Rajiv Gandhi University of Knowledge Technologies

Department of chemical engineering

Fluid mechanics lab

(CH2104)

Course Objectives

- Verify the Bernoulli's equation by using Bernoulli's apparatus.
- Calibrate the Rotameter.
- Find out the variation of orifice coefficients with Reynolds Number.
- Determine the venturi coefficient by using venturimeter.
- Find out the frictional losses in flow through pipes.
- Study the coefficient of contraction in an open orifice.
- Study the characteristic of a centrifugal pump.

List of Experiments

S.No	Name of the experiment
1.	Closed circuit venturi Meter
2.	Closed circuit orifice meter test rig
3.	Closed circuit pipe friction apparatus
4.	Bernoulli's theorem apparatus
5.	Multistage centrifugal pump
6.	Pitot static tube

Course outcomes

- Understand basic units of measurement, convert units, and appreciate their magnitudes.
- Utilize basic measurement techniques of fluid mechanics.
- Discuss the differences among measurement techniques, their relevance and applications.
- Measure fluid pressure and relate it to flow velocity.
- Demonstrate practical understanding of the various equations of Bernoulli
- Demonstrate practical understanding of friction losses in internal flows.

CLOSED CIRCUIT VENTURIMETER

TEST RIG

Contents

USER MANUAL

CLOSED CIRCUIT VENTURIMETER TEST RIG
&
ORIFECE METER TEST RIG

CLOSED CIRCUIT VENTURIMETER

INTRODUCTION

The Closed Circuit self sufficient portable package system calibration test rig for Venturimeter is primarily designed to study and calibrate the flow meter like orifice meter. This unit has several advantages like this does not require any foundation, trench work etc. so that you can conduct the experiment keep the unit anywhere in the laboratory.

GENERAL DESCRIPTION

The apparatus consists of (1) Venturimeter (2) Piping system (3) supply pump set (4) Measuring tank (5) Differential manometer (6) Sump

CONSTRUCTIONAL SPECIFICATION

FLOW METERS

Consists of Venturimeter of size 25 mm provided for experiments. The meter has the adequate cocks also with them.

PIPING SYSTEM

Consists of a set of G.I. piping of size 25 mm with sufficient upstream and down stream lengths provided with separate control valves and" mounted on a suitable stand. Separate upstream and down stream pressure feed pipes are provided for the measurement of pressure heads with control valves situated on a common Pipe for easy operation.

SUPPLY PUMP SET

Is rigidly fixed on sump. The mono block pump with motor, operating on single phase 220/240 volts 50 Hz AC supply.

MEASURING TANK

Measuring tank with gauge glass and scale arrangement for quick and easy measurement.

DIFFERENTIAL MANOMETER

Differential manometer with 1 mm scale graduations to measure the differential head produced by the flow meter.

SUMP

Sump to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONNING

- Check whether all the joints are leak proof and water tight.
- Fill the manometer to about half the height with mercury
- Close all the cocks, pressure feed pipes and manometer to prevent damage and over loading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.
- Check proper electrical connections to the switch, which is internally connected to the motor.

Aim: - To calibrate a given venturimeter and to study the variation of coefficient of discharge of it with discharge.

Apparatus: - Venturimeter, manometer, stop watch, experimental set-up.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.

3. By regulating the valve control th flow rate and select the corresponding pressure tapings (i.e. of venturimeter).

4. Make sure while taking readings, that the manometer is properly primed. Priming is the operation of filling the manometer's upper part and the connecting pipes with water by venting the air from the pipes. Note down the difference of head "h" from the manometer scale.

5. Note down the time required for the rise of 10cm (i.e. 0.01m) water in the collecting tank by using stop watch. Calculate actual discharge using below formula.

Discharge: - The time taken to collect some 'x' cm of water in the collecting tank in m^3/sec.

$$Q_{act} = \frac{A \times R}{t}$$

Where:

A = area of the collecting tank in m^2 (0.3m X 0.3m)
R = rise of water level taken in meters (say 0.1m or 10cm)
t = time taken for rise of water level to rise 'r' in't' seconds.

6. Using difference in mercury level " h "calculate the theoretical discharge of venturimeter by using following expression.

$$Q_{th} = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$

Where,

h- Difference of head in meter of water = (h1-h2) (Sn /So – 1) = (h1-h2) 12.6/1000 m
a_1 - area of venturi at inlet
a_2 - area of venturi at throat
g -Acceleration due to gravity
d_1 -Inlet diameter in meters.
d_2 -Throat diameter in meters.

7. Calculate the coefficient of discharge of venturimeter (Cd):

$$Cd = \frac{Q_{act}}{Q_{th}}$$

8. Repeat the steps 3 to 7 for different sets of readings by regulating the discharge valve.

S. No.	Venturi inlet diameter d_1	Throat Diameter d_2
1.	25mm	13.5 mm

EXPERIMENTS

The apparatus is primarily designed for conducting experiments on the coefficient of discharge of flow meters. Each flow meter can be connected to the manometer through the pressure feed opening and the corresponding cocks.

While taking readings, close all the cocks in the pressure feed pipes except the two (Down-stream and upstream) cocks which directly connect the manometer to the required flow meter, for which the differential head is to be measured. (Make sure while taking reading that the manometer is properly primed. Priming is the operation of filling the manometer upper part and the connecting pipes with water and venting the air from the pipes).

First open the inlet gate valve of the apparatus. Adjust the control valve kept at the exit end of the apparatus to a desired flow rate and maintain the flow steadily.

The actual discharge is measured with the help of the measuring tank. The differential head produced by the flow meter can be found from the manometer for any flow rate.

TABULAR FORM

S. No.	Time for (10 cm) raise of water level in sec.	Actual discharge Qa	Differential head in mm of mercury			Theoretical discharge = Qt	Cd = Qt/Qa
			h1	h2	h		

CLOSED CIRCUIT ORIFICE METER TEST RIG

Contents

CLOSED CIRCUIT ORIFICEMETER TEST RIG

INTRODUCTION

Closed Circuit self sufficient portable package system calibration test rig for Orificemeter is primarily designed to study and calibrate the flow meter like orifice meter. This unit has several advantages like this does not require any foundation, trench work etc. so that you can conduct the experiment keep the unit anywhere in the laboratory.

GENERAL DESCRIPTION

The apparatus consists of (1) Orifice meter (2) Piping system (3) supply pump set (4) Measuring tank (5) Differential manometer (6) Sump

CONSTRUCTIONAL SPECIFICATION

FLOW METERS

Consists of Orifice meter of size 25 mm provided for experiments. The meter has the adequate cocks also with them.

PIPING SYSTEM

Consists of a set of G.I. piping of size 25 mm with sufficient upstream and down stream lengths provided with separate control valves and mounted on a suitable stand. Separate upstream and down stream pressure feed pipes are provided for the measurement of pressure heads with control valves situated on a common plate for easy operation.

SUPPLY PUMP SET

Is rigidly fixed on sump. The mono block pump with motor. Operating on single phase 220/240 volts 50 Hz AC supply.

MEASURING TANK

Measuring tank with gauge glass and scale arrangement for quick and easy measurement.

DIFFERENTIAL MANOMETER

Differential manometer with 1 mm scale graduations to measure the differential head produced by the flow meter.

SUMP

Sump to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONNING

- Check whether all the joints are leak proof and water tight.
- Fill the manometer to about half the height with mercury
- Close all the cocks, pressure feed pipes and manometer to prevent damage and over loading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.
- Check proper electrical connections to the switch, which is internally connected to the motor.

Aim: - To calibrate a given Orifice meter and to study the variation of coefficient of discharge of it with discharge.

Apparatus: -Orifice meter, manometer, stop watch, experimental set-up.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.

3. By regulating the valve control the flow rate and select the corresponding pressure tapings(i.e. of orifice meter).

4. Make sure while taking readings, that the manometer is properly primed. Priming is the operation of filling the manometer's upper part and the connecting pipes with water by venting the air from the pipes. Note down the difference of head "h" from the manometer scale.

5. Note down the time required for the rise of 10cm (i.e. 0.01m) water in the collecting tank by using stop watch. Calculate actual discharge using below formula.

Discharge:- The time taken to collect some 'R' cm of water in the collecting tank in m^3/sec.

$$Q_{act} = \frac{A \times R}{t}$$

Where:

A = area of the collecting tank in m^2 (0.3m X 0.3m)
R = rise of water level taken in meters (say 0.1m or 10cm)
t = time taken for rise of water level to rise 'r' in't' seconds.

6. Using difference in mercury level "h"calculate the theoretical discharge of venturimeter by using following expression.

$$Q_{th} = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$

Where,

h- Difference of head in meter of water = (h1-h2)(Sn /So – 1) = (h1-h2) 12.6/1000 m
a_1 - area of orifice at inlet
a_2 - area of orifice.
g -Acceleration due to gravity
d_1 -Inlet diameter in meters.
d_2 -Throat diameter in meters.

7. Calculate the coefficient of discharge of Orifice meter (Cd):

$$Cd = \frac{Q_{act}}{Q_{th}}$$

8. Repeat the steps 3 to 7 for different sets of readings by regulating the discharge valve.

S. No.	Orifice inlet diameter d_1	Orifice diameter d_2
1.	25mm	14.0

EXPERIMENTS

The apparatus is primarily designed for conducting experiments on the coefficient of discharge of flow meters. Each flow meter can be connected to the manometer through the pressure feed opening and the corresponding cocks.

While taking readings, close all the cocks in the pressure feed pipes except the two (Down-stream and upstream) cocks which directly connect the manometer to the required flow meter, for which the differential head is to be measured. (Make sure while taking reading that the manometer is properly primed. Priming is the operation of filling the manometer upper part and the connecting pipes with water and venting the air from the pipes).

First open the inlet gate valve of the apparatus. Adjust the control valve kept at the exit end of the apparatus to a desired flow rate and maintain the flow steadily.

The actual discharge is measured with the help of the measuring tank. The differential head produced by the flow meter can be found from the manometer for any flow rate.

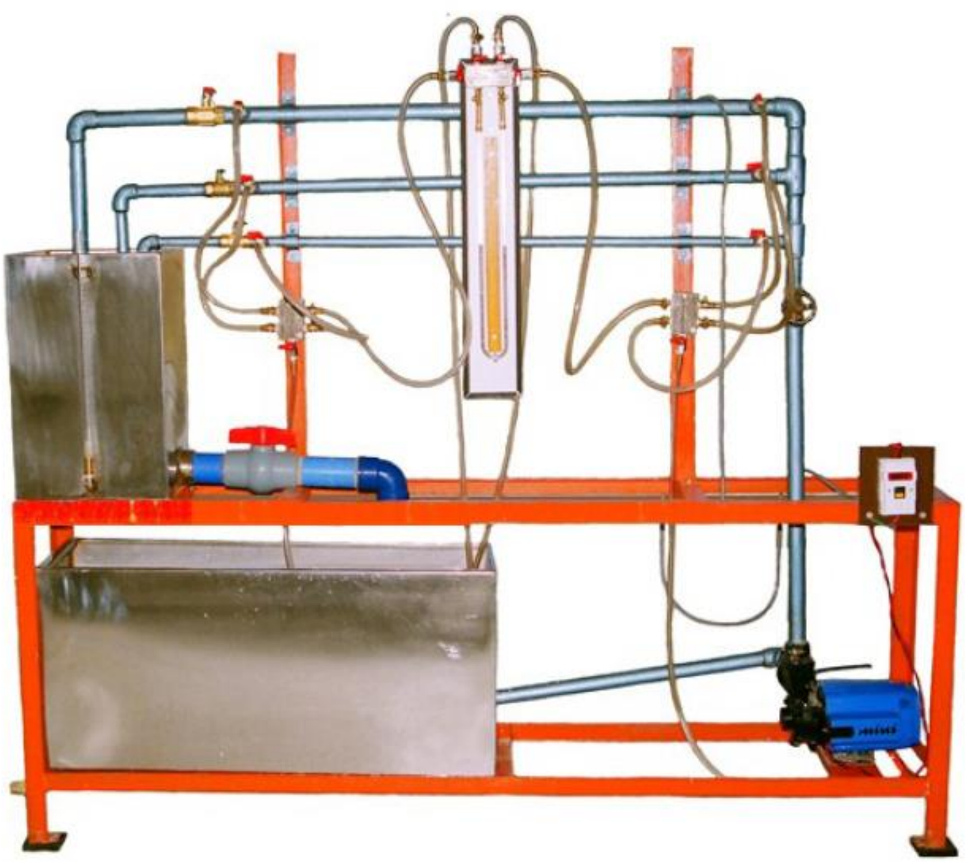
TABULAR FORM

S. No.	Time for (10 cm) raise of water level in sec.	Actual discharge = Qa	Differential head in mm of mercury			Theoretical discharge = Qt	cd = Qt/Qa
			h1	h2	H		

<u>Contents</u>

USER MANUAL

CLOSED CIRCUIT PIPE FRICTION APPARATUS



INTRODUCTION

The Closed Circuit Self- sufficient portable package system Apparatus for frictional losses in pipes is primarily designed for conducting experiments on the frictional losses in pipes of different sizes. This unit has several advantages like, this does not require any foundation, trench work, etc, and so that you can conduct the experiments keeping the unit anywhere in the laboratory soon after receiving the equipment.

GENERAL DESCRIPTION

The unit consists mainly of 1) Piping System 2) Measuring Tank 3) Differential Manometer 4) Supply pump set 5) Sump.

CONSTRUCTIONAL SPECIFICATION

PIPING SYSTEM

Piping System of size 15 mm, 20 mm and 25 mm dia. With tapings at 01 meter distance and a flow control valve.

MEASURING TANK

Measuring tank is provided to measure the discharge of water from the unit.

DIFFERENTIAL MANOMETER

Differential manometer with 01 mm scale graduations to measure the loss of head in the pipe line.

SUPPLY PUMP SET

Supply pump set is rigidly fixed on the sump. The pump set is mono block pump with 0.5 HP motor operating on single phase 220 volts 50 Hz AC supply.

SUMP

Sump is provided to store sufficient waters for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

BEFORE COMMISSIONING

- Check whether all the joints are leak proof and watertight.
- Close all the cocks on the pressure feed pipes and Manometer to prevent damage and overloading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertical.
- Check proper electrical connections to the switch, which is internally connected to the motor.

Aim: - To calculate the Darcy's friction factor for a given pipe line.

Apparatus: - experimental set-up, stop watch.

Procedure:-

1. Start the motor keeping the delivery valve close.

2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.

3. By regulating the valve control the flow rate and select the corresponding pressure tapings.

4. Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes. Note down the loss of head "hf" from the manometer scale.

5. Note down the time required for the rise of 10cm (i.e. 0.1m) water in the collecting tank by using stop watch. Calculate discharge using below formula.

Discharge: - The time taken to collect some 'x' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A \times R}{t}$$

Where:

A = area of the collecting tank in m^2 (0.3m X 0.3m)
R = rise of water level taken in meters (say 0.1m or 10cm)
t = time taken for rise of water level to rise 'r' in 't' seconds.

6. Calculate the velocity of the jet by following formula

$$V = \frac{\text{Discharge}}{\text{Area of the pipe}} = Q/A \quad \text{m/sec}$$

A = cross sectional area of the pipe= $\Pi d^2/4$
d = pipe diameter

7. Calculate the coefficient of friction for the given pipe by

$$hf = \frac{4fLv^2}{2gd}$$

Where,

hf - Loss of head of water = (h1-h2)(Sn /So – 1) = (h1-h2) 12.6/1000 m
f - Co-efficient of friction for the pipe
L - Discharge between sections for which loss of head is measured (1 meter)
v - Average velocity of flow in m/sec
g - Acceleration due to gravity 9.81m/sec
d - Pipe diameter in meters

8. Repeat the steps 2 to 7 for different sets of readings by regulating the discharge valve.

EXPERIMENTS

The apparatus is primarily designed for conducting experiments on the frictional losses in pipes of different sizes. Three different sizes of pipes are provided for wide range of experiments. Each individual pipe can be connected to the Manometer through the pressure feed pipes having individual quick operating cocks.

While taking reading close all the cocks in the pressure feed pipe except the two (upstream and downstream) cocks, which directly connect the manometer to the required pipe for which the loss in head has to be determined. (Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes).

First open the inlet gate valve of the apparatus. Adjust the control valve kept at the exit end of the apparatus to a desired flow rate and maintain the flow steadily.

The actual discharge is measured with the help of the measuring tank. For each size of the pipe the area of cross section of flow can be calculated from the known diameter of the pipes. From these two valves and the average velocity of stream through the pipe can be calculated.

The actual loss of head is determined from the Manometer readings. The frictional loss of head in pipes is given by the Darcy's formula

The friction coefficient indicates 'f '.

TABULAR FORM

S. No.	Ø of pipe	Area (a)	Time for rise of 10 cm water	Discharge	Velocity	Loss of Head (hf)	Co-efficient of friction (f)
1.							
2.							
3.							
4.							
5.							

BERNOULLI's THEOREM APPARATUS

Contents

INSTRUCTION MANUAL
BERNOULLI'S THEOREM APPARATUS

Verification of Bernoulli's theorem

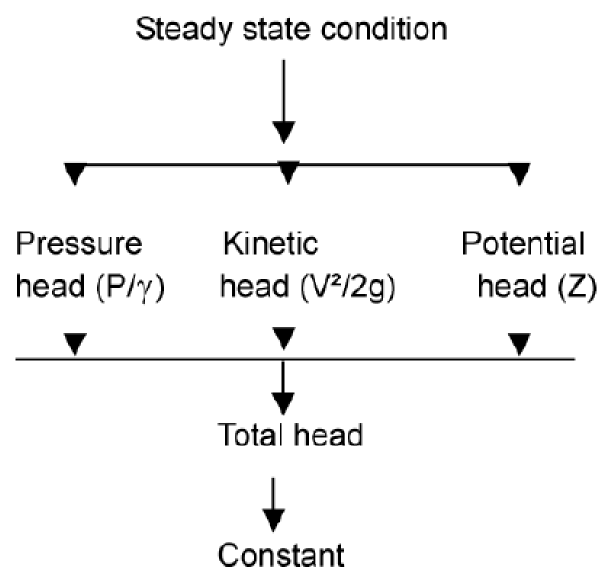
Proposition1: Bernoulli's Theorem
For a steady, continuous, incompressible, non-viscous fluid flow, the total energy or total head remains constant at all the sections along the fluid flow provided there is no loss or addition of energy.

$P/\gamma + V^2/2g + Z =$ Total head = constant

Where P/γ = Pressure head (m)
$V^2/2g$ = Velocity or kinetic head (m) ($V = Q/A$ = m/s)
Z = Potential head (Height above some assumed datum level)

Proposition 2: Application of Bernoulli's Theorem
Bernoulli's equation is based on Euler's equation of motion. It is applicable to flow of fluid through pipe and channel. In Euler's equation the force of viscosity is neglected. Bernoulli's equation is required to be modified if the flow is compressible & unsteady.

Concept Structure

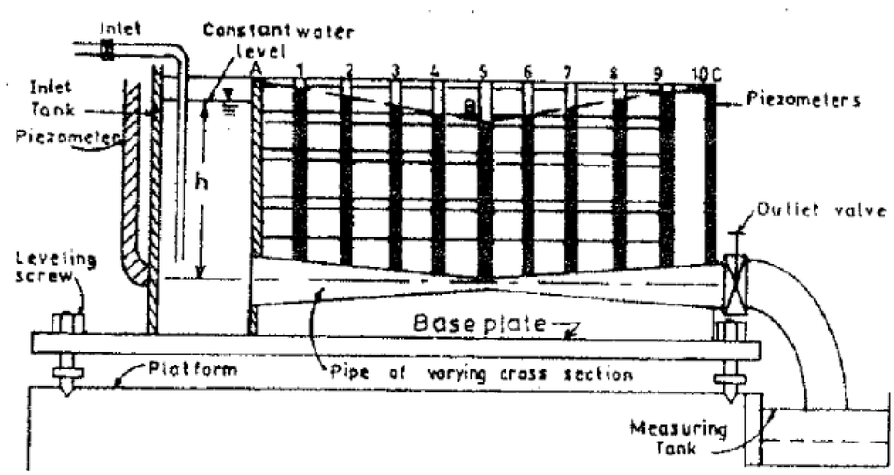


BERNOULLIS THEOREM APPARATUS

INTRODUCTION

The closed circuit self-sufficient portable package system Bernoulli's Theorem Apparatus does not require any foundation, trench work, etc., so that you can conduct experiment with keeping the unit anywhere.

Diagram



GENERAL DESCRIPTION

The unit consists of supply chamber and experimental duct made out of SS sheet. The interlinking duct is smoothly varying in cross section so that the velocity of flow changes gradually for the purpose of experiments with minimum of friction loss and loss the due to turbulence. Piezometer tubes are provided at suitable intervals along with duct for the measurement of pressure head at various points. A flow control valve is provided at the exit of the duct for adjusting and keeping different flow rates through the apparatus. A collecting tank is provided for the measurement of rate of flow. Piezometer tubes are provided at suitable intervals along with duct for the measurement of pressure head at various points. A flow control valve is provided at the exit of the duct for adjusting and keeping different flow rates through the apparatus. A collecting tank is provided for the measurement of rate of flow.

The unit consists a sump of size 1250 x 300 x 300 mm height and a monoblock pump, capacity is 0.5 HP, single phase 220 V, 2800 RPM and pump of size 25 mm to discharge about 15 LPM at 30 m total head.

EXPERIMENT

The apparatus is fitted with Piezometer tubes and scales at 9 cross sectional points, along the experimental duct at suitable intervals for measurement of pressure head. The area of flow section (a) is written on each one of these seven sections. The velocity of flow (V) can be calculated at each of these sections from the flow rate (Q) obtained from the measuring tank that is V = Q/a from this velocity head $V^2/2g$ can be calculated for each section.

For the verification of Bernoulli's Theorem, the velocity head when superposed over the hydraulic gradient gives the energy gradient must be a level line. However, in the flow of need fluid, contain losses of energy is inevitable and this can be readily seen by plating energy gradient. Such sets of readings can be taken for different flow rated by adjusting the valve kept at the outlet.

For each set of readings:

Area of measuring tank A = Length x Breadth in (mm) ; time for (h) 100 mm rise in seconds. Rate of flow

$$\text{Discharge} = \frac{A \times h}{t} \text{ meter cube per second}$$

Where,
A = Area of the measuring tank in meters= 0.3 m x 0.3 m
h = Rise of water level (say 10 cm) in meters.
T = Time in seconds for raise of water level (say 10 cm)

Tabular Column

Run No.	Discharge (Q)	Piezometer Tube No.	1	2	3	4	5	6	7	8	9
1		P/γ=Pressure Head									
		V=Q/A (Velocity)									
		$V^2/2g$ (Velocity Head)									
		Z =Datum Head									
		Total Head= P/γ + $V^2/2g$ +Z									
2		P/γ=Pressure Head									
		V=Q/A (Velocity)									
		$V^2/2g$ (Velocity Head)									
		Z =Datum Head									
		Total Head= P/γ + $V^2/2g$ +Z									
3		P/γ=Pressure Head									
		V=Q/A (Velocity)									
		$V^2/2g$ (Velocity Head)									
		Z =Datum Head									
		Total Head= P/γ + $V^2/2g$ +Z									

MULTISTAGE CENTRIFUGAL PUMP

Contents

Sivan INDUSTRIES
The Project People
Off. Ph : 0424-4020887
90470 42887
Cell : 98430-12887
93/3, Sathy Road, Veerappan Chatram,
Near. Bharathi Theatre Bus Stop,
ERODE - 638 004. TAMILNADU.

EXPERIMENT NO. MULTISTAGE CENTRIFUGAL PUMP

3.1 Objective 3.2 Apparatus Required 3.3 Experimental setup 3.4 Procedures 3.5 Observation Table 3.6 Calculation 3.7 Results & Discussions 3.8 Precaution 3.9 Viva Voce Questions

3.1 Objective:

To study the characteristics of Multistage (Two Stage) Centrifugal pump, to calculate the efficiency and the draw the following curves:

- Discharge VS Head
- Discharge VS Efficiency
- Discharge VS Power

3.2 Apparatus Required: Multistage Centrifugal pump Test rig.

3.3 Experimental setup:

The test rig consists of a motor and multi stage pump directly couple through a flanged coupling arrangement and further it is mounted on a sump tank. A collecting tank is provided to measure discharge of the pump. A panel board consisting of energy meter to measure the power input to the motor, and a starter to start the pump. The rig is complete with suction and discharge pressure gauges along with suitable pipeline and control valve arrangements.

3.4 Procedure:

a. Prime the pump if necessary.
b. Keep the bypass valve and main valve fully open.
c. Start the pump.
d. Note down the readings at different pressure heads and discharge.

3.5 Observation Table:

Sl. No.	Discharge Q (cm^3/s)	Input power P_i (HP)	Suction Head H_s (cm)	Delivery Head H_d (cm)	Total Head H_m (cm)	Output power P_o (Hp)	Efficiency η

Sivan INDUSTRIES
The Project People

Off. Ph : 0424-4020887
90470 42887
Cell : 98430-12887
93/3, Sathy Road, Veerappan Chatram,
Near. Bharathi Theatre Bus Stop,
ERODE - 638 004. TAMILNADU.

3.6 Calculations:

Shaft input power to the motor = power input by energy meter

$$= \frac{No.of\ revolution\ X\ 3600}{Time\ X\ Energy\ meter\ constant\ X\ 0.736} =$$

Where rpm = Rotation of energy meter disc

Time = Time for one revolution of the disc

0.736 = Conversion factor from KW to HP

Motor efficiency = 75 %

Shaft input to the pump (Pi) = Shaft input to the motor X Motor efficiency

= .. ..

Total Head (H_m) = Suction head (H_s) + Delivery head (H_d)

=

Output of the pump $= \frac{\rho g Q H_m}{750} =$ .... out put of the Pump $= \frac{\rho g Q H_m}{750}$

Where ρ = Density of water

Q = Discharge in m^3/s

V = ~~Volume~~ 0.3m X 0.3m X 0.1m

L = Length of the collecting tank in m

W = width of the collecting tank in m

H = Height of Water in collecting tank in m read through Gauge glass and scale.

$$\text{Efficiency of the pump } (\eta_0) = \frac{\text{Output Power}}{\text{Input Power}} x100 =$$

3.7 Results & Discussions:

Following curves are drawn and efficiency is calculated.

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

Off. Ph : 0424-4020887
90470 42887
Cell : 98430-12887
93/3, Sathy Road, Veerappan Chatram,
Near. Bharathi Theatre Bus Stop,
ERODE - 638 004. TAMILNADU.

Discussions:

3.8 Precaution:

a. Priming is must before starting the pump.
b. Pump should never be run empty.
c. Use clean water in the sump tank.

Theoretical data: (STANDARD DATA) :

Monometric efficiency	= 39-45 %
Overall efficiency	= 75-85 %

3.9 Viva Voce Questions:

1. What is priming of a pump? Why it is necessary to prime a pump?
2. What is cavitation? Where does it occur in a centrifugal pump?
3. What are the main parts of a centrifugal pump?
4. What is the basic difference between a centrifugal and a reciprocating pump?

PITOT STATIC TUBE

Contents

Sivan INDUSTRIES
The Project People

Off. Ph : 0424-4020887
90470 42887
Cell : 98430-12887
93/3, Sathy Road, Veerappan Chatram,
Near. Bharathi Theatre Bus Stop,
ERODE - 638 004. TAMILNADU.

EXPERIMENT NO. PITOT STATIC TUBE

11.1 Objective: To determine the velocity coefficient of closed circuit pitot tube apparatus.

11.2 Apparatus Required: Pitot static tube apparatus and stopwatch.

11.3 Theory:

A pitot tube is a simple device used for measuring the velocity of flow. The basic principle used in this device is that if the velocity of flow at a particular point is reduced to zero, which is known as stagnation point, the pressure is increased due to conversion of the kinetic energy into pressure energy, and by measuring the increase in the pressure energy at this point the velocity of flow can be determined.

The simple Pitot tube consists of a glass tube, large enough for capillary effects to be negligible and bent at right angles. A single tube of this type may be used for measuring the velocity of flow in an open channel. If the Pitot tube is used for measuring the velocity of flow in a pipe or any other closed conduit then the Pitot tube may be inserted in the pipe as shown in fig 7. Since the pitot tube measures the stagnation pressure head (or the total head) at its dipped end, the static pressure head is also required to be measured at the same section where the tip of the pitot tube is held, in order to determine the dynamic pressure head 'h'. For measuring the static pressure head a pressure tap is provided at this section to which a Piezometer may be connected. Alternatively the dynamic pressure head may also be determined directly by connecting a suitable differential manometer between the Pitot tube and the pressure tap meant for measuring the static pressure.

The equipment is designed as a self-sufficient system, which includes a sump tank, measuring tank and a pump with piping circuit. A acrylic duct is fitted in the line with a provision of a traversing type pitot tube. Flow through the duct can be varied with the bypass valve provided at the outlet of the pump. A inclined tube manometer is fitted across the pitot tube to measure the dynamic pressure head.

11.4 Experimental Setup:

Prandle type pitot tubes are provided at both inlet & outlet, so that the velocity had can be determined separately. This prandle pitot tube consisting of two co- axial tubes and one coming within the other and both bend in the L shape so, that when interred inside the pipe. The tubes are parallel to the axis of the pipes at the place of measurements. The inner tube has a facing upstream and hence measure the total head including both pressure and velocity. The outlet tube has holes at he sides so, that it measure only the pressure head , thus the difference between the two given the velocity a head separately hence , the inner and outer tubes are connected to a differential manometer to indicate the velocity head .

11.5 Procedure:

1. Start the pump and the water shall start flowing through the duct.
2. Allow some time for the flow to get uniform flow.
3. Note down the reading of U-tube manometer.
4. Measure the actual discharge.
5. Change the discharge and repeat the above procedure.

11.6 Observations:

1. Diameter of pipe d = 25 mm
2. Area of measuring tank = 300mm X 300 mm.

11.7 Observation Table:

Sl. No	Manometer reading in terms of mercury column 'hg' in (cm of Hg)			manometer reading 'h_w' in (cm of water)	Discharge in (liters)	Time taken for discharge 't' in (sec)
	h1	h2	hg=h1-h2			
1						
2						
3						

11.8 Sample Calculations:

1. Manometer reading in cm of water $h_w = h_g$ (13.6-1)=…………….cm of water
2. Theoretical Velocity $V_t = \sqrt{2\,g\,h_w}$ cm/sec = ………..cm/sec
3. Area of the duct A=… ………...cm^2
4. Actual discharge $Q_a = q/t$ =…… …… Cm^3/sec

5. Actual Velocity $V_a = Q_a / A$ =…………cm/sec
6. Coefficient of Velocity $C_v = V_a / V_t$ =………………

11.9 Result Table:

Sl. No	Manometer reading 'h_w' in (cm of water)	Theoretical Velocity 'V_t' in (cm/sec)	Actual Velocity 'V_a' (cm/sec)	Coefficient of velocity 'C_v'
1				
2				
3				
Average velocity of co-efficient of velocity (C_v)				

11.10 Result and discussion:

The average Co-efficient of velocity of the Pitot tube C_v =………………

$Q_a = V \times A$