Terna Public Charitable Trust's

College of Engineering, Osmanabad

Dept. of Civil Engineering

Class:- S.Y.B Tech **Sub:-** Hydraulics-I

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EXPERIMENT NO: 01

Title: Determination of viscosity of lubricating oil by - Red Wood viscometer apparatus

Aim: To determine of viscosity of lubricating oil by - Red Wood viscometer apparatus

Apparatus required: - Red Wood viscometer no. 1, stop watch, flask, thermometer, etc.

Theory: Viscosity is the property of a fluid that determines its resistance to flow. It is an indicator of flow ability of a lubricating oil; the lowest the viscosity, greater the flow ability. It is mainly due to the forces of cohesion between the molecules of lubricating oil.

Absolute Viscosity may be defined as "the tangential force per unit area which is required to maintain a unit (eta). Its Unit in CGS system is poise and itsηvelocity gradient between two parallel layers.

Viscosity Index: Viscosity generally decreases with increase in temperature. The maintenance of viscosity over the range of temperature is called the viscosity Index (V.I)

A relatively small change/no change in viscosity with temperature is indicated by high viscosity index whereas low viscosity index shows relatively large change in viscosity with temperature

Effect of temperature on viscosity: Viscosity of lubricating oil is inversely proportional to the temperature i.e. with increase of temperature, viscosity decreases. This is due to the decrease in intermolecular attraction At higher temperature, oil must have sufficient viscosity to carry loads. Hence heavier oils are used at higher temperature. Similarly, light oils are used at low ambient temperature Effect of pressure on viscosity Lubricating oils are subjected to extreme pressure at the interphase between gears and rolling element. At such higher pressure, viscosity of lubricating oil increases considerably.

Viscosity helps in selecting good lubricating oil Light oils Heavy Oils Having low density High density Easy flow ability Low flow ability Used for; High speed, low pressure Used for; Low speed, high pressure & Low temperature & high temperature.

Construction:

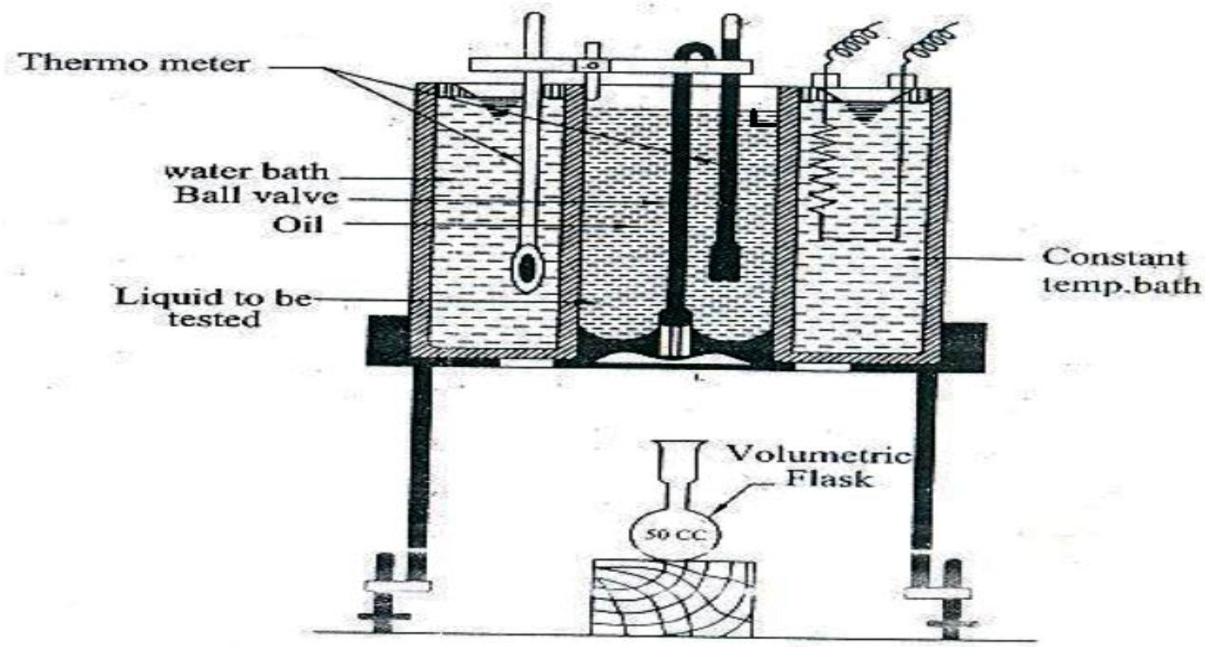


Figure: Red Wood viscometer

PROCEDURE:

- Clean the viscometer cup properly with the help of suitable solvent e.g. CCl4, ether, petroleum spirit or benzene and dry it to remove any traces of solvent.
- Level the viscometer with the help of leveling screws.
- Fill the outer bath with water for determining the viscosity at 80 ^{o} c and below.
- Place the ball valve on the jet to close it and pour the test oil into the cup up to the tip of indicator.
- Place a clean dry Kohlrausch flask immediately below and directly in line with discharging jet.
- Insert a clean thermometer and a stirrer in the cup and cover it with a lid.
- Heat the water filled in the bath slowly with constant stirring. When the oil in the cup attains a desired temperature, stop the heating.
- Lift the ball valve and start the stop watch. Oil from the jet flows into the flask.
- Stop the stop watch when lower meniscus of the oil reaches the 50 ml mark on the neck of receiving flask.
- Record the time taken for 50 ml of the oil to collect in the flask.
- Repeat the experiment to get more readings.

OBSERVATION TABLE:

Sr. no.	Temperature of oil (^oC)	Time required to fill 50ml of flask in seconds
1		
2		
3		

Calculation:

RESULT: -

The viscosity of given oil sample using Redwood viscometer no.1 is ……………… Stokes.

Experiment no 2

Aim:-

Demonstration of working of different types valves are required to be introduced in fitting the pipelines for one or all the following purpose

i) To stop the flow of liquid together
ii) To regulate the rate of flow of the liquid.
iii) To regulate the head or pressure in the pipelines.

According to the motion of the valve element, the control valves may be classified in the following three categories.

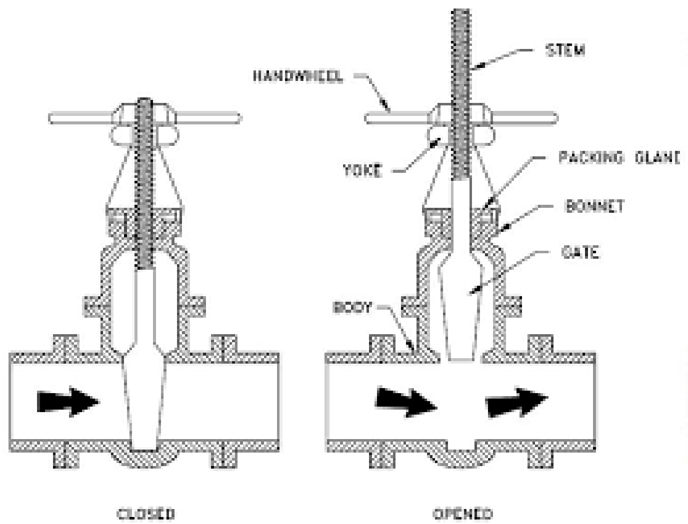
i) Valve element moves transversely across the water way.
ii) Valve element rotates about an axis traverse to water way.
iii) Valve element slides axially or longitudinally.

a) With transverse motion.

In this category of the valve, the following two types of valve may be considered.

1) Full way or sluice or gate valve:-

These is a very commonly used valve in which the moving element has the form of a disc or circular gate wedge shaped in cross section having a nut which engage with the spread of operating spindle as shown in the figure in the fully open position the gate is withdrawn clear of the water way and hence this valve is designed as fully way valve.



Sluice or Gate valve

2)Global valve or stop valve :-

As shown in the accompanying figure, in this case the valve element is wing guided mitre or disc, which in the closed position of the valve is forced on this circular seat by the screwed spindle.

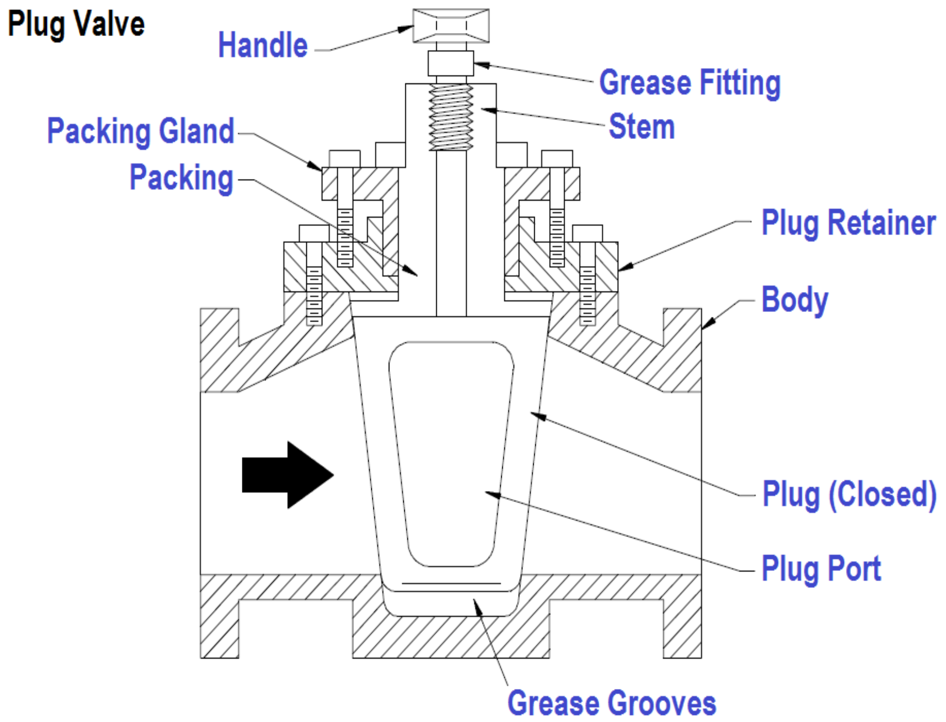
a)When This spindle realness of the valve element the pressure of the incoming liquid is sufficient to lift in the opening the valve.

b) With rotary motion: - The following two types of valve may be considered in this category.

i) Butterfly Valve:- In this valve the cylindrical valve body forms virtually a continuation of the pipe itself and it houses a moving element of elliptical shape rotation of the valve spindle. Brings the valve element either into the closed position or into the fully open position, in which it is parallel with the pipe axis as shown in the accompanying figure.

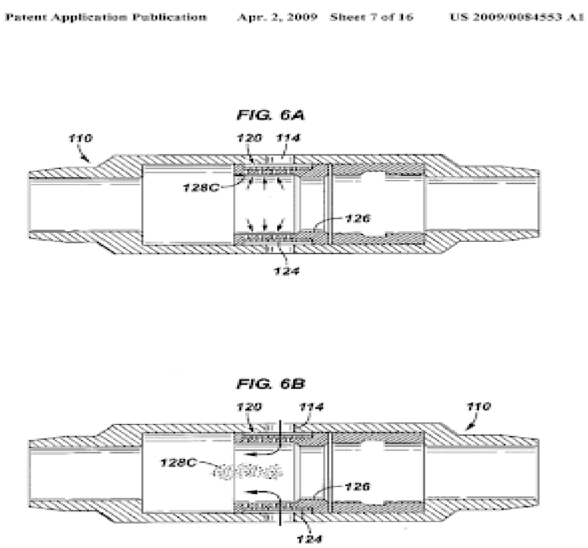
Butterfly valve

ii)Plug valve:- A Conical plug has a part which in the open position of the valve is line within the pipe after being moment turned through go the plug completely close the water way as shown in fig the sectional view in the accompanying figure.



c) With axial motion:- In this category the following two types of valve may be included.

i) Sleeve Valve:- As shown in fig a cylindrical sleeve surrounding the body of the valve can be moved longitudinally so as to open or close the water such valve are usually fixed at a outlet of the pipe where it serves as an energy dispersed.



Sleeve valve

ii) Needle valve:- It is another type of valve with as axially moving element the operating piston is formed integrally with the needle which regulate the area of the water way.

High pressure admitted to one side or the other of the piston cause the needle or the other of the piston to take up the desired position accompaying figure. Shows the value.

a) In the fully open piston.
b) In the fully closed piston and
c) In the partially closed position.

The needle valve resist cavitation damage quite successfully because as shown in fig in the case of needle valve the zone of intense eddying lies near the axis of the water way for away from the pipe walls.

Needle valve

The sluice valve is however more susceptible to cavitations damage particularly when used continuously in partially open position.

However, in spite of this drawback the sluice valve is used to control valve being suitable for the pipe very small as well as very large diameters the globe valve is mast widely used in the domestic water trap.

However. The globe valves are also used for the pipeline of very large diameter.

The butterfly valves are generally used for regulating the flow of water in penstocks supplying water to turbines installed in hydropower station. Similarly, the needle valves are the also used for regulating the flow of liquid through large diameter such as penstocks.

Pipe fitting:- A pipe fitting is used in plumbing system to join multiple pipes of same size of different size to regular regulate the flow or to measure the flow.

Types of pipe fitting:-

1) Coupling, 2) Elbow. 3) Tee type. 4) Cross type. 5) Unions.

6) Adapters. 7) Reducers. 8) Olet. 9) Plug. 10) Cap.

1) Coupling:- A coupling is used to connect the pipes of same diameter coupling are also useful if the pipe is broken or leakage occurs.

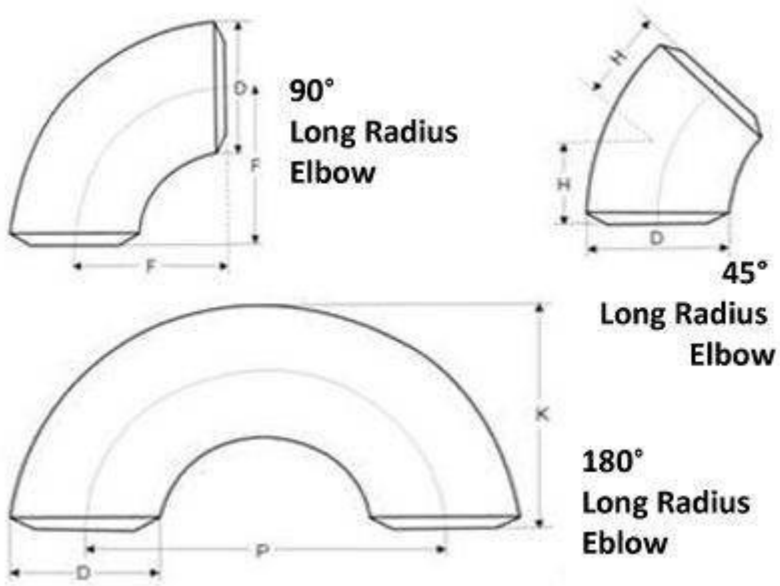
Generally, there are two types of coupling as below. Generally, there are two types of coupling as below. a) Compression coupling. b) Slip coupling.

a)Compression Coupling:-It is regular coupling which is connected between two pipe and it prevent leakage by the arrangement of gaskets or rubbles scale an both sides otherwise glue is provided.

b)Slip coupling:- It is easier to install and it contains two pipe which are arranged as one into other inner pipe can slide upto same length, so, we can fix long length arranged pipe by slip coupling.

2) Elbow :- Elbow are used to change the direction of flow between two pipes elbow are generally available with an angle of 225 45 and 90.

If pipes are used otherwise are same diameter than normal elbows are used otherwise reduces elbows are used.



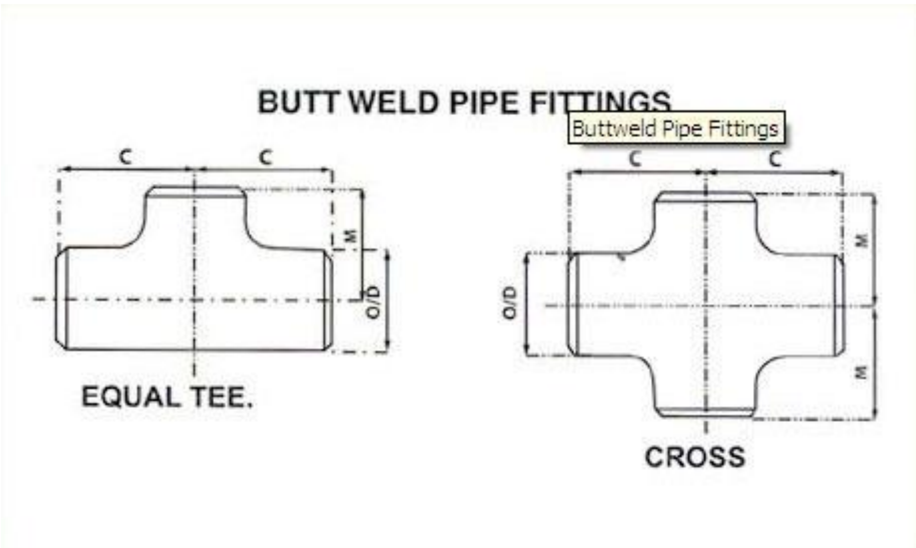
3) Tee type pipe fitting:- Tee type fitting is a component of plumbing system which is in –T shape

It is moving on inlet and two outlet are arranged at go to the main line connection.

It can also be used to combine the flow from two inlets to one

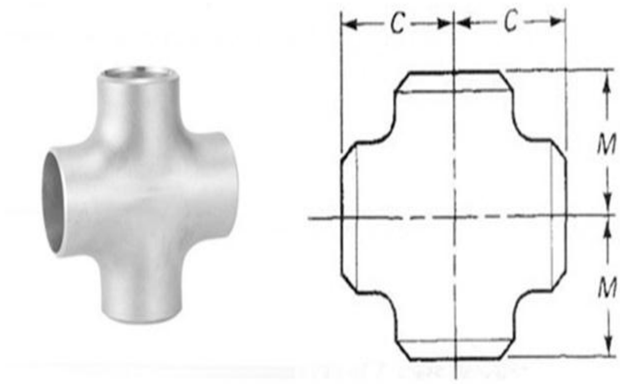
They are available in different material and different sixes

If the three sides of Tee fitting are similar in size then it is called as equal tee, otherwise it is called as unequal tee.



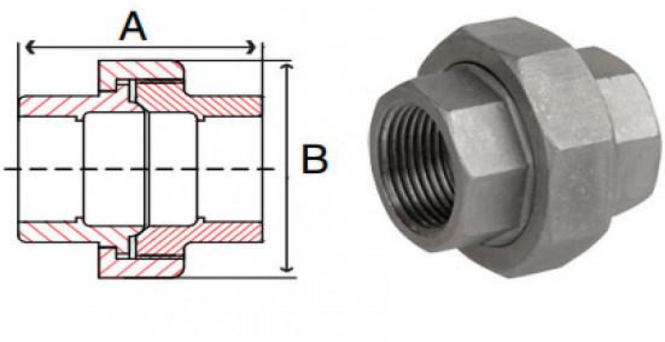
4) Cross type:- Cross type fitting contain four opening in four direction.

These are connected when there are four pipes meeting at a point, these fittings generate more amount of stress on pipe as the temperature changes, because they are located at the center o f four connection points cross section fittings are generally used for fire sprinkler system.



5) Unions:- Union is a type of fitting which function are similar to coupling bat coupling cannot be removed after fixing but in this case we can remove the union whenever we needed.

Unions consist nut, male and female ended threads. So this is also useful for maintaining purpose of pipe.



6) Adapters:- if the pipe are not having special ends are plain end than adopters make then threaded either male or female whichever is needed. One end of adopters is plain which is glued or welded to the plain pipe end.

Experiment No 03

Pressure measuring devices

Aim: Study of Pressure Measurement devices.

Theory :

Everyday pressure measurements, such as for tire pressure, are usually made relative to ambient air pressure. In other cases measurements are made relative to a vacuum or to some other specific reference. When distinguishing between these zero references, the following terms are used:

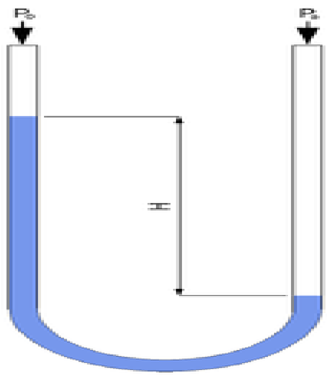
Absolute pressure is zero-referenced against a perfect vacuum, so it is equal to gauge pressure plus atmospheric pressure.

Gauge pressure is zero-referenced against ambient air pressure, so it is equal to absolute pressure minus atmospheric pressure. Negative signs are usually omitted. To distinguish a negative pressure, the value may be appended with the word "vacuum" or the gauge may be labeled a "vacuum gauge."

Differential pressure is the difference in pressure between two points.

Description : The apparatus consists of

1. **U Tube Manometer**



By using Bernoulli's equation and the derived pressure head equation, liquids can be used for instrumentation where gravity is present. Liquid column gauges consist of a vertical column of liquid in a tube that has ends which are exposed to different pressures. The column will rise or fall until its weight (a force applied due to gravity) is in equilibrium with the pressure differential between the two ends of the tube (a force applied due to fluid pressure). A very simple version is a U-shaped tube half-full of liquid, one side of which is connected to the region of interest while the reference pressure (which might be the atmospheric pressure or a vacuum) is applied to the other. The difference in liquid level represents the applied pressure. The pressure exerted by a column of fluid of height h and density ρ is given by the hydrostatic pressure equation,

$P = hg\rho$.

P = Gauge Pressure

h = Manometer Difference m

ρ = Density of manometric fluid kg/m^3

g = acceleration due to gravity = 9.81 $m\ s^{-2}$

2. **Single limb Manometeer**

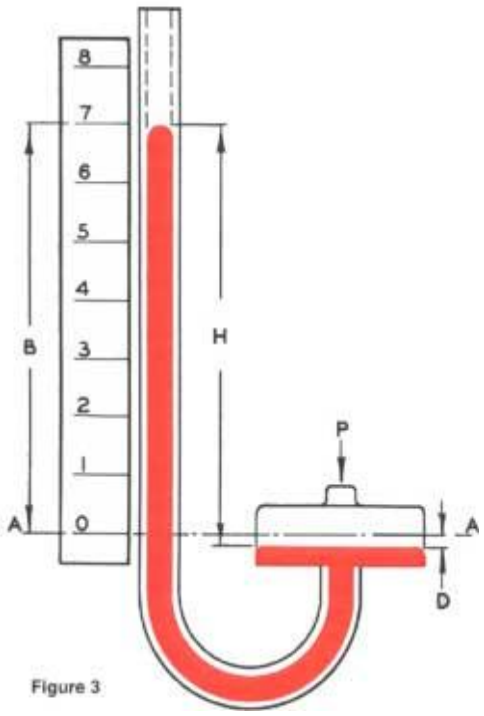


Figure 3

if one leg of the manometer is increased many times in area to that of the other, the volume of fluid displaced will represent very little change of height in the smaller area leg. This condition results in an ideal arrangement whereby it is necessary to read only one convenient scale adjacent to a single indicating tube rather than two in the U-type. The larger area leg is called the "well".

3. Inclined Tube Manometer

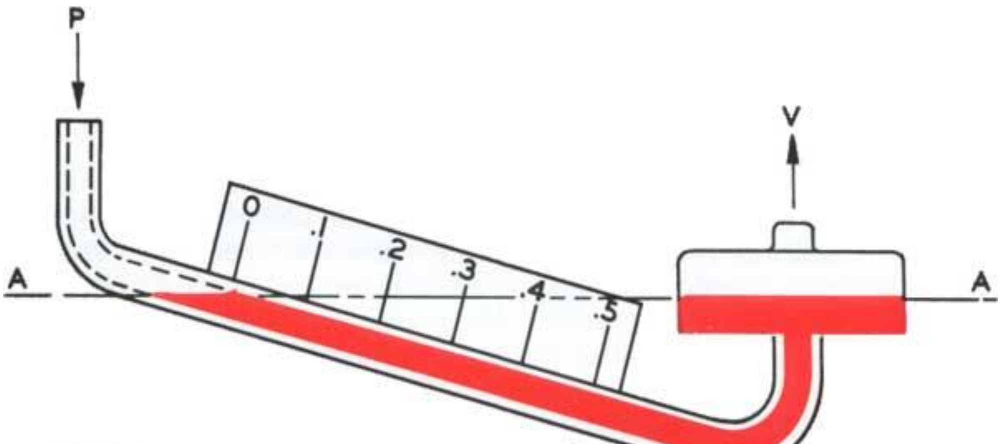


Figure 4

Many applications require accurate measurement of low pressure such as drafts and very low differentials, primarily in air and gas installations. In these applications the manometer is arranged with the indicating tube inclined,

$P = hg\rho.\sin\theta$

P = Gauge Pressure

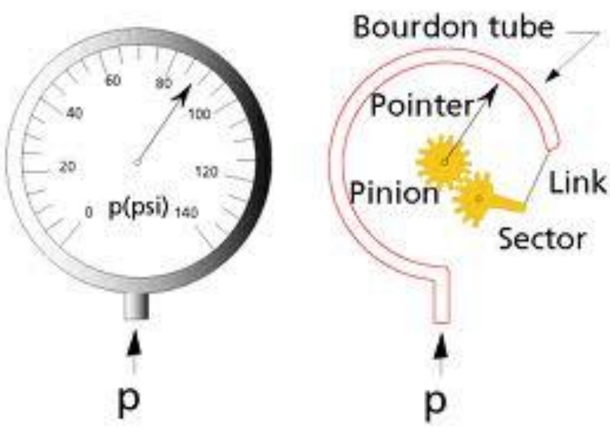
h = Manometer Difference m

ρ = Density of manometric fluid kg/m^3

g = acceleration due to gravity = 9.81 $m\ s^{-2}$

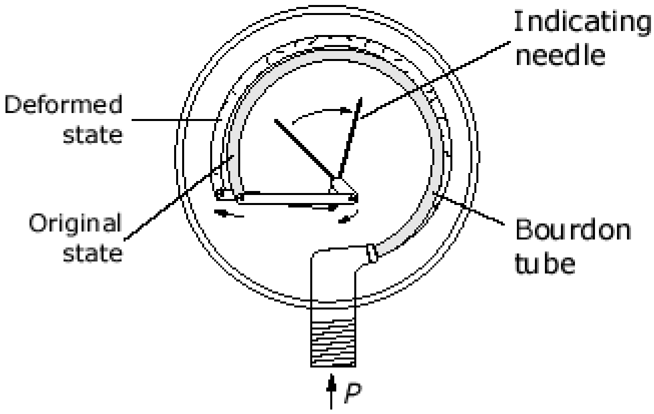
θ = angle of the inclined limb from the horizontal

4. Pressure Guage



The Bourdon pressure gauge uses the principle that a flattened tube tends to straighten or regain its circular form in cross-section when pressurized. Although this change in cross-section may be hardly noticeable, and thus involving moderate stresses within the elastic range of easily workable materials, the strain of the material of the tube is magnified by forming the tube into a C shape or even a helix, such that the entire tube tends to straighten out or uncoil, elastically, as it is pressurized. Eugene Bourdon patented his gauge in France in 1849, and it was widely adopted because of its superior sensitivity, linearity, and accuracy;

5. **<u>Vaccum Guage</u>**



A **vacuum gauge** is used to measure the pressure in a vacuumThe inside of a tube which is bent into a circular arc (the so-called Bourdon tube) is connected to the vacuum system. Due to the effect of the external atmospheric pressure, the end of the tube bends more or less during the evacuation process. This actuates the pointer arrangement which is attached to this point. The corresponding pressure can be read off on a linear scale. With Bourdon gauges it is possible to roughly determine pressures between 10 mbar (7.5 Torr) and atmospheric pressure

Observation Table :

Sr no	Flow rate	U Tube Manometer	Single limb Manometer	Inclined tube Manometer	PRESSURE GAUGE	VACUUM GAUGE

Experiment No. : 04
Measurement of discharge

Aim: - To determine the co-efficient of discharge of a rectangular notch.

Theory:-

Notch: Notch is a device or arrangement made across the flow in open channel for measuring the discharge.

The discharge coefficient Cd of a rectangular notch must be determined by applying formula

$$Q = \frac{2}{3} L\, C_d \sqrt{2g}\, H^{3/2}$$

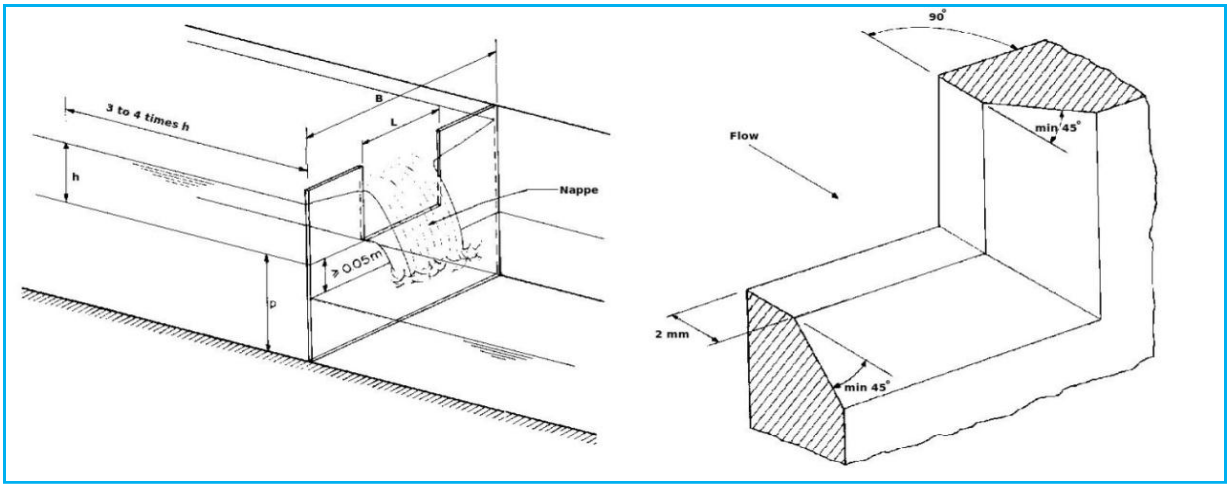


Fig.1 Rectangular Notch Apparatus Setup

Experimental Procedure:-

1. Check the experimental setup for leaks. Measure the dimensions of collecting tank and the notch.
2. Observe the initial reading of the hook gauge and make sure there is no discharge. Note down the sill level position of the hook gauge.
3. Open the inlet valve of the supply pipe for a slightly increased discharge. Wait for sometime till the flow become steady.
4. Adjust the hook gauge to touch the new water level and note down the reading. Difference of this hook gauge reading with initial still level reading is the head over the notch (h).
5. Collect the water in the collecting tank and observe the time t to collect R

Raise/Height of water.

6. Repeat the above procedure for different flow rates by adjusting the inlet valve opening and tabulate the readings.
7. Complete the tabulation and find the mean value of CD.
8. Draw the necessary graphs and calibrate the notch.

Observations:-

Initial Hook gauge reading = mm

Observation Table

Sl.No.	Sill level reading mm	Reading of head over the sill Mm	Head over the sill h cm	Rise cm	Time taken t sec.	Q_{th} m^3/s	Q_{act} m^3/s	Coefficient of discharge C_d

Specimen Calculations:-

$Q_a = A.R/t$

where $A = 6400\ cm^2$

$Q_a = C_d\ Q_{th}$

$Q_{th} = (2/3)\ L \sqrt{(2g)}\ h^{3/2}$

g = Acceleration due to gravity = $9.81\ m/sec^2$

$C_d = Q_a/Q_t$

Results:-

Coefficient of discharge of the given triangular notch from

1.Calculations

2. Graph

Conclusion:-

Average Cd ______________

Experiment No: 05

To Verify Bernoulli’s Theorem

Aim-: To verify the Bernoulli’s theorem.

Apparatus-: Bernoulli’s Set – Up, Stop Watch, & Meter Scale.

Theory-: Bernoulli’s Theorem states that, in a steady, ideal flow of an incompressible flow of fluid, the total energy at any point of the fluid is constant. The total energy consists of Pressure Energy, Kinetic Energy, & Potential Energy (Datum Energy). The energy per unit weight of the fluid is Pressure Energy.

Therefore,

Pressure Energy = $P / \rho g$

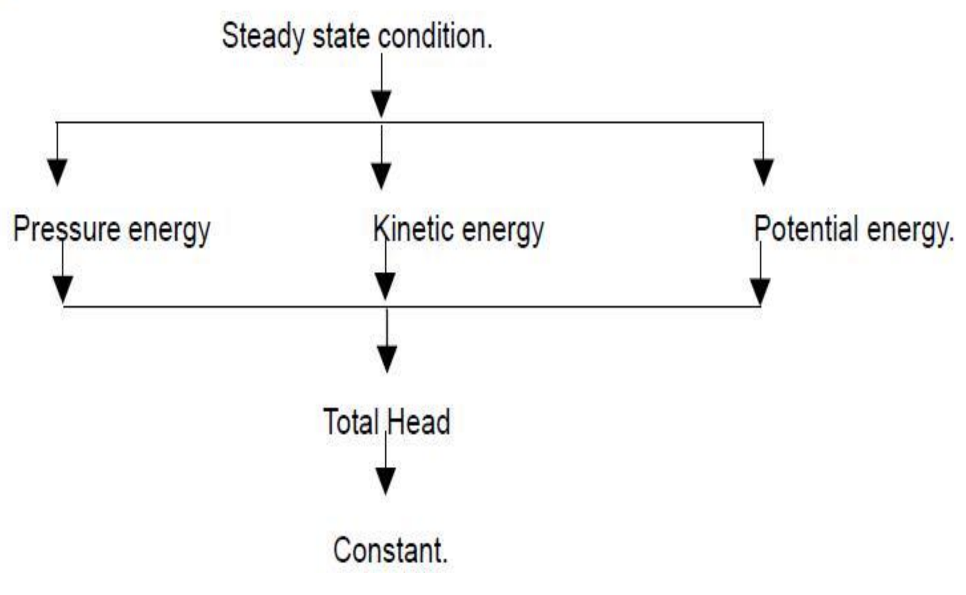
Kinetic Energy = $V^2 / 2g$ &

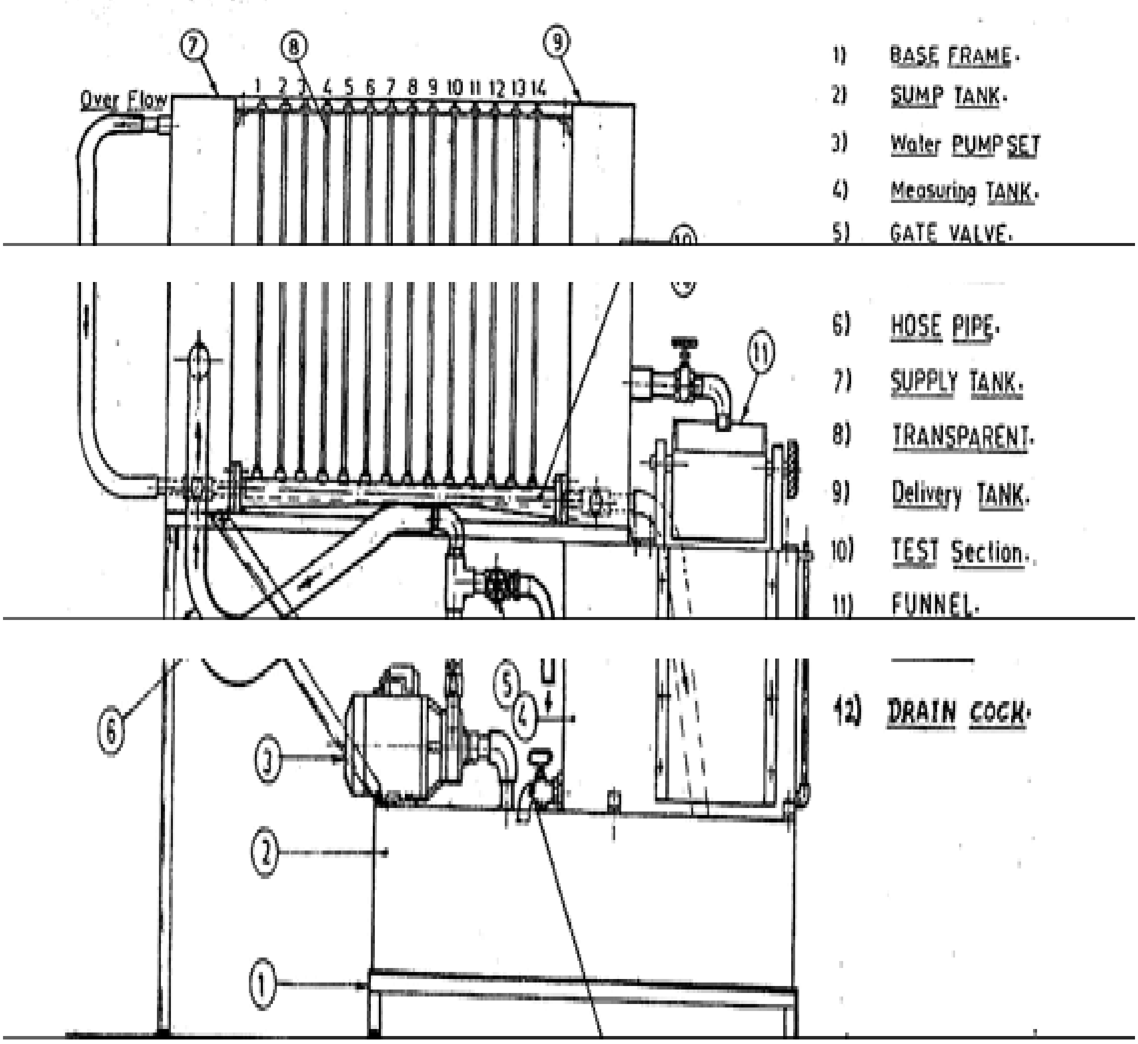
Datum Energy = Z

The applications of Bernoulli’s theorem are-:

1) Venturi Meter
2) Orifice Meter
3) Pitot Tube

Concept structure:





Description-: The equipment is designed as a self sufficient unit; it has a sump tank, measuring tank, & 0.5 HP monoblock pump for water circulation. The apparatus consists of Supply Tank & Delivery Tank, which are connected to a Perspex flow channel. The channel tapers for a length of 25 cm & then piezo-meter tubes are fixed at a distance of 5 cm , centre – to – centre for measurement of pressure head.

Procedure-:

1. Keep the bypass valve open & start the pump & slowly start closing the valve.
2. The water shall start flowing through the flow channel. The level in the piezometer tubes shall start rising.
3. Open the valve at the delivery tank side, & adjust the head in piezometer tubes to a steady position.
4. Measure the heads at all the points and also discharge with the help of Diversion

Pan in the measuring tank.

5. Change the discharge & repeat the procedure.

6. Do the necessary calculations using the readings noted down before.

Specifications-:

Tube No	01	02	03	04	05	06	07	08	09
Dia. Of Tube (mm)	23	20	17.5	16.5	14.5	16.5	17.5	20	23

Observation Table-:

Piezometer Tube No		**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**
Run No1	P/w (Pressure Head)									
	V=Q/A Velocity									
	$V^2/2g$ (Vel. Head)									
	Z Datum Head									
	$P/w+ V^2/2g+Z$ (Total head)									
Run No 2	P/w (Pressure Head)									
	V=Q/A Velocity									
	$V^2/2g$ (Vel. Head)									
	Z Datum Head									
	$P/w+ V^2/2g+Z$ (Total head)									
Run No 3	P/w (Pressure Head)									
	V=Q/A Velocity									
	$V^2/2g$ (Vel. Head)									
	Z Datum Head									
	$P/w+ V^2/2g+Z$ (Total head)									

Results-:

1) For Run No. 01,
Discharge (Q_1) is = ………m^3/sec; Total head is_____ mtrs.

2) For Run No. 02,
Discharge (Q_2) is = ………m^3/sec; Total head is_____ mtrs.

3) For Run No. 03,

Discharge (Q_3) is = ………m^3/sec; Total head is_____ mtrs.

Conclusion: - Practically, the total head doesn’t remain constant as Bernoulli claims to frictional losses

Experiment No 06

Determination of metacentric height

Aim: - To Determine the Metacentric Height of a Cargo / War Ship

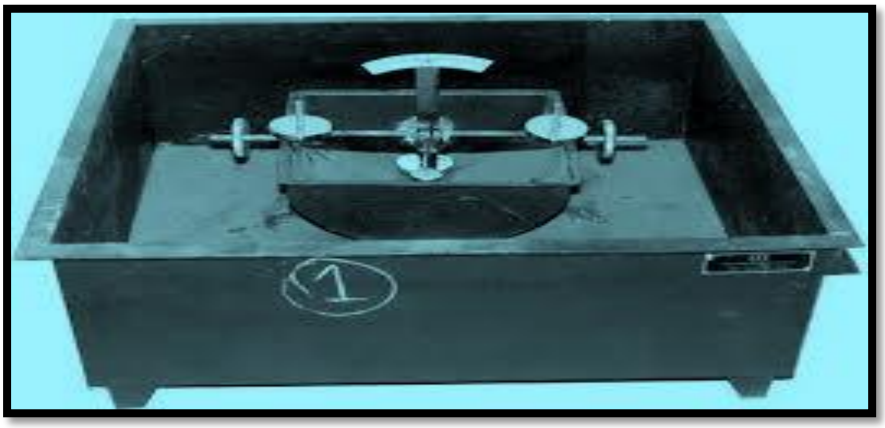
Introduction :- When any object (Body) is immersed partially in a liquid say water and is at rest ,both of its center of gravity G and center of buoyancy B will lie on same vertical line .

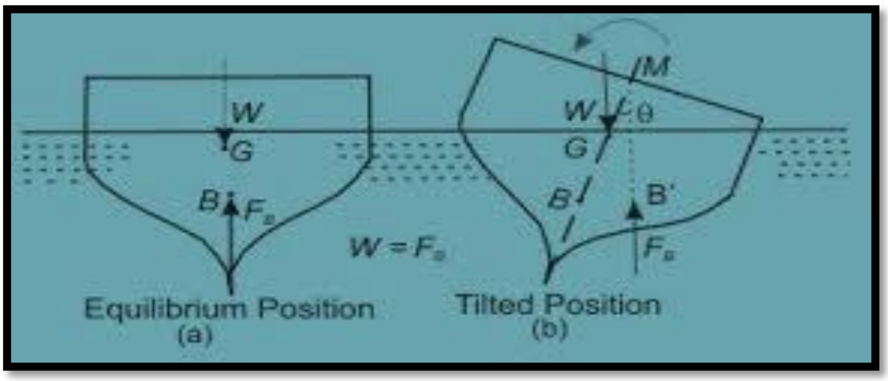
Also self weight of the ship W and opposite reaction force Fb act through same vertical line .If the body is slightly tilted for a small angle of heel the center of buoyancy will change its position .wherein G remains in same position.

Metacenter is defined as, the point about which the body starts oscillating when it is tilted (inclined) by a small angle.

Metacenter may also be defined as, the point at which the line of action of force of buoyancy will meet the normal axis of the body when the body is given a small angular displacement.

Metacentric Height is defined as, the distance between the Metacenter of a floating body & center of gravity.





Description:-

The ship model is approximately 37 cm size square in plan and is about 23 cm high. The model is floated on water. The ship is tilted by moving a small weight at the level of the deck of the ship. To note down the tilt of the ship, a plumb is provided which records the tilt on a graduated arc of a circle. An arrangement is made to load the ship as a War ship or Cargo ship.

Procedure :-

1. Fill required quantity of water into sump.
2. Initially remove additional weight from ship.
3. Immerse ship into sump.
4. It floats partially.
5. Level the ship and sump and see the ponter position with protractor.
6. Now put one rolling weight at a distance sat 165 mm fro center –d1
7. Now ship tilts that side,note down angle of tilt this is Ɵ1.
8. Now put rolling weight in opposite dirction at a distance say again say 165 mm –d2
9. Once again ship tilts,note down angle this is Ɵ2.
10. Angle of heel will be sum of Ɵ1 and Ɵ2 .
11. Total distance will be d mt which is sum of d1 and d2 .
12. Repeat experiment for rolling weight at different position.

Calculatio :-

1. Total distance $d = d1 + d2$ mts.
2. Angle of Heel $\Theta = \Theta1 + \Theta2$
3. Rolling weight m = ………kg
4. Weight of ship W = ………kg (Bare weight of ship = 3.0 kg)

Metacentric height :-

$$M = (m \times d) / (W \times \tan \Theta)$$

Experiment No- 07

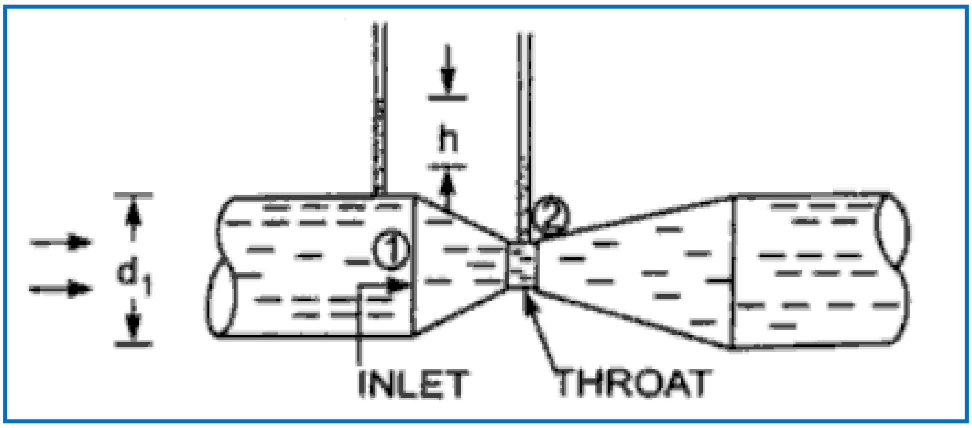
Aim : - Calibration of venturimeter and orificemeter.

Theory :-Venturi meters and orifice meters are widely used for determination of flow of fluid. While using the venturimeter or orificemeters their calibration is important. The equipment enables to determine the co-efficient of discharge of venturimeter and orficemeter.

Apparatus : -

1. Supply pipe of ∅ 28 mm (1”) connected to inlet manifold.
2. Venturi meter size inlet ∅ 26 mm and throat ∅ 13 mm
3. Orifice meter size inlet ∅ 26 mm and throat ∅ 13 mm
4. Differential mercury manometer tappings provided at inlet and throat of venturimeter and orificemeter. Manometer size 40cm height. Measuring tank size - 400 mm x 300 mm x 300 mm height.

   Sump tank : 400x 900x400mm.



Experimental Procedure : -

Before starting the experiment please see that;

1. Clean water in the sump tank is filled to approx. ¾ of its height.

1) The pressure relief valves above the manometer tubes are fully open.
2) The pressure valves of both the meters are fully closed.
3) The bypass gate valve, drain valve of the measuring tank and the gate valve of the meter (say venturimeter) which is to be calibrated is kept

open while that of the gate valve of the other meter is kept fully closed.

Now, start the flow.

4) Open the manometer pressure cocks of the venturimeter. Let the water flow through the pressure relief valves above the manometer. Remove all the air bubbles and than close both the pressure relief cocks slowly and simultaneously so that mercury does not get lifted out from the manometer. Observe the mercury head difference in the manometer.

5) Close the gate valve of measuring tank and measure the time required for 10 cm rise of the water in the measuring tank.

   Repeat the procedure by changing the discharge.

Also the same procedure may be followed for orificemeter.

Precautions : -

1) Operate manometer valve gently while removal of air bubble so that mercury in manometer does not get lifted out from the manometer.
2) Drain all the water from the sump tank after completion of the experiment.

Observation Table : -

Sr. No.	Type of meter	Manometer diff. h (m)	Time for 10 cm rise in measuring tank. (sec)

Data:-

* Inlet diameter of Venturimeter / Orificemeter = 26 mm = 0.026 m

* Throat of venturimeter / Orificemeter diameter = 13 mm = 0.013 m

Calculations :-

1) Actual discharge , $Q_a = \dfrac{0.4 \times 0.3 \times 0.1}{t}$

2) Let 'H' be the water head across manometer in , m.

$\therefore$ H = Manometer difference (Sp. gravity of Mercury - Sp. gravity of water)

or H = Manometer difference x (13.6 - 1)

A = cross sectional area at inlet to venturimeter / Orificemeter = 5.30 x 10^{-4} m^2

a = Cross sectional area at throat to venturimeter / Orificemeter diameter.

= 1.32 X 10^{-4} m^2

∴ Theoretical Discharge,

$$Q_{th} = \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh} \quad m_3/s$$

3) Co-efficient of discharge $C_d = \dfrac{Q_a}{Q_{th}}$

Conclusion : -

1. Calibrated values of co-efficient of discharge for Venturimeter is .... .

2. Calibrated values of co- efficient of discharge for Orificemeter is......

Sample calculations : -

FLOW MEASUREMENT BY VENTURI & ORIFICE METER APPARATUS

a) Observation Table (Venturimeter) : -

Sr. No.	Manometer diff. h (m)	Time for 10 liter water discharge t (Sec.)
1	0.032	19

CALCULATION : -

1) Actual discharge , $Q_a = \dfrac{0.01}{19} = 5.26 \text{ X } 10^{-4} \, m^3 / s$

2) Q_{th} = 0.00318

= 0.00318 0.032

= 5.68 x 10^{-4} m^3 / s

3) Co-efficient of discharge $C_d = \dfrac{Q_a}{Q_{th}}$

$$= \frac{5.26 \text{X } 10^{-4}}{5.68 \text{ X } 10^{-4}} = 0.926$$

b) Observation Table (Orificemeter) : -

Sr. No.	Manometer diff. h (m)	Time for 10 liter water discharge t (Sec.)
1	0.088	18.72

Calculation :-

1) Actual discharge , $Q_a = \dfrac{0.01}{18.72} = 5.34 \times 10^{-4}\ m^3 / s$

2) $Q_{th} = 0.002778 \quad h$

$= 0.002778 \quad 0.088 \quad = 8.24 \times 10^{-4}\ m^3 / s$

3) Co-efficient of discharge $C_d = \dfrac{Q_a}{Q_{th}} = \dfrac{5.34 \times 10^{-4}}{8.24 \times 10^{-4}} = 0.64$

Sample calculations are only for reference purpose.

Experiment No: 08
Determination of pipe friction factor

AIM: To determine Fluid friction factor for the given pipes.

Introduction and Theory

The flow of liquid through a pipe is resisted by viscous shear stresses within the liquid and the turbulence that occurs along the internal walls of the pipe, created by the roughness of the pipe material. This resistance is usually known as pipe friction and is measured is meters head of the fluid, thus the term head loss is also used to express the resistance to flow.

Many factors affect the head loss in pipes, the viscosity of the fluid being handled, the size of the pipes, the roughness of the internal surface of the pipes, the changes in elevations within the system and the length of travel of the fluid.

The resistance through various valves and fittings will also contribute to the overall head loss. In a well designed system the resistance through valves and fittings will be of minor significance to the overall head loss and thus are called Major losses in fluid flow.

The Darcy-Weisbach equation Weisbach first proposed the equation we now know as the Darcy-Weisbach formula or Darcy-Weisbach equation:

hf = f (L/D) x (v2/2g)

where:

hf = head loss (m)

f = Darcy friction factor

L = length of pipe work (m)

d = inner diameter of pipe work (m)

v = velocity of fluid (m/s)

g = acceleration due to gravity (m/s2)

The Darcy Friction factor used with Weisbach equation has now become the standard head loss equation for calculating head loss in pipes where the flow is turbulent.

Apparatus Description

The experimental set up consists of a large number of pipes of different diameters.

The pipes have tapping at certain distance so that a head loss can be measure with the help of a U - Tube manometer. The flow of water through a pipeline is regulated by operating a control valve which is provided in main supply line. Actual discharge through pipeline is calculated by collecting the water in measuring tank and by noting the time for collection.

Pipe Diameter:

Pipe 1: ID: 15mm

Pipe 2: ID: 25mm

Pipe 3: ID: 40mm

Experimental Procedure :

1) Fill the storage tank/sump with the water.

2) Switch on the pump and keep the control valve fully open and close the bypass valve to have maximum flow rate through the meter.

3) To find friction factor of pipe 1 open control valve of the same and close other to valves

4) Open the vent cocks provided for the particular pipe 1 of the manometer.

5) Note down the difference of level of mercury in the manometer limbs.
6) Keep the drain valve of the measuring tank open till its time to start collecting the water.
7) Close the drain valve of the measuring tank and collect known quantity of water
8) Note down the time required for the same.
9) Change the flow rate of water through the meter with the help of control valve and repeat the above procedure.
10) Similarly for pipe 2 and 3 . Repeat the same procedure indicated in step 4-9
11) Take about 2-3 readings for different flow rates.

Observations Table:
Length of test section (L) = mm
Pipe 1
Internal Diameter of Pipe D= _15mm
Cross Sectional Area of Pipe = ____ m^2

Sr. No.	T sec	h1-h2 (mm)	V (m/s)

Pipe 2
Internal Diameter of Pipe D= 25mm
Cross Sectional Area of Pipe = ____ m^2

Sr. No.	T sec	h1-h2 (mm)	V (m/s)

Pipe 3
Internal Diameter of Pipe D= 40mm
Cross Sectional Area of Pipe = ____ m^2

Sr. No.	T sec	h1-h2 (mm)	V (m/s)

Calculations
Mean velocity of flow, V = Q/A m/s
Where, Q =
According to Darcy- Weisbach Equation for frictional loss of head due to pipe friction:-

$$hf = h1 - h2 = f * l * \frac{v}{2gD}$$

In the above equation, everything is known to us except “f”
Conversion Factor :- 1 mm of Hg = 0.0126 m of water

Conclusion

1) The friction factor for pipe is as follows:

R Pipe 1 =

R Pipe 2 =

R Pipe 3 =

2) For same size pipe G.I./P.U. has more frictional loss compared to G.I./PU pipes

Experiment No 09

Determination of loss of head due to pipe fittings

Aim :

To find out **LOSSES** in different types of fittings.

Introduction :

When a fluid flows through a straight pipe, the resulting pressure drop can be predicted with confidence, using the equations available in the literature. Different types of fittings, usually used in the industries, offer additional resistance which cannot be calculated directly and hence must be determined experimentally or from published information.

Theory :

The resistance of fittings is usually expressed in terms of the equivalent length, i. e. the length of straight pipe of the same nominal diameter which would give the same resistance as the fittings under the same conditions of flow. If the equivalent length is expressed in pipe diameter, the resistance of all similar fittings is almost independent of the size of the fittings. The resistance of valves, in particular, varies considerably from one manufacturer's design to another. It is important to note that, the equivalent resistance is a function of the flow rate and at low Reynold's numbers may differ considerably from the published value.

Experimental set up :

Experimental set-up consists of 5 test sections of 25 mm dia. Straight pipes in which (1) Elbow (2) Bend (3) 60^0 Angle bend (4) Contraction (5) Enlargement are inserted. The upstream and downstream calming sections were provided in the test sections. The pressure drops were measured by means of U-tube manometer.

Procedure :

1. While test 1^{st} pipe tests, close all valves of the top pipes.
2. Open valve for 1^{st} pipe.
3. Open the valves of any Pipe Fitting fitted on line the pipes which are connected to manometer tube.
4. Close all other valves connected to manometer.
5. Start the pump.

6. Take manometer reading after getting steady state.
7. Measure water flow rate, with the help of stop watch & measuring tank.
8. Take 2-3 reading for different flow rate.
9. Repeat the above process for another fittings.

Precautions :

1. Open the valves slowly which are connected to manometer tube.

A. Head Losses Due To Sudden Contraction

Observations :

Diameter of Small Pipe	(d_2)	:	0.015 mtr.
Diameter of Big Pipe	(d_1)	:	0.026 mtr.
Area of Small Pipe	(A_2)	:	1.767×10^{-4} m^2
Area of Measuring Tank	(A)	:	0.5 x 0.35 = 0.175 m^2

Observation table :

Head Loss (hf) in mm of Hg				
Time Required for 50 mm rise of water level in Tank (t) Sec				

Calculation :

1. Discharge (Q) :

$$= \frac{A \times h}{t} \quad \mathbf{m^3/Sec}$$

2. Velocity Of Liquid in Small Pipe (V_2) :

$= \quad Q / A_2$ **m/Sec.**

3. Contraction Constant (k) :

$$hf = k \times \frac{V_2^{\,2}}{2 \times g}$$

B. Head Losses Due To Sudden Enlargement

Observations :

Diameter of Small Pipe (d_2) : 0.015 mtr.

Diameter of Big Pipe (d_1) : 0.025 mtr.

Area of Small Pipe (A_2) : 1.767×10^{-4} m^2

Area of Big Pipe (A_1) : 4.908×10^{-4} m^2

Area of Measuring Tank (A) : $0.5 \times 0.35 = 0.175$ m^2

Observation table :

Head Loss (hf) in mm of Hg				
Time Required for 50 mm rise of water level in Tank (t) Sec				

CALCULATION :

1. Discharge (Q) :

$$= \frac{A \times h}{t} \quad \mathbf{m^3/Sec}$$

2. Velocity Of Liquid in Small Pipe (V_2) :

$= \quad Q / A_2$ **m/Sec.**

3. Velocity Of Liquid in Big Pipe (V_1) :

$= Q / A_1$ **m/Sec.**

4. Enlargement Constant (k) :

$$hf = k \times \frac{(\mathbf{V_2 - V_1})^2}{2 \times g}$$

C. Head Losses In Bend

Observations:

Diameter of Bend	(d_1)	:	0.025 mtr.
Area of Bend Pipe	(A_1)	:	4.908×10^{-4} m^2
Area of Measuring Tank	(A)	:	0.5 x 0.35 = 0.175 m^2

Observation table :

Head Loss (hf) in mm of Hg				
Time Required for 50 mm rise of water level in Tank (t) Sec				

Calculation :

1. Discharge (Q) :

$$= \frac{A \times h}{t} \quad \mathbf{m^3/Sec}$$

2. Velocity Of Liquid in Bend Pipe (V_1) :

$= Q / A_1$ **m/Sec.**

3. Bend Constant (k) :

$$hf = k \times \frac{V_1^{\,2}}{2 \times g}$$

D Head Losses In elbow

Observation :

Diameter of elbow (d_1) : 0.025 mtr.

Area of Elbow (A_1) : 4.908×10^{-4} m^2

Area of Measuring Tank (A) : $0.5 \times 0.35 = 0.175\ m^2$

Observation table:

Head Loss (hf) in mm of Hg				
Time Required for 50 mm rise of water level in Tank (t) Sec				

Calculation :

1. Discharge (Q) :

$$= \frac{A \times h}{t} \quad \mathbf{m^3/Sec}$$

2. Velocity Of Liquid in El-BowPipe (V_1) :

$= Q / A_1$ **m/Sec.**

3. Elbow Constant (k) :

$$hf = k \times \frac{V_1^{2}}{2 \times g}$$

E. Head Losses In 60 Degree Bend

Observation :

Diameter of Bend (d_1) : 0.025 mtr.

Area of Bend Pipe (A_1) : 4.908×10^{-4} m^2

Area of Measuring Tank (A) : $0.5 \times 0.35 = 0.175\ m^2$

Observation table:

Head Loss (hf) in mm of Hg				
Time Required for 50 mm rise of water level in Tank (t) Sec				

Calculation :

1. Discharge (Q) :

$$= \frac{A \times h}{t} \quad \mathbf{m^3/Sec}$$

2. Velocity Of Liquid in Bend Pipe (V_1) :

$= Q / A_1$ **m/Sec.**

3. Bend Constant (k) :

$$hf = k \times \frac{V_1^{2}}{2 \times g}$$

Quiz on the subject:-

1. What is Meta-Center and Metacentric height?
2. Why it is important to study Meta-centric height experiment?
3. What is meant by Buoyancy?
4. Write Bernoulli's equation for real fluid flow
5. What are the assumptions made in Bernoulli's equation's derivation?
6. What are the applications of Bernoulli's equation?
7. Can be the same calibration be used if the venturimeter is inclined?
8. What is so special about Borda's mouth piece?
9. What are the various types of mouth pieces?
10. What is the difference between an orifice and a mouth piece?
11. Why the co-efficient of discharge for a mouth piece is higher than that for an orifice?
12. How do you distinguish physically a laminar flow and turbulent flow?
13. What is a broad crested weir? Bring out the points of difference vis-à-vis or sharp crested weir
14. What are the advantages of a triangular notch or weir over a rectangular notch?
15. What is the effect on computed discharge over a weir or notch due to error in the measurement of head?
16. What is a broad crested weir? Bring out the points of difference vis-à-vis or sharp crested weir
17. What are the advantages of a triangular notch or weir over a rectangular notch?
18. What is the effect on computed discharge over a weir or notch due to error in the measurement of head?
19. Enlist various losses in pipes.
20. Give the equations for each loss.
21. Enlist various minor losses.
22. Explain siphonic action.
23. Give Chezy's formula.
24. Define total energy line.
25. Define hydraulic gradient line.
26. What is meant by water hammer?
27. Define pipes in compound or pipes in series.
28. Define equivalent pipe.

29. What is Darcy-Weisbach equation?

30. Define mouthpiece.

31. State the classification of mouthpicece.