EXPERIMENTS IN FLUID MECHANICS

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DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT : FLUID MECHANICS

SUBJECT CODE: 130101 & 130602

INDEX

PRACTICAL: 01

METACENTRIC HEIGHT OF SHIP MODEL

When a body is immersed in fluid, it is subjected to an upwards force which tends to lift up the body. This is called buoyancy and the upward force is called buoyant force. Archimede's principle states that when a body is immersed in a fluid, wholly or partially, it is buoyed or lifted up by a force which is equal to the weight of the fluid displaced by the body.

When a body is floating in liquid, it is acted upon by two forces, viz. Weight of body acting downwards through center of gravity and upward buoyant force acting through center of -buoyancy. Both these forces are equal and opposite in direction and the body is in equilibrium. Center of buoyancy of a body is centroid of the volume of liquid displaced. If the body is tilted slightly, then position of center of gravity remains the same but center of buoyancy occupies the new position, as geometry volume changes. If a vertical line is drawn through the new center of buoyancy, it intersects the line joining initial center of buoyancy and center of gravity at a point, know as metacenter. The distance between metacenter and center of gravity is called metacentric height.

Stability of a floating body depends upon the metacentric height .If metacenter lies above the center of gravity, the slight angular displacement of body causes to form a restoring couple, which tends to bring the body to it's original position. This is called stable equilibrium.

When metacenter lies below the center of gravity, then slight angular displacement of body causes to form a couple which tends to increase the angular displacement further. This is called unstable equilibrium. When metacenter lies exactly on center of gravity then slight angular displacement does not create any couple, hence body remains in it's new position. This is called neutral equilibrium. Hence, in design of ship, care has to be taken to keep the metacenter well above the center of gravity, so that ship is in stable equilibrium.

The ‘DYNAMIC’ apparatus consist of a ship model, which is made of half round shape. A movable weight slides in a guide bar at the deck. When the weight is shifted from the center position, the ship tilts slightly. The angle of tilt (or angle of heel) is measured with the help of angular scale fitted on upside. The position of metacenter is then determine by displacement of weight and angle of heel.

EXPERIMENTAL PROCEDURE

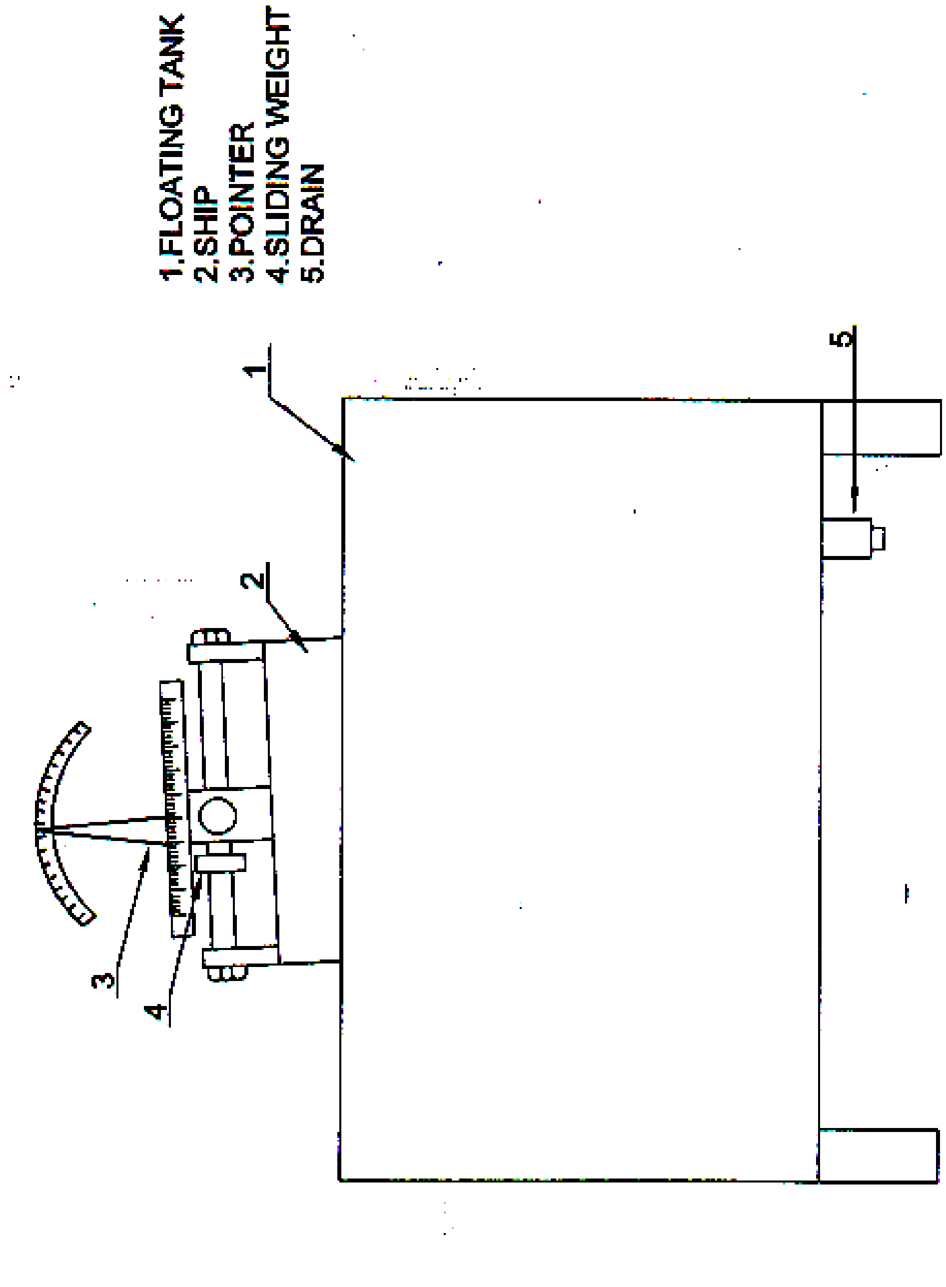
1. Fill up water in the floating tank.
2. Keeps the ship floating over the water.
3. See that plumb indicates zero reading.
4. Displace the weight on the deck.
5. Measure the displacement of weight and distance indicated by plumb.
6. Repeat the procedure for different displacement of weight.

OBSERVATION TABLE:-

Sr. No.	Weight displacement x cm	Angle of heel θ

CALCULATIONS :

1. Weight of the ship, w 2.400kg
2. Sliding weight on the deck, w=0.2kg.
3. Let distance moved by the weight w at the deck be x.
   Let angle of heel [through which the slip is tilted] be θ.
   Then metacentric height,
   $GM = w.x/W.\tan\theta$



METACENTRIC HEIGHT OF SHIP MODEL

DYNAMIC ENGINEERING EQUIPMENTS MIRAJ

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PRACTICAL : 02

REYNOLDS APPARATUS

Whenever a fluid is flowing through a pipe, the flow is either laminar or turbulent. When fluid is flowing in parallel layers or laminae, sliding past adjacent laminae, it is called laminar flow. When the fluid does not flow in parallel layers and there is intermingling of fluid particles then the flow is said to be turbulent. Existence of these two types was first demonstrated by ‘ OSBORN REYNOLDS ' in 1883.

The **'DYNAMIC’** apparatus consists of a constant head supply tank supplied with a water. This tank is provided with a bell mouth outlet to which a transparent tube is fitted. At outlet of the tube a regulating valve is provided. A dye tank containing coloured dye is fitted above the supply tank. The water flows through pipe and dye is injected at the center of the pipe. When the velocity of flow is low, (i.e. flow is laminar) then dye remains in the form of straight filament. As the velocity of water (i.e. flow of water) is increased, a state is reached when the dye filament becomes irregular and water. With further increase of velocity of water through the tube, dye filament becomes more and more irregular and ultimately the dye diffuses over the entire cross section of the tube.

The velocity at which the flow changes from laminar to turbulant for the case of a given fluid at given temperature and in a given pipe is known as critical velocity.

EXPERIMENTAL PROCEDURE

1. Fill up water up to the mark.
2. Fill up sufficient water in dye tank and put a small amount of potassium permagnet in to water.
3. Prime pump (remove the end plug & fill up water, remove all the air. Then tight the plug. Fitted near the flow control valve.) Connect the electric supply and start pump. Adjust the water flow. Flow to about 2 lpm. Start the dye injection.
4. Wait for some time. A steady line of dye will be observed. Adjust dye flow, if required.
5. Slowly increase the water flow sees that water level in supply tank remains constant. At particular flow rate, dye line will be disturbed note down this flow rate. By using 1lit measuring flask and stop watch.
6. Further increase the flow. The disturbances of dye line will go on increasing and at certain flow, the dye line diffuses over the entire cross section. Note down this flow.
7. Slightly increase the flow and then slowly reduce the flow. Note the flow at which diffused dye tends to become steady, (beginning of transition zone while reducing velocity.)
8. Further reduce the flow and note the flow at which dye line becomes straight and steady.
9. After completion of experiment drain all the water. [Drain plug is bottom of the sump tank] and tight the drain plug. Also clean the dye container.

OBSERATION TABLE

Sr. NO.	Flow Type	Time / 0.5 lit. (sec.)

OBSERATIONS

1. Increasing velocity
   a) Flow at beginning of transition
   b) Flow at beginning of turbulence.
2. Decreasing velocity
   a) Flow at beginning of transition
   b) Flow at beginning of laminar region.

CALCULATIONS

1. I. D. of pipe = 25 mm, cross sectional area of pipe
A = 4.9 x 10-W

Let, time required for 0.5 liter in measuring flask be 't'sec.

Then, flow, $Q = \frac{0.0005}{t}$ m^3/sec
Velocity,
$V = \frac{Q}{A}\ m/sec$

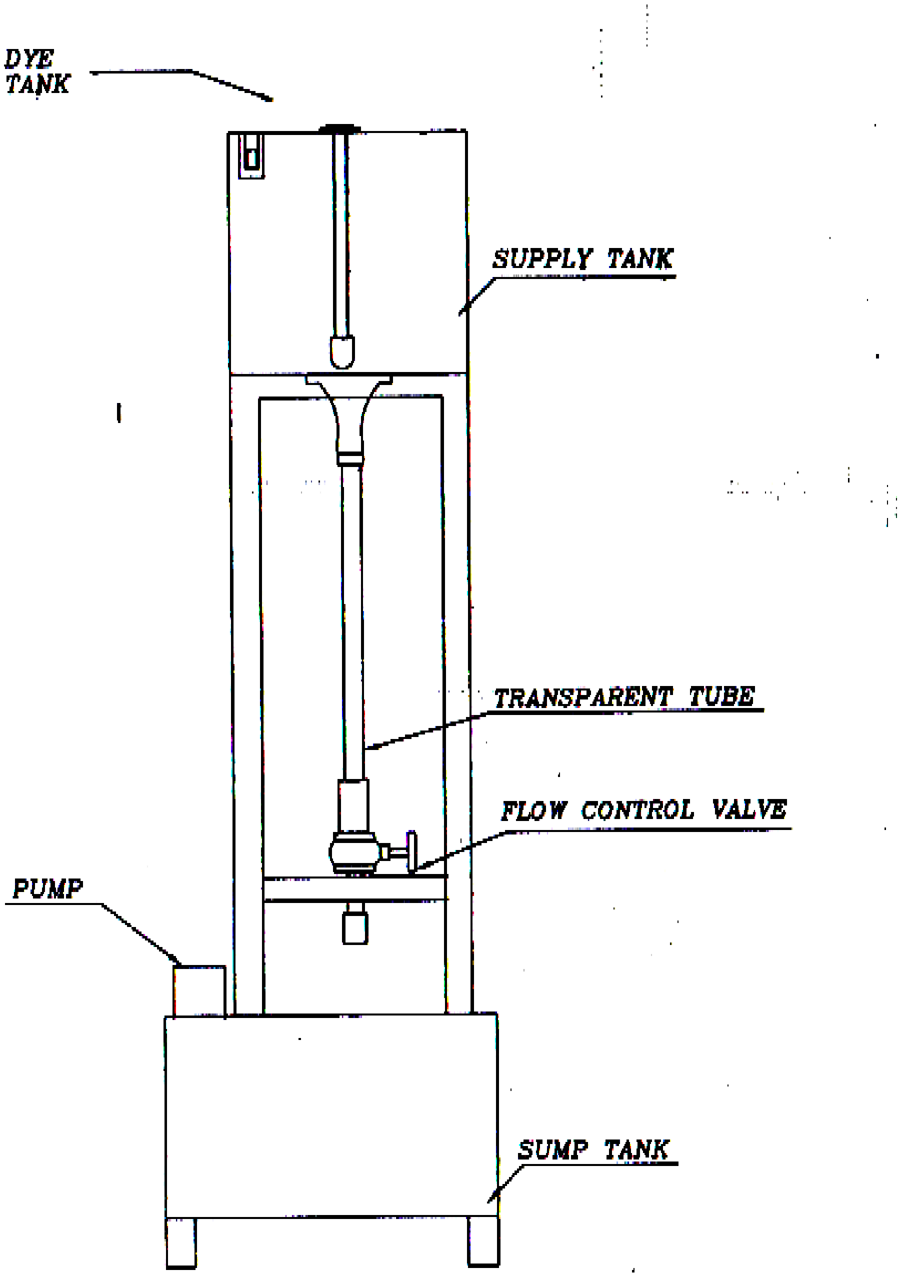
Then, Reynolds number,

$$Re = \frac{\rho\, V\, L}{\mu} = \frac{V\, L}{v}$$

ρ = Density of fluid = 9810 Kg/ m3
V = Velocity, m/sec
L =Characteristic linear dimension = 0.025mtr.
D = Diameter of the pipe = 0.025 m.
v = Kinematic viscosity of fluid =0.805 x 10^{-6} m^2/s
μ= 801.2×10^{-6} N-s/m^2

While increasing the velocity, laminar flow is disturbed at slightly higher velocity. But at the time of reducing the velocity, the flow does not turn to laminar at this velocity, but becomes laminar at still lower velocity is called lower critical velocity.

Lower critical Reynolds number flow is always laminar and above upper critical Reynolds number flow is always turbulent. Practically, upper critical Reynolds number lies between 2700 to 4000 and lower critical Reynolds, number is approximately 2000. Between Reynolds number 2000 and 4000 the transition region exists.



REYNOLDS APPARATUS

DYNAMIC ENGINEERING EQUIPMENTS MIRAJ

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PRACTICAL : 03

VERIFICATION OF BERNOULLI'S THEOREM APPARATUS

When an incompressible fluid is flowing through a closed conduit, is may be subjected to various forces, which cause change of velocity, acceleration or energies involved. The major forces involved are pressure and body forces. Due to elevation of conduits, pressure may change or due to change of cross section, velocity of fluid may change. But, though there is change of velocity, pressure also change accordingly. In other words, if velocity energy of fluid is raised, its pressure will drop, i.e. total energy of fluid is constant at any two points in the path of flow. The theorem is known as Bernoulli's theorem. Hence, when applied to steady irrotational flow of incompressible fluids,

$$\frac{P}{\omega} + \frac{V^2}{2g} + z = c$$

where,

P = pressure
V = velocity at the point
Z = potential head from datum

APPARATUS:

The apparatus consists of a rectangular flow channel which is tapered along the length. Flow area at inlet is maximum and it goes on reducing towards outlet. Water is fed to flow channel through a supply tank. Outlet is also collected through out let tank. A collector fitted can be directed either in drain or flow measurement tank.

EXPERIMENTAL PROCEDURE:

1) Connect the water pipe to the inlet valve.
2) Reduce flow by inlet gate valve, so that there is only a small rise of water in the last pressure tapping.
3) Allow the levels to stabilizes and note down the heads.
4) Close outlet valve of the measuring tank, put the collector in the measuring tank and measure the time to rise water level by 10 liters'. 5 . Now, repeat the procedure by changing the discharge, and note the drop of head towards outlet for each observation.

OBSERVATIONS:

Sr. No	Head in cms Tappings 1, 2, 3, 4,……….14	Discharge time for 10 litres of water flow)

CALCULATIONS:-

(Consider section at 1st tapping)

Area of flow channel, A = __________ m^2 ------------ (refer table)

1) Discharge, $Q = \frac{0.01}{t}$ m^3/sec

2) Velocity of water, $V = \frac{Q}{A}\ m/sec$

Hence,

3) Velocity energy or head = $\frac{V^2}{2g}$

4) Pressure head,

$$H = \frac{P}{\omega}$$

or H = h + hi

Where, h = Water rise from top channel, m

hi = Distance from top of channel to its center (See chart)

5) Now, datum line is same at inlet and outlet.

Hence, $Z_1 = Z_2 = Z_3 = 0$

According to Bernoulli's equation,

$$\frac{P_1}{\omega} + \frac{{V_1}^2}{2g} + Z_1 = \frac{P_2}{\omega} + \frac{{V_2}^2}{2g} + Z_2$$

$$H_1 + \frac{{V_1}^2}{2g} + Z_1 = H_2 + \frac{{V_2}^2}{2g} + Z_2$$

As $Z_1 = Z_2$ for the channel,

$$H_1 + \frac{{V_1}^2}{2g} = H_2 + \frac{{V_2}^2}{2g}$$

Find out the value of C for each section (at same flow rate). It is same for all section

Note- Practically, value of 'C goes on reducing slightly towards outlet, due to various factors which are not considered, e.g. friction, turbulance etc.,

CONCLUSION:-

1. As value of 'C' is fairly constant, total energy of flow Is same over the entire length.
2. As velocity of flow increases, pressure head drops.
3. Bernoulli's equation, i.e.

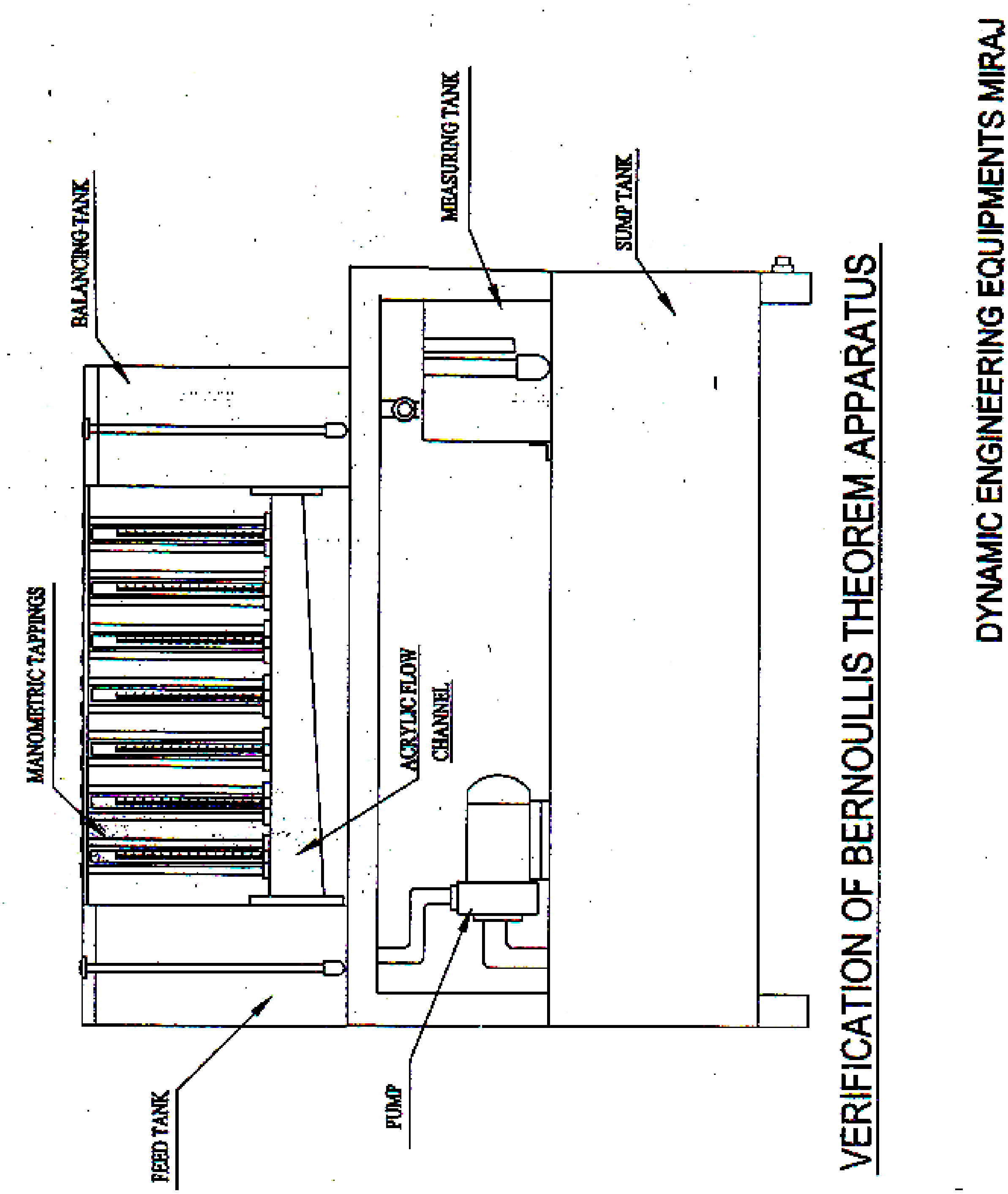
$\frac{P}{\omega} + \frac{V^2}{2g} + z = c$ is thus verified

PRECAUTIONS:-

1. Note down the head readings after the level has been stabilized.
2. After noting the discharge, drain the measuring tank.
3. After completion of experiment, drain all the water from the equipment.

TABLE

Tapping Sr. No.	h_1 m	Area m^2
Inlet		1×10^{-3}
1	0.03000	9.6×10^{-4}
2	0.02925	9.2×10^{-4}
3	0.02825	8.8×10^{-4}
4	0.02700	8.4×10^{-4}
5	0.02600	8.00×10^{-4}
6	0.02525	7.6×10^{-4}
7	0.02450	7.2×10^{-4}
8	0.02325	6.8×10^{-4}
9	0.02220	6.4×10^{-4}
10	0.02150	6×10^{-4}
11	0.02050	5.6×10^{-4}
12	0.01950	5.2×10^{-4}
13	0.01800	4.8×10^{-4}
14	0.01750	4.4×10^{-4}
outlet		$4.00 \times l0^{-4}$


BALANCING TANK
MEASURING TANK
SUMP TANK
MANOMETRIC TAPPINGS
ACRYLIC FLOW CHANNEL
FEED TANK
PUMP
VERIFICATION OF BERNOULLIS THEOREM APPARATUS
DYNAMIC ENGINEERING EQUIPMENTS MIRAJ

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PRACTICAL : 04

VENTURIMETER AND ORIFICEMETER APPARATUS

AIM : - Calibration of venturimeter and orificemeter.

APPARATUS:-

Venturi meters and orifice meters are widely used for determination of flow of fluid. While using the venturi or orifice their calibration is important. The ' **DYNAMIC** ' equipment enables to determine the co-efficient of discharge of venture meters and orificemeters.

SPECIFICATIONS : -

1. Supply pipe of ∅ 21 mm (3/4") connected to inlet manifold.
2. Venturi meter size inlet ∅ 21.5 mm and throat ∅ 15 mm
3. Orifice meter size inlet ∅ 20 mm and throat ∅ 14 mm
4. Differential mercury manometer tappings provided at inlet and throat of venturimeter and orificemeter. Manometer size 50 cm height. Measuring tank size - 300 mm x 300 mm x 300 mm height.

EXPERIMENTAL PROCEDURE : -

1. Check all the clamps for tightness
2. Open the gate valve and start the flow.
3. Open the outlet valve of the venturimeter and close the valve of orificemeter.
4. First open air cocks then open the venturimeter cocks, remove all the air bubbles and close the air cocks slowly and simultaneously so that mercury does not run away into water.
5. Close the gate valve of measuring tank and measure the time for 10 litres water discharge and also the manometer difference.

6. Repeat the procedure by changing the discharge and also for orificemeter.

1) **OBSERVATION TABLE FOR VENTURIMETER :**

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

CALCULATIONS : -

1. Actual discharge , $Q = \frac{0.01}{t}$

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

∴ 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 = 3.63 x 10^{-4} m^2

a = Cross - sectional area at throat to venturimeter = 1.76 X 10^{-4} m^2

Theoretical Discharge,

$Q_{th} = \frac{A\,a\sqrt{2gh}}{\sqrt{A^2-a^2}}$ m^3/s

$Q_{th} = 0.00318\sqrt{h}$ m^3/s = __________ (h in meter)

3. Co-efficient of discharge $C_d = \frac{Q_a}{Q_{th}}$

OBSERVATION TABLE FOR ORIFICEMETER

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

CALCULATIONS : -

1. Actual discharge , $Q = \frac{0.01}{t}$ m^3/sec
2. Let 'H' be the water head across manometer in , m.

∴ H = Manometer difference (Sp. gravity of Mercury - Sp. gravity of water)

or H = Manometer difference x (13.6 -1)

H = Manometer difference x (13.6 -1)

or H = h x 12.6 m

A = cross sectional area at inlet to Orificemeter = 3.14 x 10^{-4} m^2

a = Cross - sectional area to Orificemeter= 1.54 X 10^{-4} m^2

Theoretical Discharge,

$Q_{th} = \frac{A\,a\sqrt{2gh}}{\sqrt{A^2-a^2}}$ m^3/s

$Q_{th} = 0.00277\sqrt{h}$ m^3/s = __________ (h in meter)

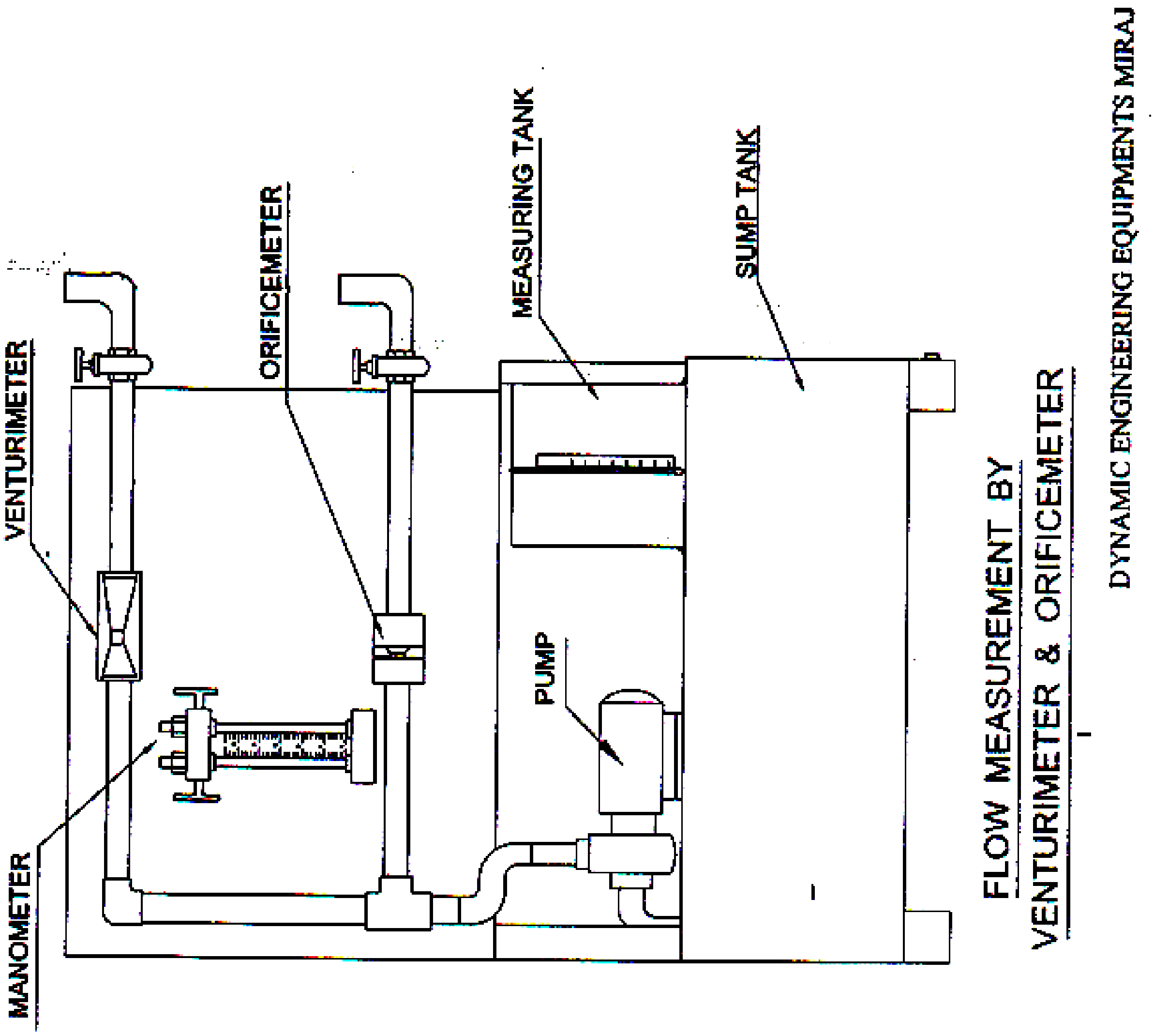
3. Co-efficient of discharge $C_d = \frac{Q_a}{Q_{th}}$

CONCLUSION : -

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

PRECAUTIONS : -

3. Operate manometer valve gently while removal of air bubble so that mercury in manometer does not run away with water.
4. Do not close the outlet valve completely.
5. Drain all the water after completion of experiment.


VENTURIMETER
ORIFICEMETER
MEASURING TANK
SUMP TANK
PUMP
MANOMETER
FLOW MEASUREMENT BY
VENTURIMETER & ORIFICEMETER
DYNAMIC ENGINEERING EQUIPMENTS MIRAJ

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PRACTICAL: 05

PITOT TUBE APPARATUS

AIM : - Calibration of Pitot Tube.

APPARATUS : - 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 there is increased due to the conversion of the kinetic energy into the pressure energy, and by measuring the increase in the pressure energy at this point the velocity of flow may be determined. This principle is adopted for measuring the velocity in the River.

The " DYNAMIC " equipment enables to determine the co-efficient of velocity of Pitot Tube.

SPECIFICATIONS : -

1) Monoblock centrifugal pump - Single - phase, 1-HP, 2880rpm.
2) Perspex Acrylic pipe of ∅ 32 mm x 200 mm long with Pitot Tube traversing arrangement.
3) Pitot Tube has a total head connection and a static head connection.
4) Supply pipe of diameter 32 mm (1-1/4 " G. I. Pipe).
5) Differential mercury manometer openings are connected to total head tapping and static head tapping. Manometer size is 400 mm height.
6) Measuring tank size is 300 mm x 300 mm x 300 mm height.

PROCEDURE: -

1) Close all the manometer cocks.
2) Open the gate valve.
3) Make the priming of pump.
4) Start the pump.
5) Adjust the flow by by-pass gate valve.
6) First open air cocks then open the Pitot Tube cocks, remove all the air bubbles and close the air cocks slowly and simultaneously so that mercury does not run away into water.
7) Adjust the Pitot Tube position as per requirement by traversing arrangement.
8) Take manometer difference reading.
9) Note down the manometer difference at different Pitot Tube position in the test pipe along the diameter.

10) Close the gate valve of measuring tank and measure the time for 10 litres water discharge.
11) Repeat the procedure by changing the discharge by by-pass gate valve.

OBSERVATION TABLE: -

SR. NO.	MANOMETER DIFFERENCE h (mtrs.) (AT PITOT TUBE POSITIONS)									TIME FOR 10 LITRES WATER DISCHARGE
	1	2	3	4	5	6	7	8	9	t (sec.)
1										
2										
3										
4										
5										

CALCULATIONS:

1. Actual discharge , $Q = \frac{0.01}{t}$ ________________m^3/sec
2. Actual Velocity , $V_{actual} = \frac{Q_a}{A}$ _______________m/sec

Where,

A = c/s area of pipe = 3.14 * d^2/4

A = 3.14 * 0.032^2/4

A = ________________m^2

$V_{actual} = \frac{Q_a}{8.04*10^{-4}}$ ________________m/s

3. Let 'H' be the water head across manometer in, mtrs

H = Manometer difference x (sp. Gravity of Hg - sp. Gravity of water)

= h x (13.6-1)
H = h x 12.6 --------------------- m of water.

4) Theoretical Velocity -

V= $\sqrt{2\ g\ H}$ m/sec.

Where,

V = Theo. Velocity of flow, m/sec.

g = gravitational acceleration = 9.81 m/sec^2

$V_1 = \sqrt{2\ g\ H_1}$

$V_2 = \sqrt{2\ g\ H_2}$

$V_g = \sqrt{2\ g\ H_g}$

Where,

V_1, V_2, are the velocities at corresponding points in the test pipe along the diameter

5) Average theoretical velocity -

$V_{theo} = \frac{V1 + V2 + \ldots\ldots\ldots + Vg}{g}$ ____________________ m/sec.

6) Co-efficient of velocity

$Cv = V_{actual}/V_{theo}$

7) Plot the graph of velocity distribution along the diameter.

CONCLUSION :

1) Calibrated value of co-efficient of velocity of Pitot Tube is------------------------.
2) Actual velocity from discharge compares with average theoretical velocity that obtained by Pitot Tube.

PRECAUTIONS : -

1. Close all the manometer cocks before starting the pump.
2. Operate manometer cocks gently while removal of air bubbles, so that mercury in manometer does not run away with water.

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PACTICAL: 06

FREE AND FORCED VORTEX APPARATUS

When a liquid contained in a cylindrical vessel is given the rotation either due to rotation of vessel about vertical axis or due to tangential velocity of water, surface of water no longer remains horizontal but it depresses at the centre and rises near the walls of the vessel. A rotating mass of fluid is called vortex and motion of rotating mass of fluid is vortex motion. Vortices are of two types viz. forced vortex and free vortex. When a cylinder is in rotation then the vortex is called forced vortex. If water enters a stationary cylinder then a vortex is called free vortex.

The 'DYNAMIC' apparatus consists of a perspex cylinder with drain at center of bottom. The cylinder is fixed over a rotating platform which can be rotated with the help of a D. C. motor at different speeds. A tangential water supply rip is provided with flow control valve. The whole unit is mounted over the sump tank. Water is supplied by a centrifugal pump.

SPECIFICATIONS:

1) Cylindrical vessel 308mm dia with central bottom cutlet, mounted over rotating platform. D. C. motor with controller to rotate the vessel.
2) Measuring tank - 300 x 300 x 300 mm mounted over the sump tank.
3) Centrifugal pump to circulate the water.
4) x-y co-ordinate measurement probe.

EXPERIMENTAL PROCEDURE .

A) Forced vortex -

1) Close the drain valve of the cylindrical vessel. Fill up some water (say **4-** 5 cms height from bottom) in the vessel.
2) Switch 'ON' the supply and slowly increase motor speed. Do not start the pump.
3) Keep motor speed constant and wait till the vortex formed in the cylinder stabilises. Once the vortex is stabilised note down the co-ordinates of the vortex & complete the observation table.
4) With the surface speed attachment of tachometer, measure outside surface speed of vessel & note down in observation table. (Tachometer is not supplied with the unit)

B) Free vortex-

1. Open the bypass valve & start the pump.
2. Slowly close the water bypass valve & drain valve of the cylinder. Water is now getting admitted through the tangential entry pipe to the cylinder.
3. Properly adjust the bottom drain valve of vessel so that a stable vortex is formed.
4. Note down co-ordinate of the vortex. Also measure time required for 10 liter level rise in measuring tank, & complete observation table.

OBSERVATIONS-

A) Forced vortex

Sr. No.	Radius (x co-ordinate) cms	Height (z) (y co-ordinate) cms	Surface speed m/min

B) Free Vortex -

Sr. No	Radius (x co-ordinate) cms	height (y co-ordinate) cms (z)	Discharge (time for 10 lit. level rise) sec. (t)

CALCULAT10NS-

A) Forced vortex -

1) Surface speed, S= _________ m/min

Rotational speed , N= S/πd rpm

Angular velocity,

$$\omega = \frac{2\pi N}{60}$$

For forced vortex,

$$Z = \frac{\omega^2 . r^2}{2g}$$

$$Z_1 = \frac{\omega^2 . r^2_1}{2g}$$

Similarly $$Z_2 = \frac{\omega^2 . r^2_2}{2g}$$ calculate values of Z at different r.

B) Free vortex –

1. Discharge , $Q = \frac{0.01}{t}$ ________________m^3/sec

   Velocity of water at entry to vassel

   $V = \frac{Q}{A} = \frac{Q}{2.01 * 10^{-4}}$ ______________m/sec

   Pipe dia. d = 1.6 cm

2. For free vortex,

   Vr = C

   Water is assumed to enter at the radius of 15 cms

   C = Vx15

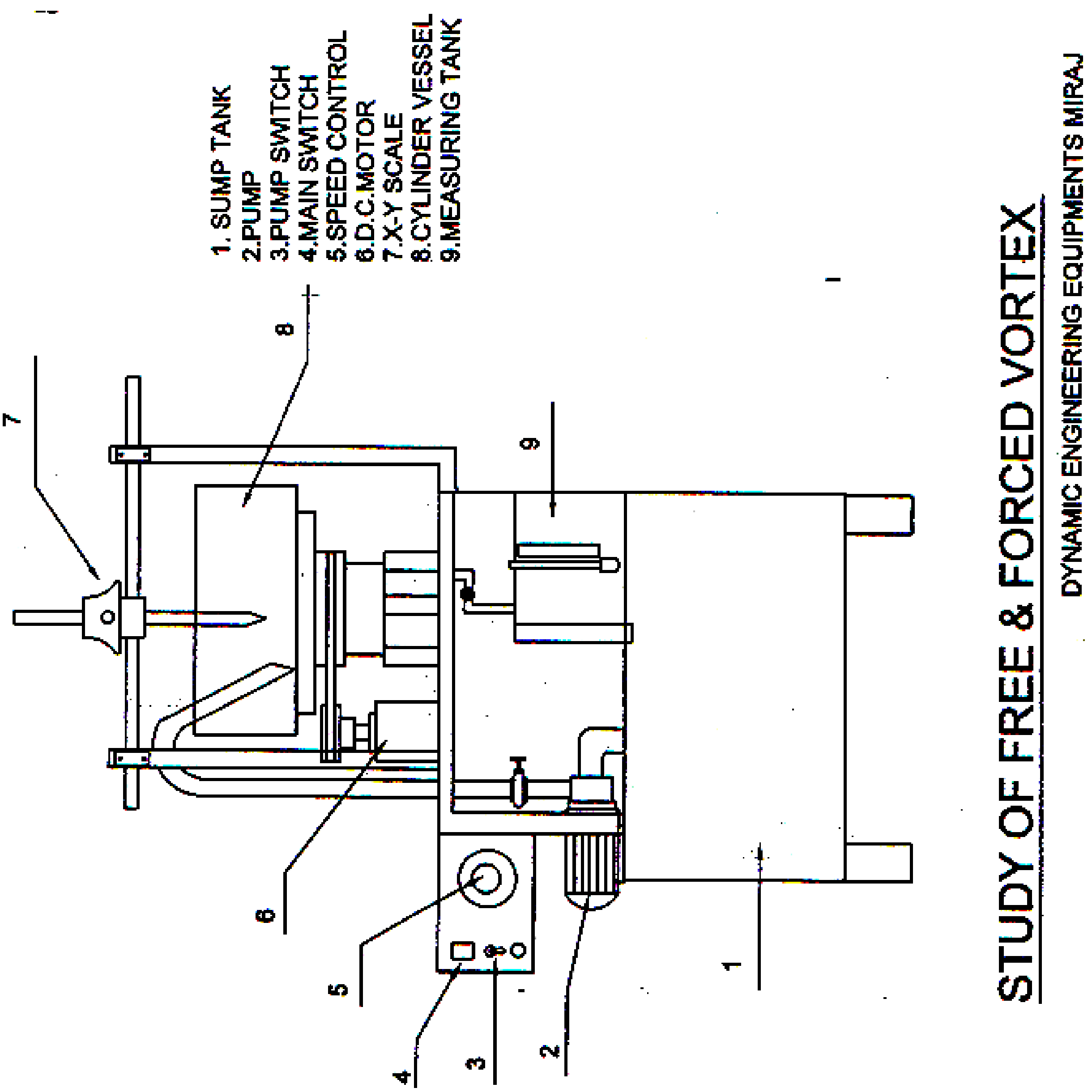
   and $Z_2 - Z_1 = C^2 \, (1/r_1^2 - r_2^2)$

   similarly calculate values of Z at different r.

Note- For forced vortex, linear velocity of the cylinder does not equal the actual water velocity near the I.D. of cylinder. Also for free vortex, as water does not enter exactly tangentially & velocity changes after it enters the cylinder which is not known, it is very difficult to calculate velocity of water exactly, the theoretical calculations deviate much from the observations. It can be readily observed that water comes out from pipe with high velocity, but velocity of water near the walls of cylinder appears to be very less.)

PRECAUTIONS:

1) While making the experiment of forced vortex, see that water does not spill away from the vessel. Do not increase the speed of rotation excessively.
2) Do not start pump for forced vortex experiment.


1. SUMP TANK
2.PUMP
3.PUMP SWITCH
4.MAIN SWITCH
5.SPEED CONTROL
6.D.C.MOTOR
7.X-Y SCALE
8.CYLINDER VESSEL
9.MEASURING TANK
1
2
3
4
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9
STUDY OF FREE & FORCED VORTEX
DYNAMIC ENGINEERING EQUIPMENTS MIRAJ

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PRACTICAL : 07

LOSSES IN PIPE FRICTION

When a fluid is flowing through the pipe, it is subjected to resistance to flow due to shear forces between the pipe wall and fluid particles and between the fluid particles also. This resistance is generally called frictional resistance. This resistance depends upon the velocity of flow and area of surface in contact. It also depends upon the type of flow, i.e. laminar or turbulent. This frictional resistance causes loss of pressure in the direction of flow.

THE APPARATUS

The apparatus consist of three pipes with I. D.'s, 28.5 mm. G.I. pipe, 22.7 G. I. pipe 17.5 mm G.I. pipe, so that loss of head can be compared for different diameters and different materials. A flow control valve is provided at outlet of pipes. Which enables experiments to be conducted at different flow rates, i.e. at different velocities.

Tappings are provided along the length of pipes, so that drop of head can be visualized along the length of pipe. Each pipe is provided with valve at outlet, which enables heads to be controlled.

EXPERIMENTAL PROCEDURE:-

1. Fill up water in the sump tank.(This water should be free of any oil content.)
2. Open all the outlet valves and start the pump.
3. Check for leakage's by closing three of outlet valves, for each pipe, and correct the leaks, if any.
4. Open the-outlet valves of the pipe to be tested.
5. Remove all the air bubbles from manometer and connecting pipes.
6. Reduce the flow. Adjust outlet valves, so that water heads in manometer are to the readable height.
7. Note down the heads and flow rate.
8. Now, increase the flow and accordingly adjust the outlet valve, so that water will not overflow. Note down heads and flow.
9. Repeat the procedure for other pipes.

(Note - during measuring the heads, slight variation may occur due to voltage changes, valves etc. in such cases, average readings may be taken.)

OBSERVATION TABLE:-

Sr. - No.	Pipe type	Head drop h 'm'	Flow rate t sec (Time for 10 Lit. in Sec).

CALCULATIONS:-

1. $\emptyset\ 28.5\ mm\ G.I.pipe$

$$\text{Area of pipe, } A = \frac{\pi}{4} \times D^2 \quad m^2$$

$$= \frac{\pi}{4} \times (0.0285)^2 \quad m^2$$

$$= 0.0006379 \ m^2$$

$$\text{Discharge, } Q = \frac{0.01}{t} \quad m.^3 / \text{Sec.}$$

$$\text{Velocity of water, } V = \frac{Q}{A} \quad m / \text{sec.}$$

Let, '**f**' be the coefficient of friction. Test length of pipe is 1 meter.

For 1 meter length, drop of head, h_f

$\therefore h_f =$ Manometer difference.

According to Darcy s- Weish batch equation,

$$h_f = \frac{f\, L\, v^2}{2\, g\, d}$$

Where

f = coefficient of friction.

L = Length of pipe = 1 m

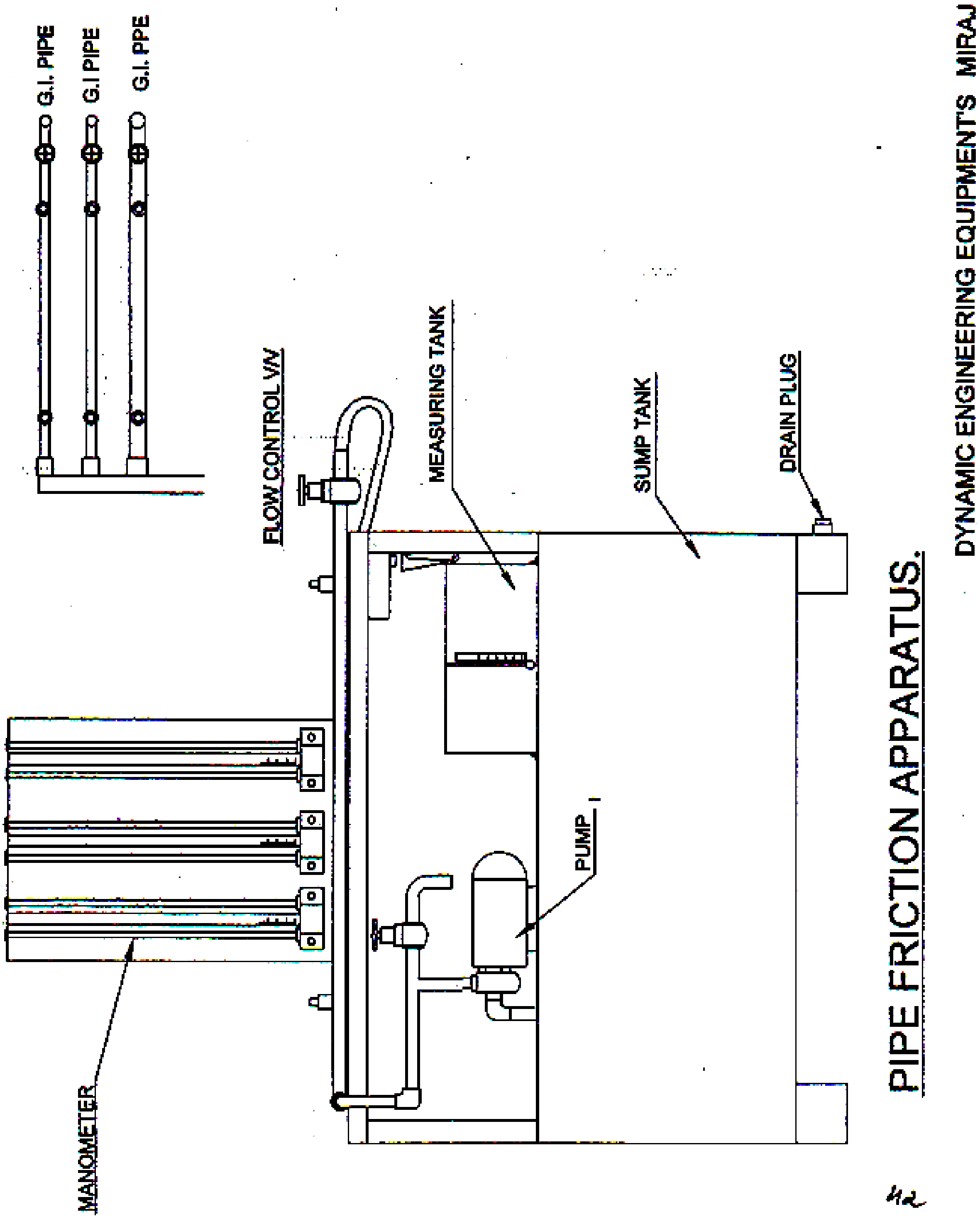
v = Velocity of water m / sec.

g = Gravitational acceleration = 9.81 m/s^2

d = Inside diameter of pipe, m

Then,

$$f = \frac{2\, g\, d\, h_f}{L\, v^2}$$


G.I. PIPE
G.I PIPE
G.I. PPE
FLOW CONTROL V/V
MEASURING TANK
SUMP TANK
DRAIN PLUG
PUMP
MANOMETER
PIPE FRICTION APPARATUS.
DYNAMIC ENGINEERING EQUIPMENT'S MIRAJ

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PRACTICAL : 08

FLOW OVER NOTCH APPARATUS

The Notch is hydraulically defined as an opening provided in the side of tank liquid level in tank is below the top edge of the opening. Notches are generally used for measuring the flow of liquid in channels.

Different shapes of 'NOTCH' generally used are Triangular, Rectangular, Trapezoidal etc. The **'DYNAMIC'** Unit is provided with following notches and weirs:-1} Triangular notch (notch angle = 60°) 2} Rectangular notch (Crest length of notch = 0.075 m)

In the **'DYNAMIC'** unit a centrifugal pump sucks the water from the sump tank, and discharges it to a small flow channel. The notch is fitted at the end of channel. All the notches and weirs are interchangeable. The water-flowing over the notch falls in the collector. Water coming from the collector can be directed to the sump tank or to the measuring tank for the measurement of flow.

EXPERIMENTAL PROCEDURE:-

1. Fit the required notch in the flow channel.
2. Fill up the water in the sump tank.
3. Close the water supply gate valve to the channel and fill up the water in the channel upto sill level.
4. See that water does not leak from the notch.
5. Check the leakage of hose pipes also and keep the collector diverted in the sump tank.
6. Take down the initial reading of crest level (sill level) by piezometer.
7. Now start the pump and open the gate valve slowly so that water starts flowing over the notch.
8. Let the water level become stable and note down the height of water surface at the upstream side by piezometer.
9. Close the drain valve of measuring tank, direct the collector into the measuring tank and measure the discharge.
10. Take the readings for different flow rates.
11. Repeat the same procedure for other notch also.

OBSERVATIONS

Notch type- Triangular / Rectangular

Sr. No.	Sill level reading 's' mts	Water height on upstream side 'h' mtr.	Discharge time for 10 litres ' t' sec.

CALCULATIONS:-

1] Rectangular notch -

1. Head over the notch, H = I h-s I m.
2. Discharge , $Q_a = \frac{0.01}{t}$ ________________ m^3/sec
3. Crest length of notch = 0.075 m Now theoretical discharge.

   $Q_{th} = 2/3. (2.g)^{05}.L. H$ 4. Co efficient of discharge.

4. Co efficient of discharge

   $C_d = Q_a / Q_{the0}$

2] Triangular notch –

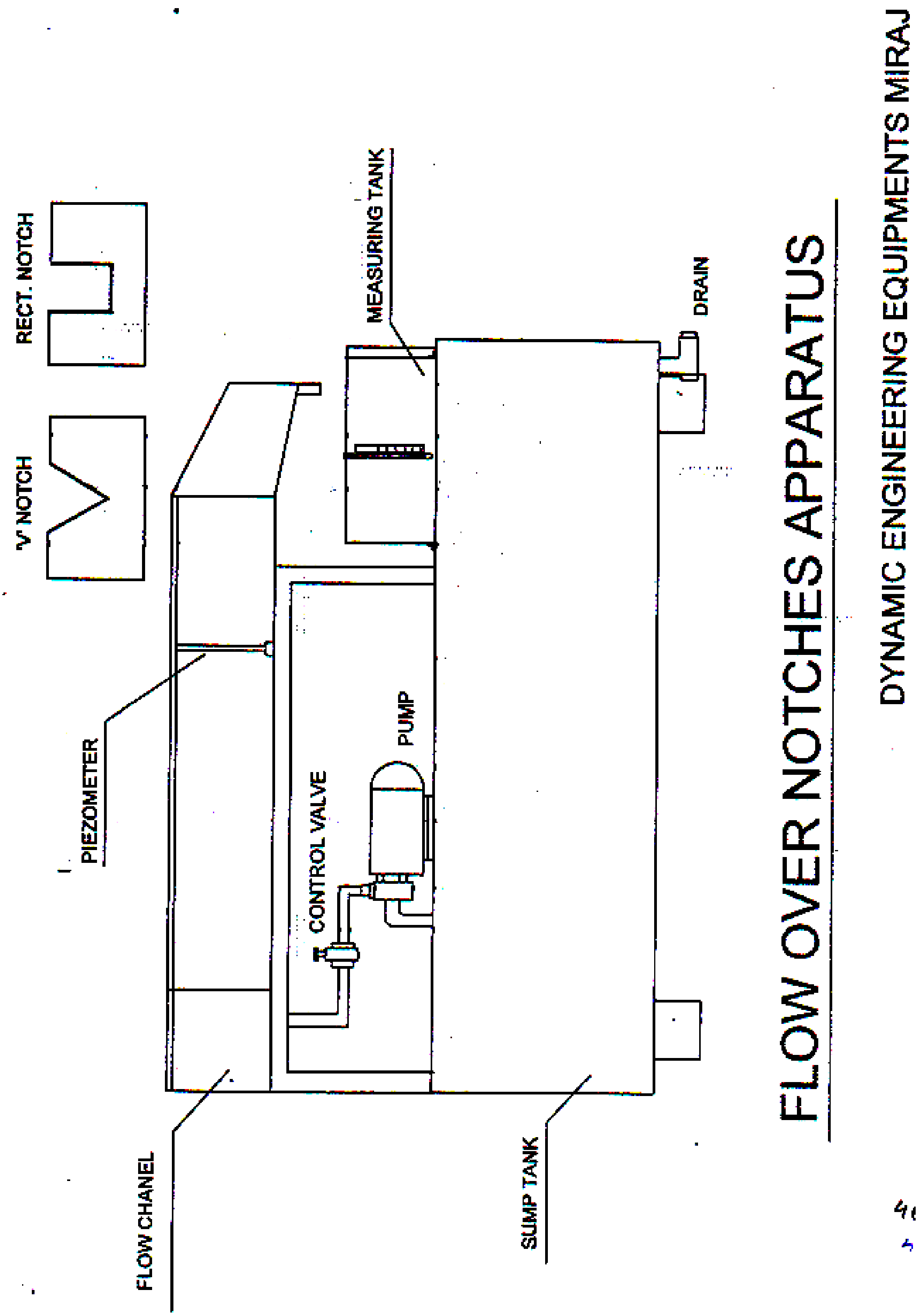
1. Head over the notch, H = I h-s I m .
2. Discharge , $Q_a = \frac{0.01}{t}$ ________________ m^3/sec
3. Now theoretical discharge,

   $Q_{th} = (8/15)\ (2 . g)^{\circ\ 5} \tan (60 / 2)\ (H)^{5/2}$

4. coefficient of discharge , $C_d = Q_a / Q_{the0}$

CONCLUSION:

1. Average Cd of Triangular notch is...
2. Average Cd of Rectangular notch is...


'V' NOTCH
RECT. NOTCH
MEASURING TANK
DRAIN
PIEZOMETER
PUMP
CONTROL VALVE
FLOW CHANEL
SUMP TANK
FLOW OVER NOTCHES APPARATUS
DYNAMIC ENGINEERING EQUIPMENTS MIRAJ

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

PRACTICAL NO: 09

FLOW OVER WEIR APPARATUS

A 'WEIR' is the name given to a concrete or masonry structure built across a river (or stream) in order to raise the level of water on the upstream side and to allow the excess water to flow over its entire length to the downstream side. Weirs may also be used for measuring the rate of flow of water in river or streams.

Different shapes of 'WEIRS' generally used are sharp-crested, broad- crested, and ogee weir.

The **DYNAMIC** Unit is provided with following weirs:-

1) Sharp-crested weir- 248 mm wide x 120 mm deep.
2) Broad- crested weir - 248 mm wide
3) Ogee weir.

In the **'DYNAMIC'** unit a centrifugal pump sucks the water from the sump tank, and discharges it to a small flow channel. The weir is fitted at the end of channel. All the weirs are interchangeable . The water-flowing over the weir falls in the collector. Water coming from the collector can be directed to the sump tank or to the measuring tank for tee measurement of flow.

EXPERIMENTAL PROCEDURE:-

1. Fit the required weir in the flow channel.
2. Fill up the water in the sump tank.
3. Close the gate valve below the channel and fill up the water in the channel up to sill level.
4. See that water does not leak from the weir.
5. Check the leakage of hose pipes also and keep the collector diverted in the sump tank.
6. Take down the initial reading of crest level (sill level) by the sliding depth gauge.
7. Now start the pump and open the gate valve slowly so that water starts flowing over the weir.
8. Let the water level become stable and note down the height of water surface at the upstream side by the sliding depth gauge.
9. Close the drain valve of measuring tank, direct the collector into the measuring tank and measure the discharge.
10. Take the readings for different flow rates.
11. Repeat the same procedure for other weir.

OBSERVATIONS

Weir type- Sharp crested / Broad crested / Ogee.

Sr. No	Sill level reading 'S' mts	water height on upstream side, 'h' mtr.	Discharge time for 10 litres 't' sec.

CALCULATIONS:-

Sharp Crested Weir

1. Head over the notch, H = I h-s I m .
2. Discharge , $Q_a = \frac{0.01}{t}$ ________________m^3/sec

   Crest length of sharp weir= 0.248 m

3. Now theoretical discharge.

   Q_{th}= 2/3. (2.g)^{05}.L. H$^{(3/4)}$ Co efficient of discharge.

4. Co efficient of discharge

   $C_d = Q_a / Q_{the0}$

Broad Crested Weir

1. Head over the notch, H = I h-s I m .
2. Discharge , $Q_a = \frac{0.01}{t}$ ________________m^3/sec

   Crest length of sharp weir= 0.248 m

3. Now theoretical discharge.

   Q_{th}= 1.7.L. H$^{(3/2)}$ Co efficient of discharge.

4. Co efficient of discharge

   $C_d = Q_a / Q_{the}$

OGEE Weir

1. Head over the notch, H = I h-s I m .
2. Discharge , $Q_a = \frac{0.01}{t}$ ________________m^3/sec

   Crest length of sharp weir= 0.248 m

3. Now theoretical discharge.

   Q_{th}= C.L. $H^{(3/2)}$ Co efficient of discharge.

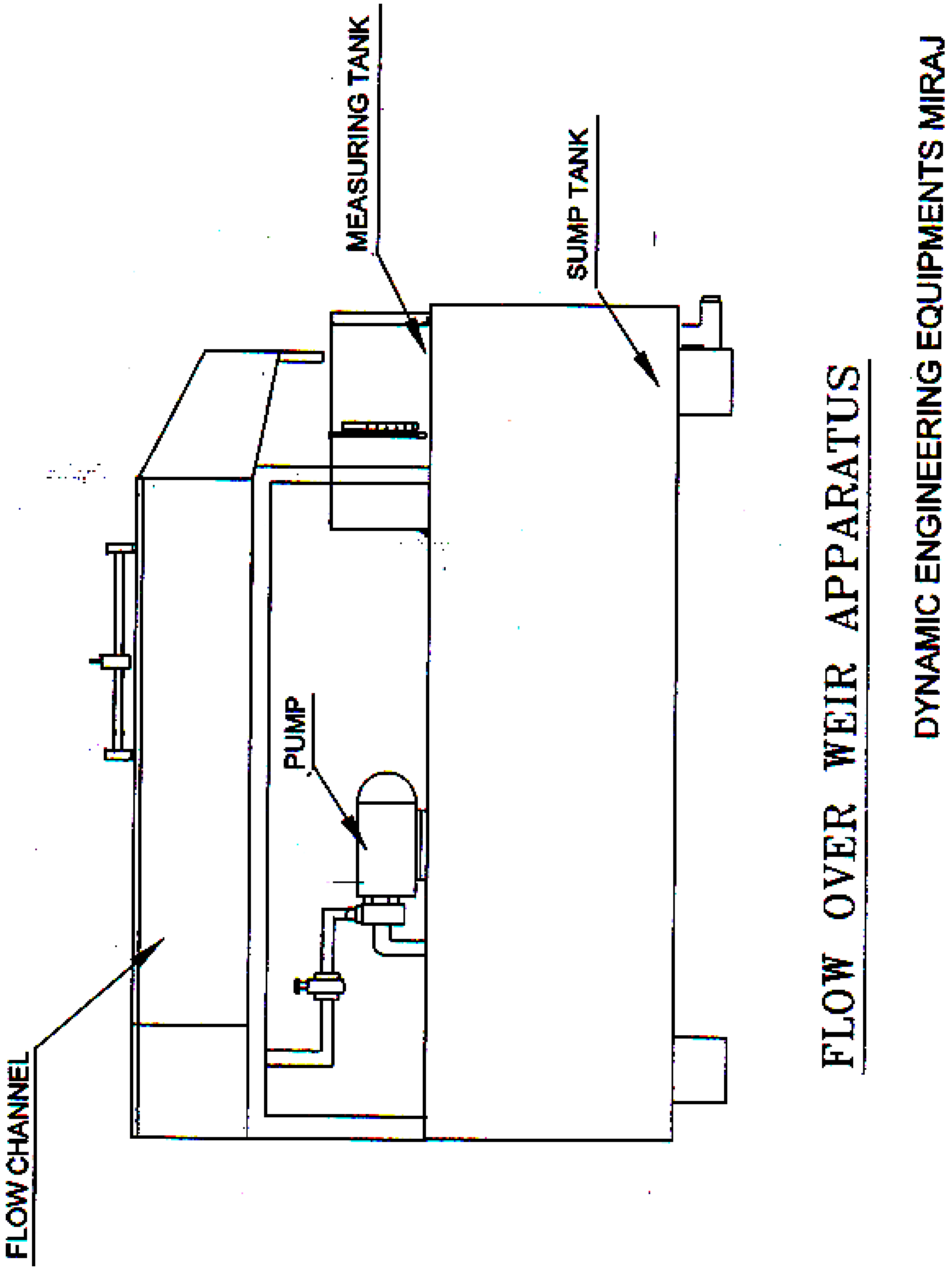
4. Co efficient of discharge

   $C_d = Q_a / L.\ H^{(3/2)}$

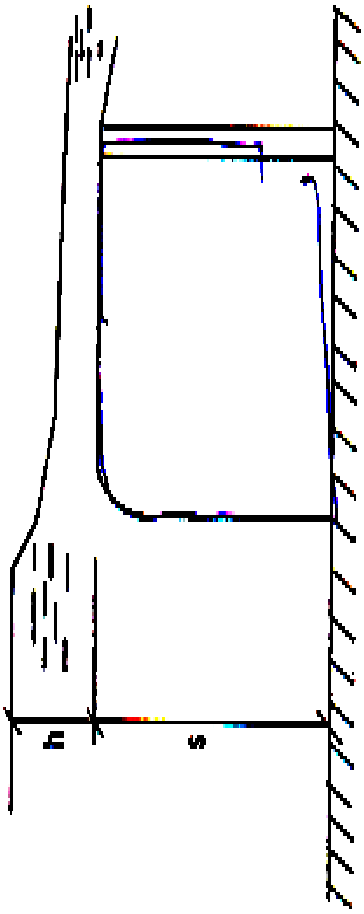
   Where C =co-efficient of spillway

CONCLUSION:-

1. Average Cd of sharp crested weir is...
2. Average Cd of Broad crested weir is...
3. Average C of Ogee weir is


MEASURING TANK
SUMP TANK
PUMP
FLOW CHANNEL
FLOW OVER WEIR APPARATUS
DYNAMIC ENGINEERING EQUIPMENTS MIRAJ

OGEE WEIR



BORAD CRESTED WEIR

SHARP CRESTED WEIR

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**

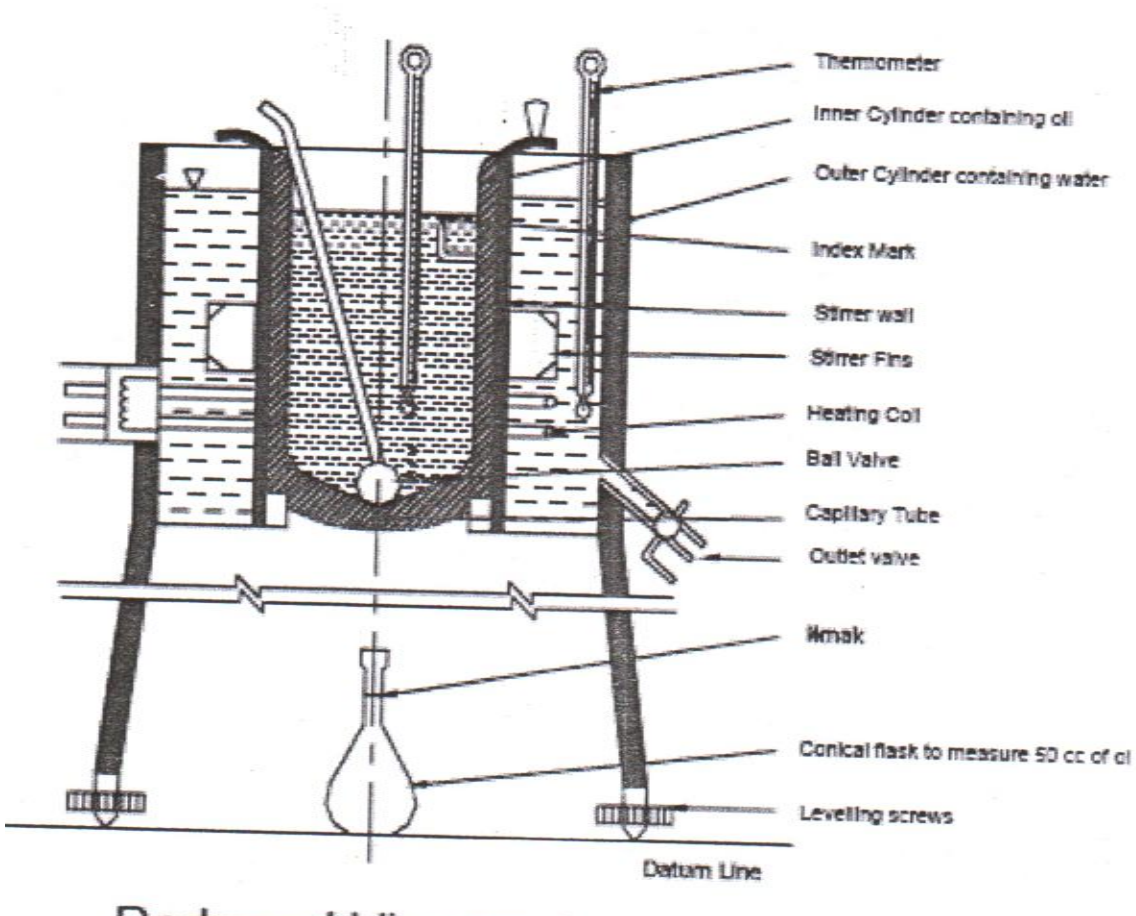
PRACTICAL NO :10

Aim: To study variation of viscosity of given oil with temperature.

Apparatus: Redwood Viscometer with accessories, Measuring Flask, Thermometer, Stopwatch etc.

Theory:

Redwood viscometer is based on the principle of laminar flow through capillary tube of standard dimension under falling head. The viscometer consists of a vertical cylinder with an orifice at the center of the base of inner cylinder. The cylinder is surrounded by a water bath, which can maintain temperature of the liquid to be tested at required temperature. The water bath is heated by electric heater. The cylinder, which is filled up to fixed height with liquid whose viscosity is to be determined is heated by water bath to the desired temperature. Then orifice is opened and the time required to pass 50 cc of oil is noted. With this arrangement variation of viscosity with temperature can be studied.



Redwood Viscometer

In case of Redwood Viscometer, the kinematic viscosity (y) of liquid and the time (t) required to pass 50cc of liquid are correlated by the expression

$y = 0.0026t - 1.175/t$

Where,
y - Kinematic Viscosity in stokes
t - time in seconds to collect 50 cc of oil.

Procedure:

1. Level the instrument with the help of circular bubble and leveling foot screws.
2. Fill the water bath.
3. Close the orifice with the ball valve and fill the cylinder up to the index mark with oil.
4. Record steady temperature of oil.
5. By lifting the ball valve, collect 50cc of the liquid in the measuring flask and measure
6. The time required for the same.
7. Repeat the procedure for different temperatures by heating oil with water bath.

Experimental data:

1. Diameter of cylinder = ... mm.
2. Height of cylinder = ... mm
3. Diameter of orifice = ... mm
4. Length of orifice =................ mm

OBSERVATION TABLE:

Sr. No.	Temperature θ (^{o}C)	Thrne to collect 50*cc of oil t (s)	Kinematic viscosity v (stokes)
1			
2			
3			
4			
5			
6			
7			
3			
y			
10			

Graph:

Graph of Kinematic viscosity y (stokes) vs. temperature °C

For Calculations:

Conclusions:

Marks: **Date:** **Faculty Sign:**