50 \times 10^{-8}}}$$

$$= \frac{4.02 \times 10^{-8}}{4.44 \times 10^{-4}}$$

$$= 8.86 \times 10^{-4}\ m^3/sec$$

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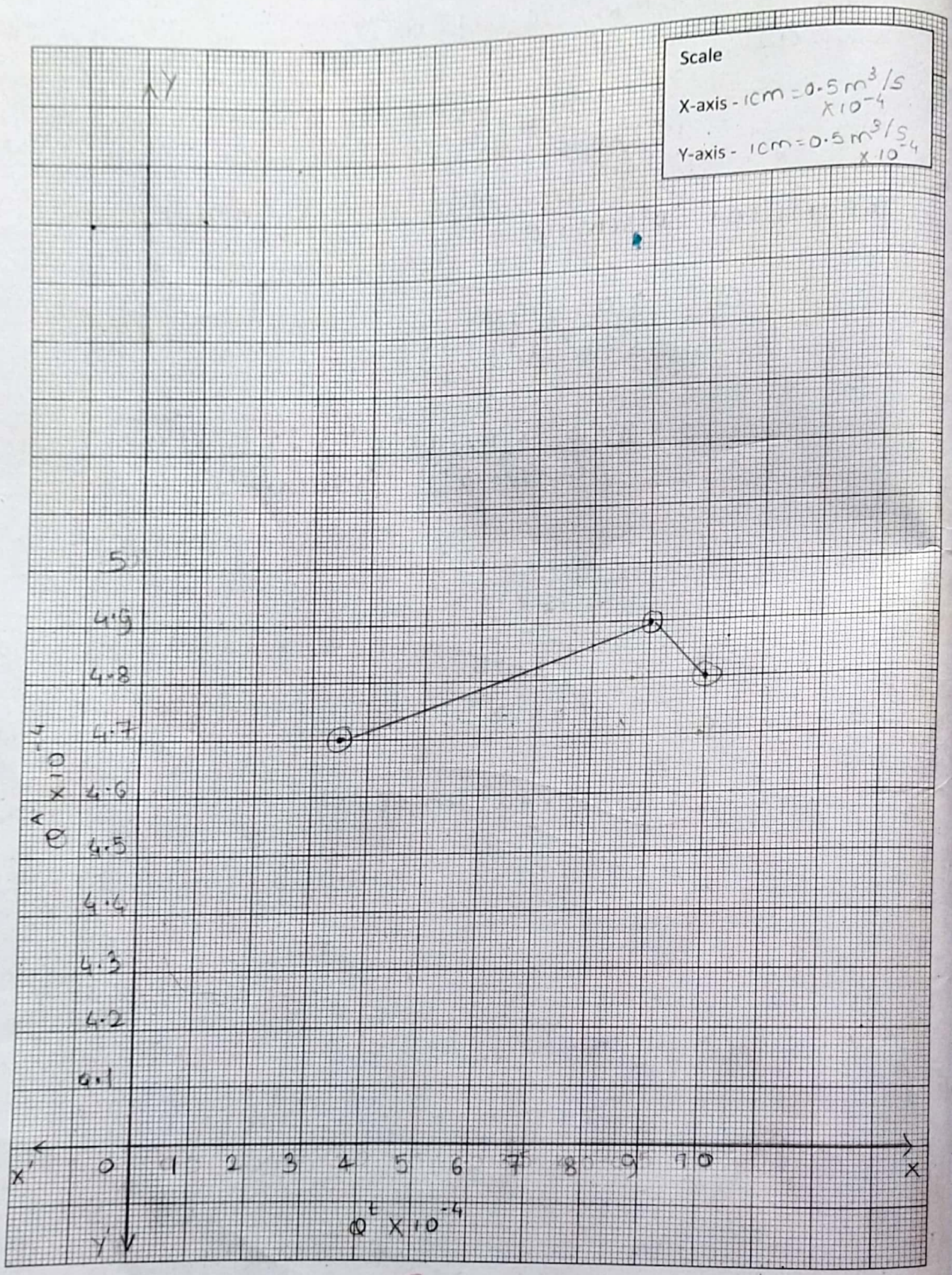

XIV Conclusions

Hence Actual discharge is less than the theoritical discharge due to some losses

XV Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the procedure of measuring actual discharge ,you used in practical
2. Define Vena Contracta.

[Space for Answer]

1] Procedure for actual discharge

(a) Turn off the valve of tank

(b) The water level with start rising in tank.

(c) The turn on the time.

(d) After turning on the time measure how much time it takes to reach 100 mm

(e) Turn ON the exit valve on tank will overflow

2] Vena contracta is the point in a fluid stream where the diameter of stream is least and fluid velocity is at its maximum. Such as in case of a stream issuing of out of nozzle.

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XIX Suggestions for Further Reading

1. https://youtu.be/PhXhGf8-KWY
2. https://youtu.be/JXQxdQt3Zac?t=4
3. https://www.youtube.com/watch?v=YrBUN-8tmsY
4. https://www.youtube.com/watch?v=0lm5n7OfxHg
5. https://www.youtube.com/watch?v=if421Ty1qcE
6. https://www.youtube.com/watch?v=4Ce5TOwmSVI
7. https://www.youtube.com/watch?v=oiTHroPw4TM

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ...Amey Rane.....
2. ...Pritesh Parmar
3. ..Chirag Thakur
4. Sushil Deshmukh

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
15	09	24	25/07/20

Practical No.6, 7, 8: Determine Frictional Losses in Sudden Expansion and Sudden Contraction in Pipe

i. Determine Frictional Losses In Bend In Pipe.
ii. Determine Frictional Losses In Elbow In Pipe.

I Practical Significance

Minor losses are the losses of head due to large number of pipe fittings such as bends, elbows, joints, valves, sudden expansion and contraction in pipe diameter. In a pipeline these fittings cause localized energy losses (pressure head) due to their shape and these losses are classified as minor losses..

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency "***Determine minor frictional losses in the fluid flow system***"

- Find the loss of head in the pipe due to various fittings.
- Make the connection of bend, elbow, coupling & reducer etc.
- Connect U tube manometer tubes at the required place between the required pipe fittings.
- Operate pump & valve.

IV Relevant Course Outcome(s)

1. Maintain flow through pipes.
2. Estimate losses in flow for the given pipe layout.

V Practical Outcome

- Find the loss of head in the pipe due to sudden expansion.
- Find the loss of head in the pipe due to sudden expansion.
- Determine frictional losses in bend in pipe.
- Determine frictional losses in elbow in pipe.

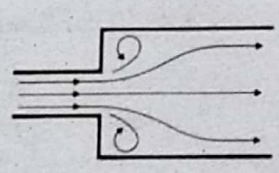
VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

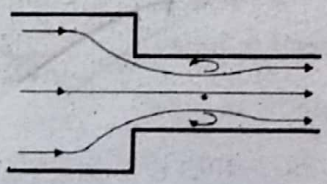
1. **Minor losses:** These are the losses of head due to large number of pipe fitting such as bends, elbows, joints, valves, sudden expansion and contraction in pipe diameter. In pipe fitting these losses are also occurred at entry & exit of pipe. These causes localized energy losses due to their shape and are classified as minor losses. Minor losses are usually neglected, as they are insignificant if they are less than 5% of the frictional losses.
2. **Loss of head due to sudden expansion:** This is energy loss due to sudden enlargement. Sudden enlargement in diameter of pipe results in formation of eddies by the flowing fluid at the corners of enlarged pipe. Because of eddies formation, loss of head takes place. Mathematically it is written as this results in loss of head which is equal to

$$H_e = \frac{(V1-V2)^2}{2g}$$

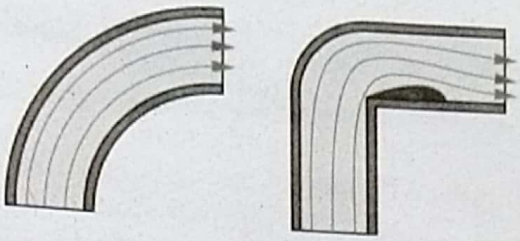


3. **Loss of head due to sudden contraction:** This is energy loss due to sudden contraction. It does not takes place due to sudden contraction but due to sudden enlargement which takes place just after vena contracta. Mathematically it is written as

$$H_e = \frac{0.5\,V^2}{2g}$$



4. **Loss of head due to bend or elbow in pipe:** This is energy loss due to bend or elbow. When bend or elbow is provided in the pipe, there is change in the direction of velocity of liquid. Due to this liquid separates from wall of bend and formation of eddies takes place.



Mathematically it is written as

$$H_b = \frac{k V^2}{2g}$$

Where, k= Coefficient of bend or elbow.

VIII Experimental setup

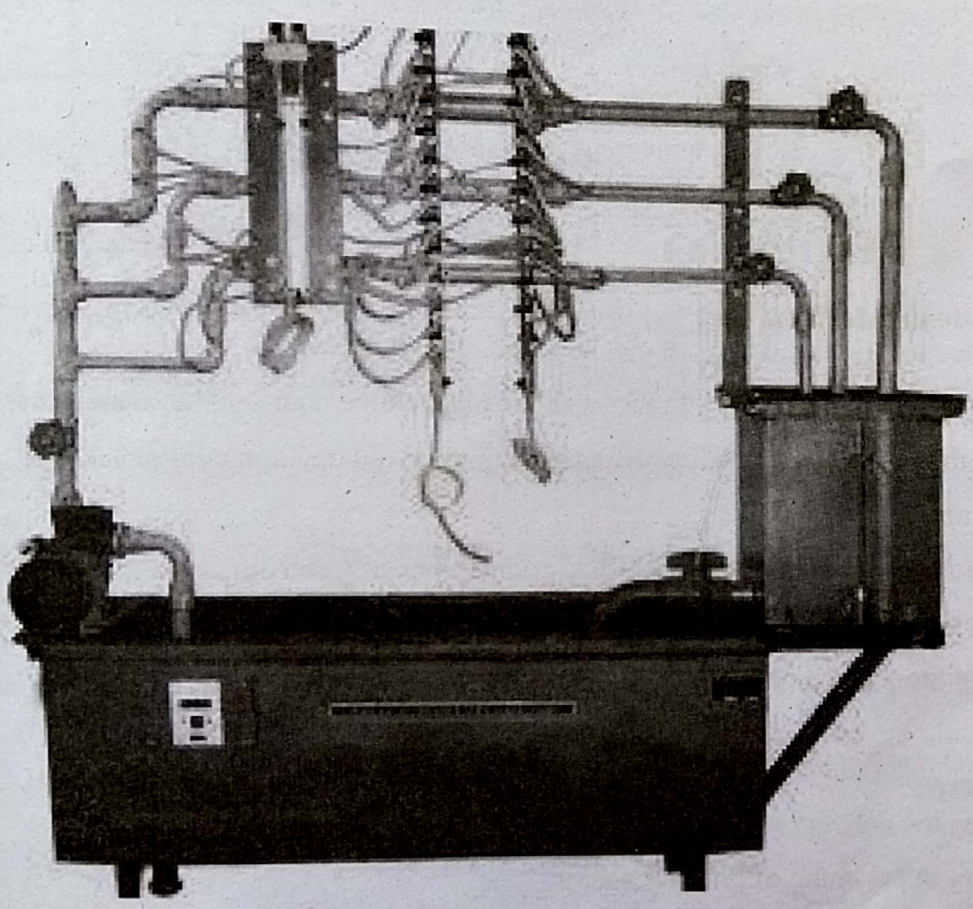


Figure 1 Experimental Set up

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Experimental Set up for minor frictional losses**	**The apparatus consists of:** • A Centrifugal pump of 25mm x 25mm with 1/2 HP Motor M.S. Sump Tank 80 Ltr. to collect the water. • M.S. Measuring Tank 30 Ltr fitted with piezometer tube to measure the discharge. • G.I. pipe of internal dia 25mm and Gunmetal ISI mark Control Valve and regulating valves are used to circulate water. • Bye-pass line is also used to regulate the discharge. • Large bend made up of G.I. • Sudden enlargement from 25mm dia to 32mm dia. • Sudden contraction from 32mm dia to 25mm. • Gunmetal gate valve of 25mm dia. A U tube manometer is connected to pet cock through plastic tubing to measure head difference. The tanks are well •	1
2	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
3	Measuring Scale/steel rule	Range upto 60 cms	1

X Precautions to be Followed

1. Handle the pipe fitting like elbow, bend etc. with due care.
2. Observe that bubbles are not present in the plastic tube connected to manometer.
3. Open the delivery valve of centrifugal pump, to avoid development of sudden pressure.
4. Avoid improper handling of electrical connections of Centrifugal pump.
5. Please ensure priming is required for centrifugal pump or not.
6. Handle Stop watch carefully.

XI Procedure

a. Open the delivery valve of centrifugal pump.

b. Carry out priming of pump if necessary.

c. Adjust inlet & outlet valve such that **'sudden enlargement arrangement'** of pipe is only connected.

d. Connect point 1 and 2 on the given pipe circuit to the manometers limbs

e. Start the pump which allows water to flow through Storage tank.

f. Adjust the discharge by control valve stop valve and ensure steady flow in system.

g. Note the difference of levels of the mercury columns.

h. Collect water in a measuring tank to measure the actual discharge for 30 seconds (or suitable for set up)

i. Use stop watch to measure time 'T'.

j. Drain the water collected in the measuring tank after each observation.

k. Adjust inlet & outlet valve such that **'sudden contraction arrangement'** of pipe is only connected.

l. Repeat the step 4 to 7 for when **'sudden contraction arrangement'** is connected in system.

m. Adjust inlet & outlet valve such that **'Elbow fitting'** in the pipe is only connected.

n. Repeat the step 4 to 7 for when **'Elbow fitting** 'is connected in system.

o. Adjust inlet & outlet valve such that **'Bend fitting** 'in the pipe is only connected.

p. Repeat the step 4 to 7 for when **'Bend fitting** 'is connected in system

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.	Setup for minor frictional loss.		0.36 X 0.26 m Tank.	01	
2.	Stopwatch		Mechanical or Digital	01	
3.	Measuring scale.		Range upto 60 cms	01	

XIII Actual Procedure Followed

Refer XI

XIV Precautions Followed

1. Handle the pipe fitting like elbow, etc. with due care.
2. Make sure the bubbles are not present in pipe.
3. Handle the stopwatch carefully.

XV Observations and Calculations.

Sr. No.	Nature of pipe fitting	Inlet & Exit diameter of pipe		Manometer Reading		Pressure Difference	Actual Head Lost in meters of water column height $H=H_{hg}$ (13.6-1)	Rise of water level of Measuring Tank in 10 sec
				H_1	H_2	$H_{hg}=(H_2-H_1)/100$ Meters of Hg		
		m	m	cm	cm	m	m	m
		Inlet	Exit					
1	Sudden Enlargement	12.5	25.4	14.4	15.7	+0.013	+0.1386	19
		12.5	25.4	14.0	15.5	+0.015	+0.189	18
		12.5	25.4	14.3	15.5	+0.012	+0.1512	21
2	Sudden Contraction	25.4	12.5	13.9	16.2	0.022	0.2772	31
		25.4	12.5	12.0	18.0	0.06	0.756	19
		25.4	12.5	13.9	16.2	0.023	0.2898	28.53
3	Bend	12.5	12.5	12.0	18.0	0.06	0.756	19
		12.5	12.5	11.0	19.0	0.08	1.008	20
		12.5	12.5	11.4	18.8	0.074	0.9324	20
4	Elbow	12.5	12.5	12.2	17.8	0.056	0.7056	17
		12.5	12.5	14.0	16.0	0.02	0.252	17
		12.5	12.5	13.3	16.8	0.035	0.441	18

3. Discharge Measurement reading

Measuring tank Dimension= Width **W** = 0.36 m, Breadth, **B** = 0.26 m

Height of water observed in auxiliary tube H_1= 0.1 m

Time required for collecting water = 19 seconds.

For Sudden enlargement:

Diameter of pipe at entry, d_1 = 12.5×10^{-3} m

Diameter of pipe at enlargement, d_2 = 25.4×10^{-3} m

For Sudden Contraction:

Diameter of pipe at entry, d_3 = 25.4×10^{-3} m

Diameter of pipe at contraction, d_4 = 12.5×10^{-3} m

Angle of bend 90^0, diameter of pipe d_5= 12.5×10^{-3} m

Diameter of pipe at elbow d_6= 12.5×10^{-3} m

Calculation of Discharge Measurement reading.

(i) Actual Discharge = $Q_{act} = \frac{\text{Volume of Water collected}}{\text{Time}} = W*B*H_1/t$

$Q_{act} = \frac{V}{t} = 4.9263 \times 10^{-4}$ m/sec

Case I- Loss of head due to sudden enlargement

a. Velocity of water at entry $V_1 = Q/A_1 = \frac{\pi}{4} \times d_1^2$

= 4.0143 m/sec

b. Velocity of water at Outlet $V_2 = Q/A_2 = \frac{\pi}{4} \times d_2^2$

= 0.9722 m/sec

c. Theoretical loss of head due to sudden enlargement: H_e

$H_e = \frac{(V1-V2)^2}{2g}$

= 0.547168 m of water

Case II- Loss of head due to sudden Contraction

1. Velocity of water at entry $V_3 = Q/A_3 = \frac{\pi}{4} \times d_3^2$

= 0.9722 m/sec

2. Velocity of water at Outlet $V_4 = Q/A_4 = \frac{\pi}{4} \times d_4^2$

= 4.0143 m/sec

3. Theoretical loss of head due to sudden Contraction: H_c

$$H_c = \frac{0.5\, V4^2}{2g}$$

= 0.411066 m of water

Case III: - Bend

1. Actual Loss of head due to Bend Hb_{act} = 0.756 m of water (from observation tab

2. Theoretical Loss of head due to Bend = $H_b = \frac{k\, V5^2}{2g}$

3. Velocity of water flowing through bend = $V_5 = Q/A_5 = \frac{\pi}{4} \times d_5^2$ = 4.0143 m/sec

Equating actual loss of head = Theoretical loss of head

$$H_b = = \frac{k\, V_5^2}{2g} = \frac{0.756 = k \cdot (4.0143)^2}{2 \times 9.81}$$

Constant for bend k = H_b act x 2g / $V5^2$ = 0.9205

Case III: - Elbow

1. Actual Loss of head for given Elbow $H_{el\ act}$ = 0.4411 m of water (from observation table)

2. Theoretical Loss of head due to Elbow = $H_{el\ th} = \frac{k\, V_6^2}{2g}$

3. Velocity of water flowing through Elbow = $V_6 = Q/A_6 = \frac{\pi}{4} \times d_6^2$ = 4.0143 m/sec

Equating actual loss of head = Theoretical loss of head

$$H_{el} = = \frac{kel\, V_6^2}{2g} = \frac{0.4411 = kel \cdot (4.0143)^2}{2 \times 9.81}$$

Loss coefficient of Elbow 'k_{el}' = 2 g H_{el} / V_6^2

4. Constant for Elbow L= He act x 2g / $V6^2$

= 0.5369 m of water

Result

Case I- For sudden enlargement

Actual Loss of head = 0.1386 m of water

Theoretical Loss of head = 0.4768 m of water

Case II- For sudden Contraction

Actual Loss of head = 0.756 m of water

Theoretical Loss of head = 0.41066 m of water

Case III:-Constant for Bend k= 0.9205

Case IV:-Constant for Elbow k_{el}= 0.5369

XVI Interpretation of Results

1) Sudden enlargement - Actual loss = 0.1386 m of water
2) Sudden contraction - Actual loss = 0.756 m of water
3) For bend, k = 0.9205
4) For elbow, k_{el} = 0.5369

XVII Conclusions

We determined frictional losses in sudden expansion and sudden contraction in pipe and also frictional losses in bend in pipe and in elbow in pipe.

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1.What is compound pipe? State its use.

2.Compare pipes in series & pipes in parallel (any two).

3.How water hammer can be minimized?

4.For two cases of flow in a sudden contraction in the pipe line & flow in a sudden expansion of pipe line , draw the flow pattern, Hydraulic gradiant line (HGL) & Total energy line(TEL)

[Space for Answer]

1) When two or more pipes of different lengths and diameters are connected to each other to form a pipeline, the arrangement is called as 'pipes in series' or 'Compound pipe'.

→ Uses of compound pipe

It is a type of sealant which is used with some of the compounds to adjoin the pipes.

2] Pipe in series	Pipe in parallel
① When two or more pipes of different lengths and diameters are connected to each other to form a pipeline, the arrangement is called as 'Pipe in series'	① When quantity of fluid flowing per second (discharge) from one reservior to another reservior is to be increased, an arrangement is known as 'Pipe in parallel'
② For pipes in series, (i) Total head lost due to friction, $h_f = h_{f1} + h_{f2} + h_{f3}$ (ii) $Q = A_1V_1 = A_2V_2 = A_3V_3$	② For pipes in parallel, (i) Total discharge, $Q = Q_1 + Q_2$ (ii) Head lost for all pipes will be same if the pipes are arranged in parallel

3] The following characteristics may reduce or eliminate water hammer

① Reduce the pressure of the water supply to the building by fitting or regulator.

② Lower fluid velocities.

③ To keep water hammer low, pipe sizing charts for some applications recommend flow velocity at or below 1.5 m/s (4.9 ft/s)

XIX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=6DFe8eUrbcI
2. https://www.youtube.com/watch?v=WMtiH5LyOYI
3. https://www.youtube.com/watch?v=6jClbqlGctY
4. https://www.youtube.com/watch?v=IcJOkRZPNMI

XX Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. Amey Rane.....
2. Pritpn Parmar
3. Chirag Thakur.....
4. Sushil Deshmukh

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	
15	10	25	AP 29/02/19

Practical No. 11 & 12: Dismantle and Assemble 0f Centrifugal Pump.

I Practical Significance

Centrifugal pump uses rotational kinetic energy to deliver the fluid. The rotational energy typically comes from an engine or electric motor. The fluid enters the pump impeller along or near to the rotating axis, accelerates in the propeller and flung out to the periphery by centrifugal force

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Maintain hydraulic machinery using knowledge of fluid mechanics'.

IV Relevant Course Outcome(s)

- Maintain Hydraulic Pump.

V Practical Outcome

- Dismantle a Centrifugal pump
- Assemble Centrifugal pump

VI. Relevant Affective Domain related Outcomes.

1. Maintain hydraulic joints.
2. Follow safe practices.
3. Practice energy conservation.
4. Demonstrate working as a leader/ a team member.
5. Follow ethical practices.

VII Minimum Theoretical Background

The centrifugal pump's function is as simple as its design. It is filled with liquid and the impeller is rotated. Rotation imparts energy to the liquid causing it to exit the impeller's vanes at a greater velocity than it possessed when it entered. This outward flow reduces the pressure at the impeller eye, allowing more liquid to enter. The liquid that exits the impeller is collected in the casing (volute) where its velocity is converted to pressure before it leaves the pump's discharge

VIII Experimental setup

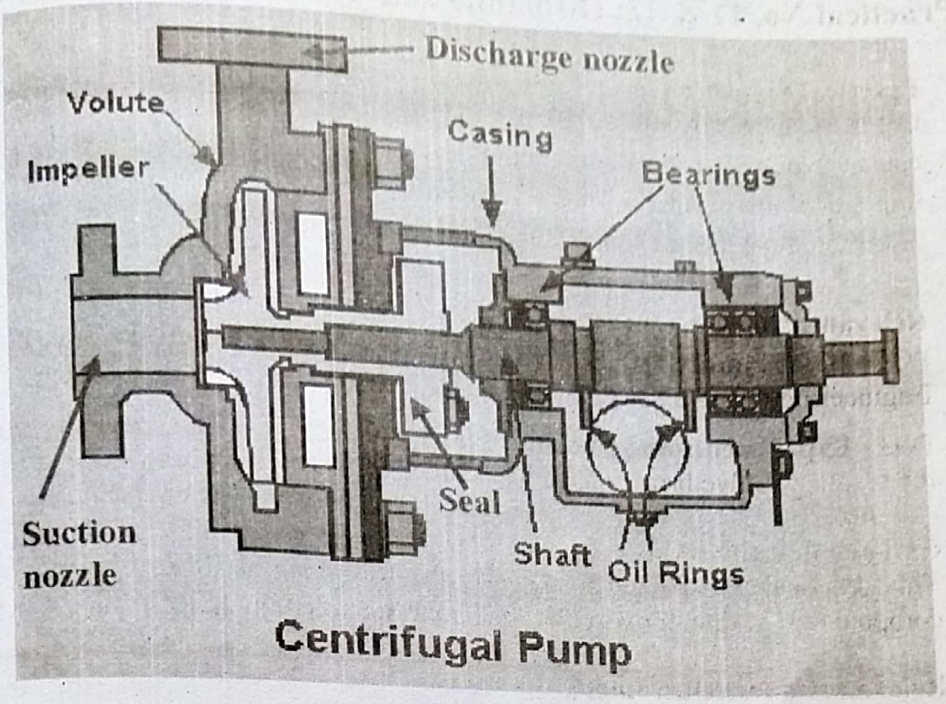


Figure 1- Schematic Diagram of Centrifugal Pump

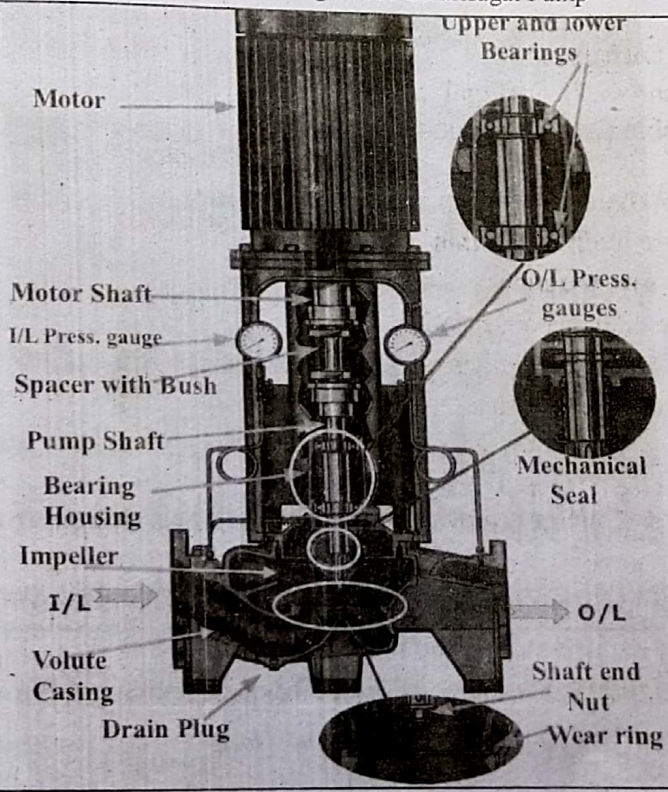


Figure 2 - Centrifugal Pump

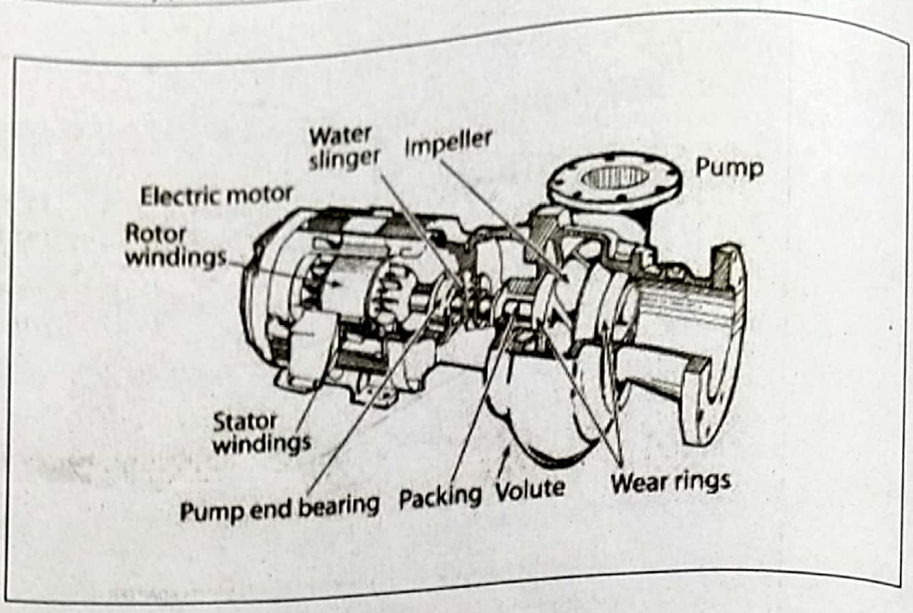


Figure 3: Internal Details of Centrifugal Pump

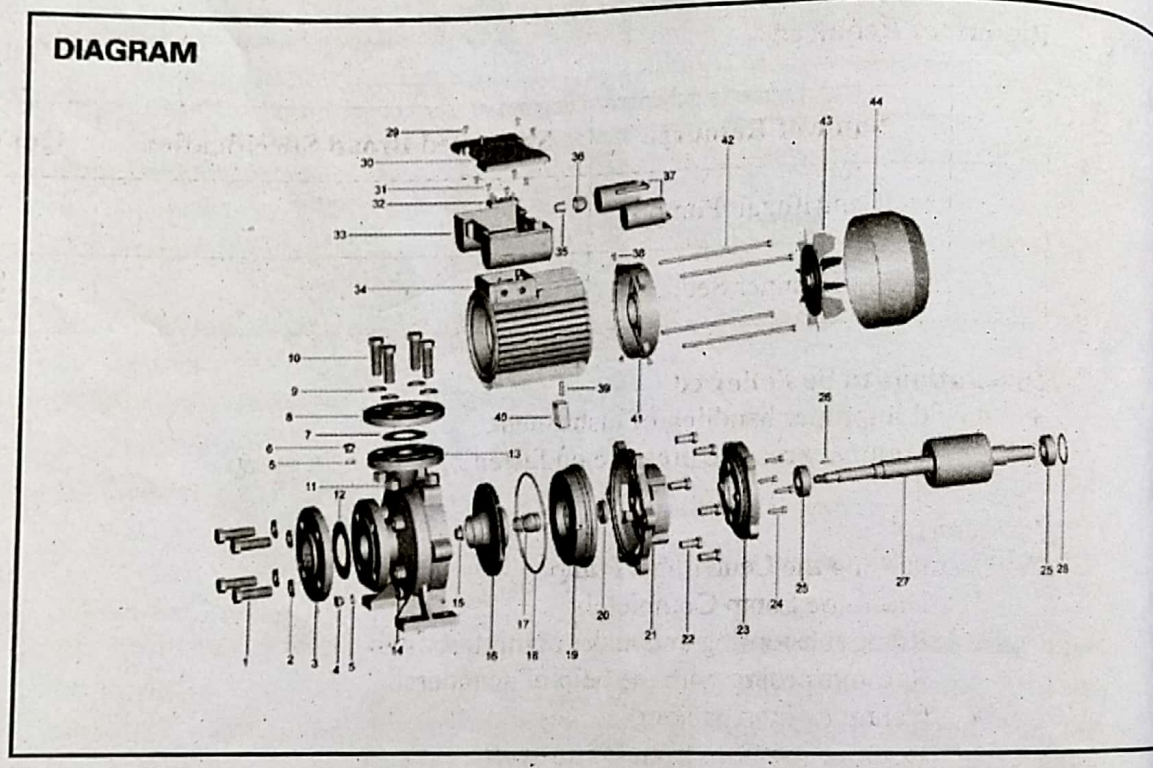


Figure 3: Sequence of Assembly of Centrifugal Pump Model 1

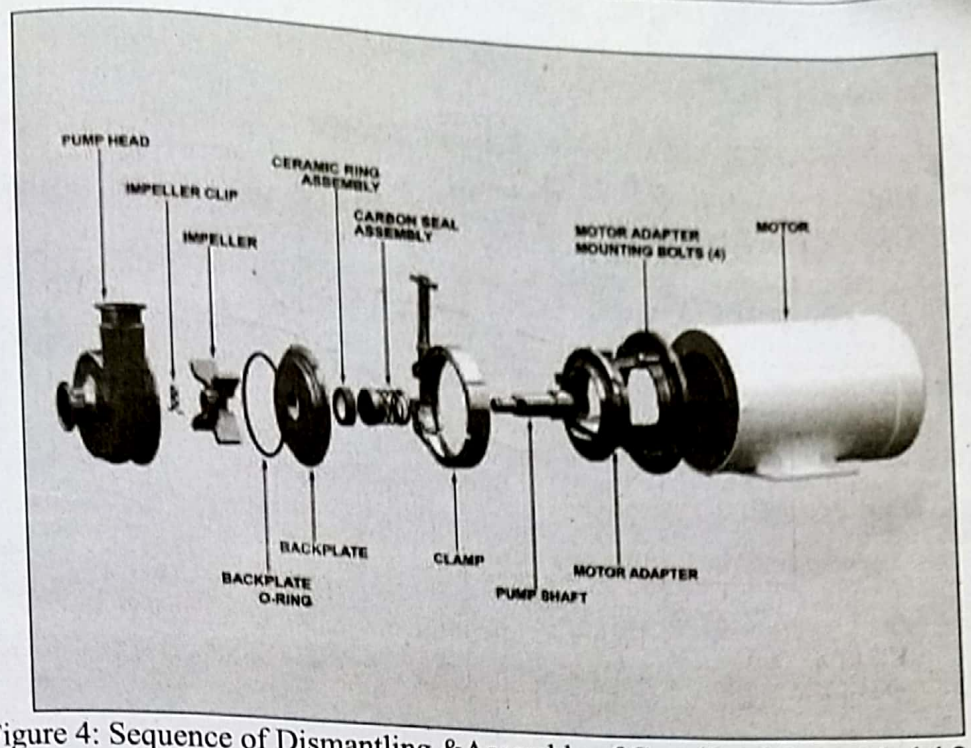


Figure 4: Sequence of Dismantling &Assembly of Centrifugal Pump Model 2

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Centrifugal Pump		1
2	Spanner Set		1 set

X Precautions to be Followed

1. Avoid improper handling of instrument.
2. Don't apply excessive pressure on fastening parts of a pump.

XI Procedure

A. Dismantling the Centrifugal Pump

1 Drain the Pump Completely
2 Remove coupling and make pump free from motor
3 Remove casing with the help of spanners
4 Remove gland packing
5 Remove impeller from Pump shaft
6 Observe the condition of parts.

B. Assembly of Centrifugal Pump

1. Assemble the shaft with bearing bush
2. Clean the shaft and remove all dirt particles
3. Assemble impeller with given marking
4. Assemble the housing /casing
5. Check pump shaft to rotate freely
6. Tighten the bolts of housing
7. Tight bolts of coupling

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.	Centrifugal Pump			1	
2.	spanner set			1	
3.					

XIII Actual Procedure Followed

A- Dismantling the Centrifugal Pump

Refer XI

B- Assembly of Centrifugal pump Pump

Refer XI

XIV Precautions Followed

1) Avoid improper handling of instrument.
2) Don't apply excessive pressure on fastening parts of a pump.

XV Observations and Calculations

Sr No	Name of Part	Condition of part	Causes of Damage	Suggestive Remedies
1	Coupling	Good		change coupling
2	Pump Housing/Casing	Good		Clean

3	**Impeller**	Below Average	Low efficiem	clean the impeller
4	**Pump Shaft**	Average		Lubrication
5	**Gland Packing**	Good		Clean
6	**Wear Rings**	Worst		Champering
7	**Suction Pipe**	Below Average	Some breaks Pump not lifting water	Damage Parts
8	**Delivery pipe**	Average		Clean

XVI Results

Hence we dismanled and assembled the pump

XVII Interpretation of Results

different parts of the pump were to be taken

XVIII Conclusions

Centrifugal pump uses a rotational kinetic energy to deliver the fluid, the rotational energy type of comes from an electric circuit.

XIX Practical Related Questions

Note: Below given are few sample questions for refereince. Teachers must design more such questions so as to ensure the achievement of identified CO.

a. Name any five Indian Manufacturers of Hydraulic Centrifugal pumps

b. Write detail specification of Centrifugal Pump used for practical

[Space for Answer]

1]- 1) Sejal Engineering
2) Green pumps and equipments
3) M·S Engineering Works.
4) shree ANR enterprise private limited
5) Amrut energy private.

2]- 1) Specification of centrifugal pump
2) Discharge rise
3) Maximum discharge.
4) Overall rise
5) Capacity

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=sLZeR7RMGFA

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the instruments	20%
2	Sequence of removing the parts	40%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ...Amey...Rane.....
2. ..Pritesh..Parmar.
3. .Chirag..Thakur...
4. Sushil...Deshmukh

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	
15	10	25	29/02/20

Practical No.14 & 15: Dismantle and Assemble 0f Reciprocating Pump.

I Practical Significance

Reciprocating pump is a positive plunger pump. They are used widely in lifting water from ground to the storage tanks in residential areas. They develop high pressures but has limited use. Reciprocating pump consists of "suction stroke" and a "delivery stroke". Suction stroke is the place where the water is sucked in from the ground and delivery stroke is the place where the sucked water is delivered to the required place.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency 'Maintain hydraulic machinery using knowledge of fluid mechanics':

IV Relevant Course Outcome(s)

- Maintain Hydraulic Pump.

V Practical Outcome

- Dismantle a Reciprocating pump

VI. Relevant Affective Domain related Outcomes.

1. Maintain pressure gauges, electronic energy meter, stop watch in good condition.
2. Follow safe practices.
3. Practice energy conservation.
4. Demonstrate working as a leader/ a team member.
5. Follow ethical practices.

VII Minimum Theoretical Background

Reciprocating pump operates on the principle of pushing of liquid by a piston that executes a reciprocating motion in a closed fitting cylinder.

Components of reciprocating pumps:-

a) Piston or plunger: – a piston or plunger that reciprocates in a closely fitted cylinder.

b) Crank and Connecting rod: – crank and connecting rod mechanism operated by a power source. Power source gives rotary motion to crank. With the help of connecting rod we translate reciprocating motion to piston in the cylinder.

c) Suction pipe: – one end of suction pipe remains dip in the liquid and other end attached to the inlet of the cylinder.

d) Delivery pipe: – one end of delivery pipe attached with delivery part and other end at discharge point.

e) Suction and Delivery value: – suction and delivery values are provided at the suction end and delivery end respectively. These values are non-return values.

VIII Experimental setup

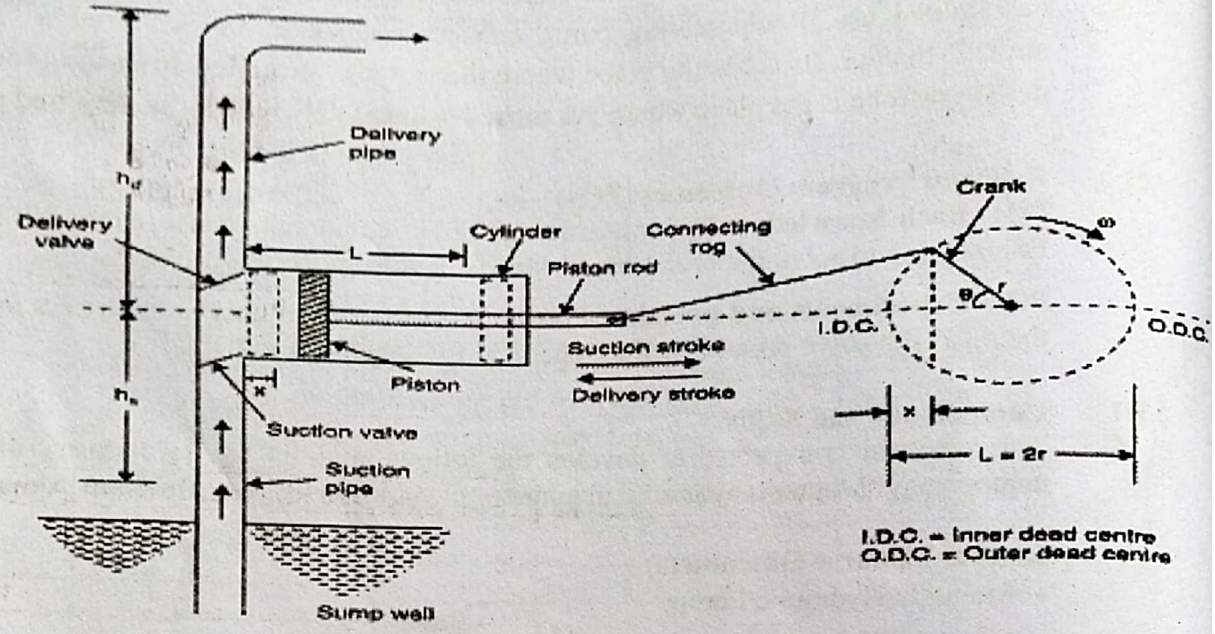

Figure No 1- Layout of reciprocating Pump

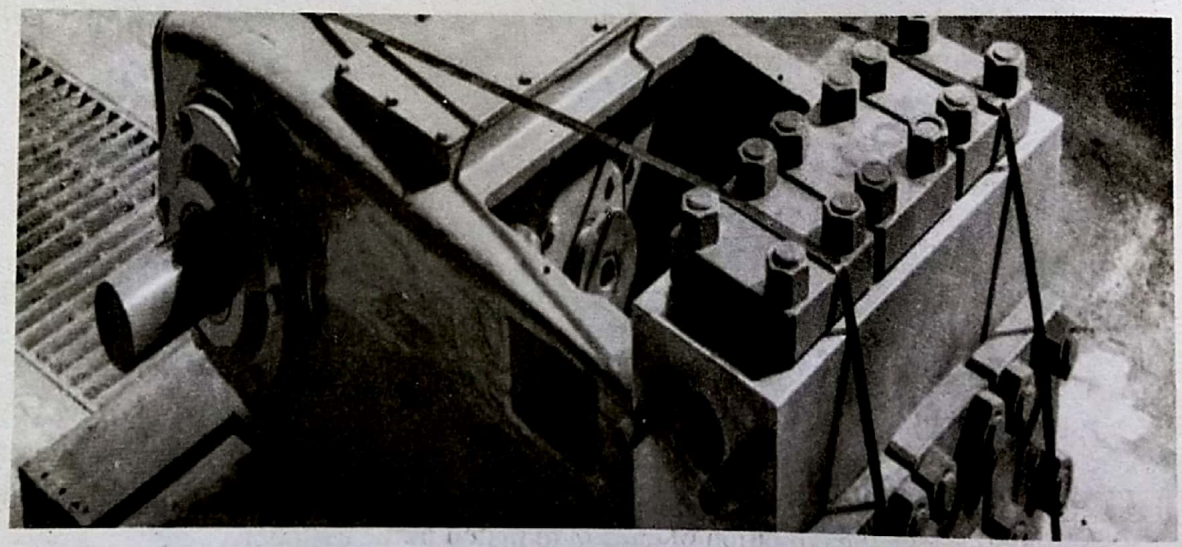

Figure No 2- Reciprocating Pump

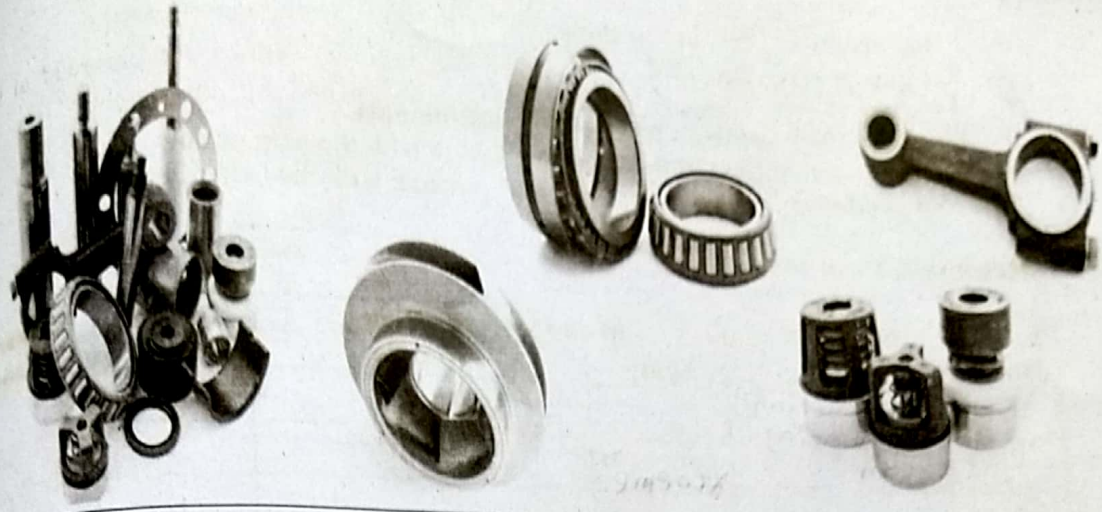

Figure No 3 – Parts of Reciprocating Pump

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single Acting Reciprocating Pump		1
2	Spanner Set		1 set

X Precautions to be Followed

1. Avoid improper handling of instrument.
2. Don't apply excessive pressure on fastening parts of a pump.

XI Procedure

A. Dismantling the Reciprocating Pump

a. Loose packing nuts of suction pipe
b. Remove suction Pipe
c. Loose packing nuts of delivery pipe
d. Remove Delivery Pipe
e. Remove the casing of a pump
f. Remove packaging seal from the pump
g. Loose the valve pin
h. Remove valves from pump
i. Remove upper piston guide
j. Unthread piston bar
k. Remove bearing between piston and connecting rod
l. Remove Bearing between Connecting rod and crank
m. Observe the conditions of each part
n. Note down the condition of each dismantled part.

B. Assembly of Reciprocating Pump

1. Assemble and connecting rod
2. Check the condition of bearing
3. Assemble piston and connecting rod

4. Place piston and piston assembly in a cylinder.
5. Replace new packing seal
6. Assemble valve in valve plates
7. Fix valve plate to the cylinder using packing nuts
8. Connect suction pipe to the suction passage with the help of nuts
9. Connect delivery pipe to the delivery passage with the help of nuts.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.	Single acting reciprocating			1	
2.	Pump	Xtreme			
3.	Spanner set			1	

XIII Actual Procedure Followed

A- Dismantling the Reciprocating Pump

Refer point XI

B Assembly of Reciprocating Pump

Refer point XI

XIV Precautions Followed

① Avoid improper handling of instrument

② Don't apply excessive pressure on the fastening parts of pump

XV Observations and Calculations

Sr No	Name of Part	Condition of part	Causes of Damage	Suggestive Remedies
1	Casing	Wear and tear	Friction and water hammering	Maintainance.

2	Piston/Plunger	Deterioration	Ring and wall of cylinder (Friction)	Change
3	Connecting Rod	Normal	-	-
4	Bearing	Normal	-	Greasing & Lubrication
5	Bushings	Good	-	-
6	Crank	Normal	-	-
7	Suction Pipe	Fouling	Fouling	clean
8	Delivery Pipe	Fouling	Fouling	clean

9	Suction Valve	Normal		Maintenance
10	Delivery valve	Normal	–	–
11	Packaging Seals	Normal	–	–

XVI Results

Hence, we Assembled and Dismantled the reciprocating pump successfully

XVII Interpretation of Results

Different parts of the reciprocating pump were studied.

XVIII Conclusions

Reciprocating pump is used to induced the flow or raise the pressure of liquid. Hence, we studied the same.

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

a. Name any five applications of Hydraulic reciprocating pumps
b. Write detail specification of Reciprocating Pump used for practical

[Space for Answer]

1] Five applications of hydraulic reciprocating pumps are as follows

① Fuel injection engines
② Water pumping
③ Petrochemical and Refinery industries
④ Hilly areas and also in Agriculture
⑤ Feed pump in boiler

2] Pump type considered - Horizontal, Triplex Reciprocating plunger pump

Power drive - Electric motor / Diesel engine

Mounting - Base plate / skid / trailer

Speed Reduction - Foot shafted mounted through gear box or belt pully arrangement

Pumped weight - 3000 / 6613 (kg (lbs)

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=sLZeR7RMGFA

XXI Assessment Scheme

	Performance Indicators	Weight age
	Process Related (15 Marks)	**(60%)**
1	Handling of the instruments	20%
2	Sequence of removing the parts	40%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ..Amey.Rane.....
2. ..Chirag...Thakur...
3. ..Paiten...Parmar....
4. ..Sushil...Deshmukh

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	
15	09	24	AP 07/03/20