DAV UNIVERSITY

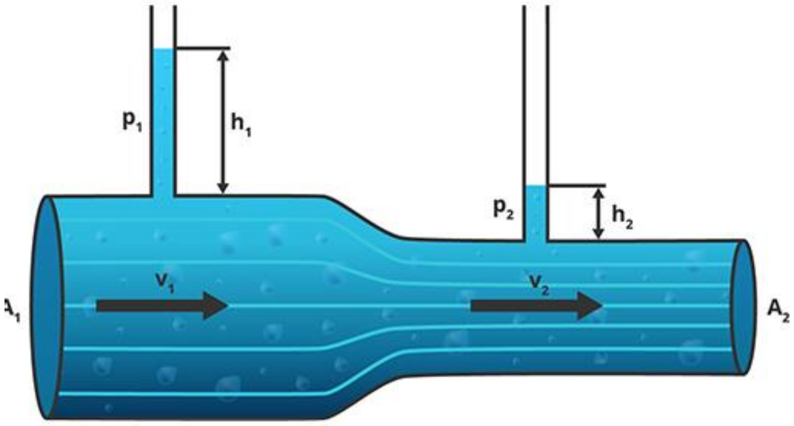
(Empowering Students with 21st Century Skills)

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

FOR

Mechanics of Fluids Lab (MEC311)



Vision of the Department

The Mechanical Engineering Department aims to be recognized as an outstanding educational centre to develop innovative engineers who are proficient in advanced fields of engineering and technology and can contribute effectively to the industry as well as for socio-economic upliftment of the society.

Mission of the Department

M1: To impart outcome-based education with a research orientation to the students to develop them as globally competitive engineers.

M2: To imbibe the students with academic, leadership and entrepreneurship skills needed by the industry in particular and society in general.

M3: To adopt flexibility and dynamism in designing the programme structures to cope up with emerging market needs.

M4: Establishment of liaison with top R & D organizations/Industries and leading educational institutions for practical exposure of the students and faculty as well as to the state of the art.

Programme Educational Outcomes (PEOs)

After the successful completion of undergraduate course, Mechanical Engineering, Graduates will be able to:

PEO1: Plan, design, construct, maintain and improve mechanical engineering systems that are technically sound, economically feasible and socially acceptable.

PEO2: Apply analytical, computational and experimental techniques to address the challenges faced in mechanical and allied engineering streams.

PEO3: Communicate effectively using conventional platforms as well as innovative / online tools and demonstrate collaboration, networking & entrepreneurial skills.

PEO4: Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning to achieve career, organizational and societal goals.

Program Outcomes (POs) - B. Tech. Mechanical Engineering

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO) - B. Tech. Mechanical Engineering

PSO1: Apply mechanical and interdisciplinary knowledge to analyze, design and manufacture products to address the needs of the society.

PSO2: Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.

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Department of Mechanical Engineering

L	T	P	Credits
0	0	2	1

Course Code	MEC311								
Course Title	**Mechanics of Fluids Lab**								
Course Outcomes	On the completion of the course the student will be able to: CO1: Understand the concept and solve problems related to statics, kinematics and dynamics of fluids CO2: Determine the fluid pressure and use various devices for measuring fluid pressure and flow rate. CO3: Apply Bernoulli's equation to fluid flow problems and boundary layer theory to determine lift and drag forces on a submerged body CO4: Apply appropriate equations and principles to analyse pipe flow problems.								
Examination Mode	Practical								
Assessment Tools	Continuous Assessment (CA)				MSE	MSP	ESE	ESP	Total
	Quiz	Assignment/ Project Work	Attendance	Lab Performance					
Weightage	-	-	-	20%	-	30%	-	50%	100

S. No.	LIST OF EXPERIEMENTS	CO Mapping
1.	To Prove Bernoulli's Theorem.	CO1
2.	To Find Coefficient of Discharge of Pitot Tube	CO1
3.	To Find Cd, Cv & Cc of an Orifice	CO1
4.	To Find Friction Factor of Pipes of Different material & Diameter.	CO2
5.	To Find Minor Losses with Sudden Enlargement & Contraction.	CO2
6.	To Find Metacentric Height of Floating Vessel.	CO2
7.	To Find Reynolds Number.	CO3
8.	To Find Coefficient of Discharge of Different Notches.	CO3
9.	To Find Coefficient of Discharge of Venturimeter and Orifice Meter.	CO3
10.	To study Free & Forced Vertex.	CO4
11.	Experiment on Laminar & Turbulent Flow	CO4

BERNOULLI’S THEOREM APPARATUS

OBJECTIVE:

- To verify Bernoulli’s equation experimentally.

AIM:

- To calculate the total energy at different points
- To plot the graph between total energy vs distance.

INTRODUCTION:

Statement of Bernoulli’s theorem: It states that in a steady, ideal flow of an incompressible fluid, the total energy at a point of fluid is constant. The total energy consists of pressure energy, kinetic energy and potential energy or datum energy. These energies per unit weight of the fluid are:

Pressure energy=$P/\rho g$= P/w

Kinetic energy= $V^2 / 2g$

Datum energy= Z

Thus mathematically, Bernoulli’s theorem is written as

$$P/\rho g + V^2 / 2g + Z = \text{Constant}$$

Assumptions: The following are the assumptions made in the derivation of Bernoulli’s equation:

1. The fluid is ideal, i.e. Viscosity is zero.
2. The flow is steady.
3. The flow is incompressible.
4. The flow is irrotational.

Here P is the static pressure, ρ is the density. V is the velocity and Z is the elevation of the fluid particle.

BERNOULLI’S PRINCIPLE

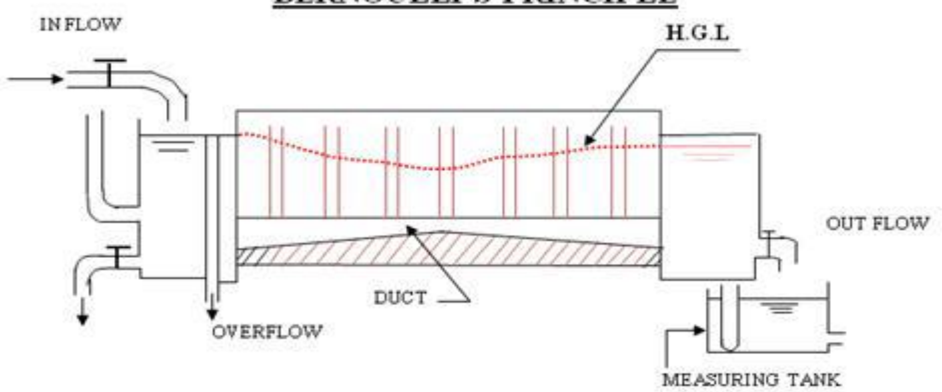


FIG.NO.1 BERNOULLI’S APPARATUS

DESCRIPTION:

The experimental setup consists of an upstream cylindrical chamber supplying water to a transparent and uniformly varying cross-sectional duct of converging-diverging section. The water from this duct flows into a downstream cylindrical section and then through a controlling gate valve into the collecting tank. 07 peizometric tapping are provided in the duct and these tapping are connected to glass tubes mounted vertically on a peizometer board. Water is supplied to the upstream cylinder chamber. By maintaining a head in the upstream chamber water flows in the transparent duct into the downstream duct and finally into the collecting tank through the regulating gate valve and bend. The regulating gate valve is used to maintain a water head in the downstream chamber. An overflow is provided for the upstream chamber. Water to the test rig is provided by a 0.5 H.P. mono bloc pump mounted on top of sump tank. Water flows through the test section and is collected in a collecting tank fitted with a suitable gauge glass, drain valve. The complete unit is mounted on an iron frame stand.

Taking the datum line to be the centre line of the conduct, the elevation head Z can be assumed to be zero. Hence for any point along the path of the fluid in the convergent-divergent duct, the sum of the velocity head and the pressure head is constant by Bernoulli's theorem. The pressure head P is measured directly from the peizometric tube the velocity calculated by measuring the actual flow rate. The scales are fixed on the peizometer and the inlet and outlet ducts such that the zero corresponds to the centerline of the duct.

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Ensure that all On/Off switches given on the panel are at OFF position.
2 Close all the valves V1 to V5.
3 Fill sump tank with water.
4 Open by-pass valve V2 given on the water supply line.
5 Switch On the main power supply & switch ON the pump.
6 Partially close by-pass valve V2 to allow water to fill in overhead tank.
7 Wait until overflow occurs from overhead tank.
8 Regulate flow of water through test section with the help of control valve V1 provided at the end of test section.
9 Ensure that the overflow still occurs; if not partially close the by-pass valve V2 to do so.
10 Measure pressure head by piezometer tubes.
11 Measure flow rate of water using measuring tank and stop watch.
12 Repeat steps (8) to (11) for different flow rate of water.

CLOSING PROCEDURE:

1 When experiment is over, switch off pump.
2 Switch off power supply to panel.
3 Drain water from all tanks with the help of given drain valves V3, V4 & V5.

OBSERVATION AND CALCULATION:

Table 1

Section	Dia. of test point, d (mm)	Cross sectional Area of test point, A(m^2)	Distance from the reference point, S(m)
1	28.0	6.16 E-4	0.04 m
2	23.5	4.34 E-4	0.0785 m
3	18.5	2.69 E-4	0.092 m
4	14.0	1.54 E-4	0.1105 m
5	18.5	2.69 E-4	0.1358 m
6	23.5	4.34 E-4	0.1562 m
7	28	6.16 E-4	0.1915 m

1. Flow rate calculations:

   Area of the collecting tank, A= 0.077 m^2

   Rise of level, R=…………cm

   Volume collected= A x R cu.m.

Time taken= t secs

Discharge, Q= (A x R)/t cu.m/sec

2. Bernoulli's equation calculations:

Velocity at any section x-Vx = Q/ Ax m/sec

Velocity head = Vx2/ 2g m of water

=100 x (Vx2/ 2g) cm of water

From Peizometer readings, static pressure at any section x, Static head= Px cm of water.

Table 2:

Section	Cross-sectional area Ax sq.m	Peizometer reading Px	Section velocity Vx m/sec	Velocity head (Vx^2/ g) /100	Px+ Velocity head
1	6.16 E-4				
2	4.34 E-4				
3	2.69 E-4				
4	1.54 E-4				
5	2.69 E-4				
6	4.34 E-4				
7	6.16 E-4				

PRECAUTION & MAINTENANCE INSTRUCTIONS:

1 Never run the apparatus if power supply is less than 200 volts and above 230 volts.

2 To prevent clogging of moving parts, run pump at least once in a fortnight.

3 Always use clean water.

4 Always keep apparatus free from dust.

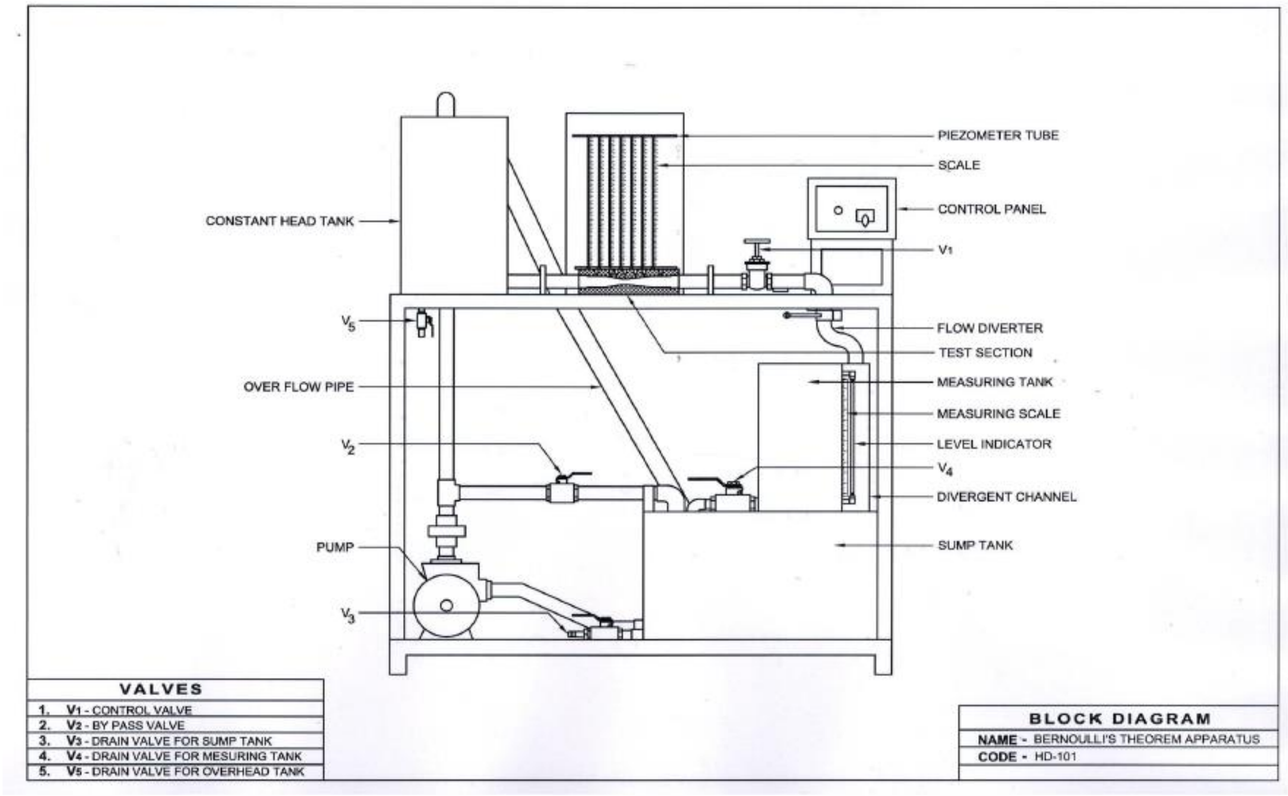
5 Drain the apparatus completely after experimentation.

TROUBLESHOOTING:

1 If pump gets jammed, open the back cover of pump and rotate the shaft manually.

2 If pump gets heated up, switch off the pump for 30 minutes.

Block Diagram:



Data Table :

Area of Measuring Tank, A :	0.077

Data Table :

Sr.No.	Diameter of Test Point d (mm) d1 to d7	Cross Sectional Area at Test Point a (m2) a1 to a7	Distance of test point from reference point S (m) S1 to S7
1	28	6.16E-04	0.04
2	23.5	4.34E-04	0.0785
3	18.5	2.69E-04	0.092
4	14	1.54E-04	0.1105
5	18.5	2.69E-04	0.13585
6	23.5	4.34E-04	0.1562
7	28	6.16E-04	0.19155

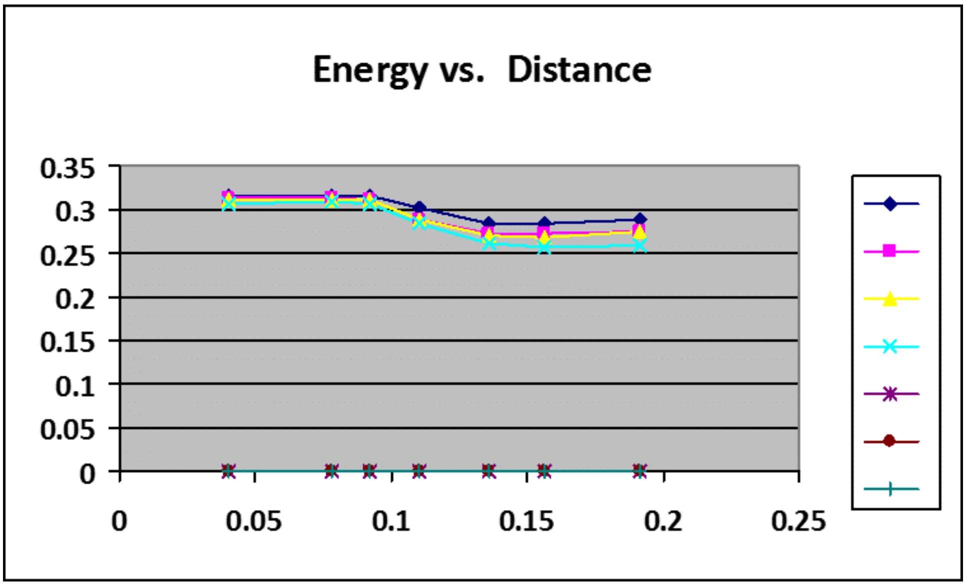
Observation Table :

Run No.	1	2	3	4
R1, cm	12.8	13.2	13.5	14.7
R2, cm	7.5	7.5	7.3	7.5
t, sec	20	20	20	20
h1, cm	31.1	30.7	30.4	29.6
h2, cm	30.6	30.1	29.7	28.7
h3, cm	28.7	27.8	27.1	25.3
h4, cm	21.3	18.5	16.6	11.9
h5, cm	25.4	23.8	23	20.7
h6, cm	27.3	25.9	25.4	23.5
h7, cm	28.2	27	26.6	25

Total Energy :

Run No.	1	2	3	4
E1, m	0.317	0.313	0.312	0.306
E2, m	0.317	0.314	0.312	0.308
E3, m	0.316	0.312	0.311	0.307
E4, m	0.302	0.288	0.288	0.284
E5, m	0.283	0.272	0.27	0.261
E6, m	0.284	0.272	0.269	0.256
E7, m	0.288	0.276	0.274	0.26

Graph :



FLOW THROUGH ORIFICE & MOUTHPIECE

OBJECTIVE:

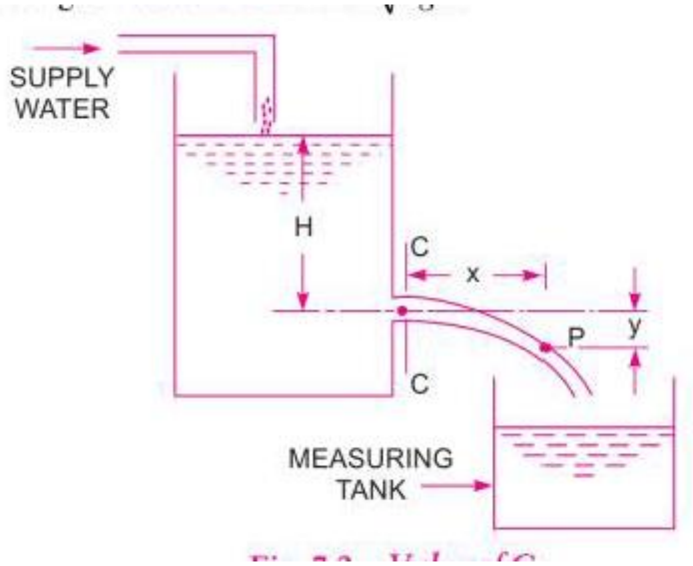
- To study the flow of liquid through orifice and the mouthpiece.

AIM:

- To determine the co-efficient of discharge and to determine the co-efficient of velocity.

INTRODUCTION:

Orifice is an opening or a hole of any size, shape or form, through which liquid flow such that its upper edge remains below the free surface of the liquid. Orifices are used for measurement or control of flow. Orifices may have any shape but generally they are circular, square or rectangular. A mouthpiece is a relatively short pipe, which is fitted internally or externally to the orifice in the side of the tank. Mouthpieces are sometime used as a flow measurement device.



THEORY:

ORIFICE:

When a liquid flows from a vessel or a tank, through an orifice it changes its direction. Due to this change of direction of the liquid, the jet is acted upon by lateral or side forces, which gradually reduce its area up to certain section. This area does not reduce further beyond, which the jet ceases and streamlines, first become parallel is known as the vena-contracta.

MOUTHPIECE:

A short piece of length about three times of its diameter, connected to the face of an orifice, is known as a mouthpiece. In what follows, it will be proved that under a given head, the rate of discharge through a mouthpiece will be more than that through an orifice of the same diameter. The reason being that while entering into the mouthpiece, the liquid gets contracted at vena-contracta. Due to this contraction, the velocity of liquid increases and the pressure decreases. The pressure at vena-contracta is less than at atmosphere. This may be verified by applying Bernoulli’s Theorem at the outlet and at the vena-contracta.

CO-EFFICIENT OF VELOCITY (CV):

It is defined as the ratio between the actual velocity of a jet of liquid at a vena-contracta Va and the theoretical velocity of the jet Vt. It is denoted by Cv and ratio of Cv is given as:

$$C_V = \frac{V_a}{V_t}$$

$$C_V = \frac{V}{\sqrt{2gH}}$$

CO-EFFICIENT OF DISCHARGE (Cd):

It is defined as the ratio of the actual discharge Qa from an orifice to the theoretical discharge Qt from the orifice. It is denoted by Cd. If Qa the actual discharge and Qt is the theoretical discharge then ratio of Cd is given as:

$$C_d = \frac{Q_a}{Q_t}$$

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

$$Q_t = a \times \sqrt{2gH}$$

DESCRIPTION:

The set up consists of a sump tank, measuring tank and constant head tank. Orifice and mouthpiece are provided with the set up that can be fixed at the constant head tank one at a time. Water is circulated from the sump tank through centrifugal pump. Constant head tank & measuring tank are provided with piezometer with scale for level measurement. A measuring arrangement is provided to measure the flow pattern, through orifice or mouthpiece, in horizontal and vertical direction. Discharge is measured by measuring tank and stop watch.

UTILITIES REQUIRED:

1 Electricity Supply: Single Phase, 220 VAC, 50 Hz, 5-15 Amp. Combined socket with earth connection.

2 Water Supply (Initial Fill).

3 Floor Drain Required.

4 Floor Area Required: 1.5 m x 0.75 m.

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Close all the valves V1 to V5.

2 Fill sump tank ¾ with clean water and ensure that no foreign particles are there.

3 Open by-pass valve V2.

4 Fix desired test piece (orifice or mouthpiece) at constant head tank.

5 Ensure that all On/Off switch given on the panel are at OFF position.

6 Switch On the main power supply & switch ON the pump.

7 Operate the flow control valve V1 and by-pass valve V2 to maintain the head of water in constant head tank at particular flow through orifice or mouthpiece.

8 Measure pointer gauge reading (in horizontal and vertical direction) at the inlet and end of the jet of water, coming out from the constant head tank.

9 Measure the flow rate of water by measuring tank and stop watch.

10 Repeat the experiment for different water head.

11 Repeat the experiment for different test pieces (Orifice and mouthpiece).

CLOSING PROCEDURE:

1 Switch OFF pump.

2 Switch off power supply to panel.

3 Drain water from all tanks with the help of given drain valves V3, V4 & V5.

PRECAUTION & MAINTENANCE INSTRUCTIONS:

1 Never run the apparatus if power supply is less than 200 Volts and above 230 Volts

2 Never fully close the flow control valve V1 and by pass valve V2 simultaneously.

3 To prevent clogging of moving parts, Run Pump at least once in a fortnight.

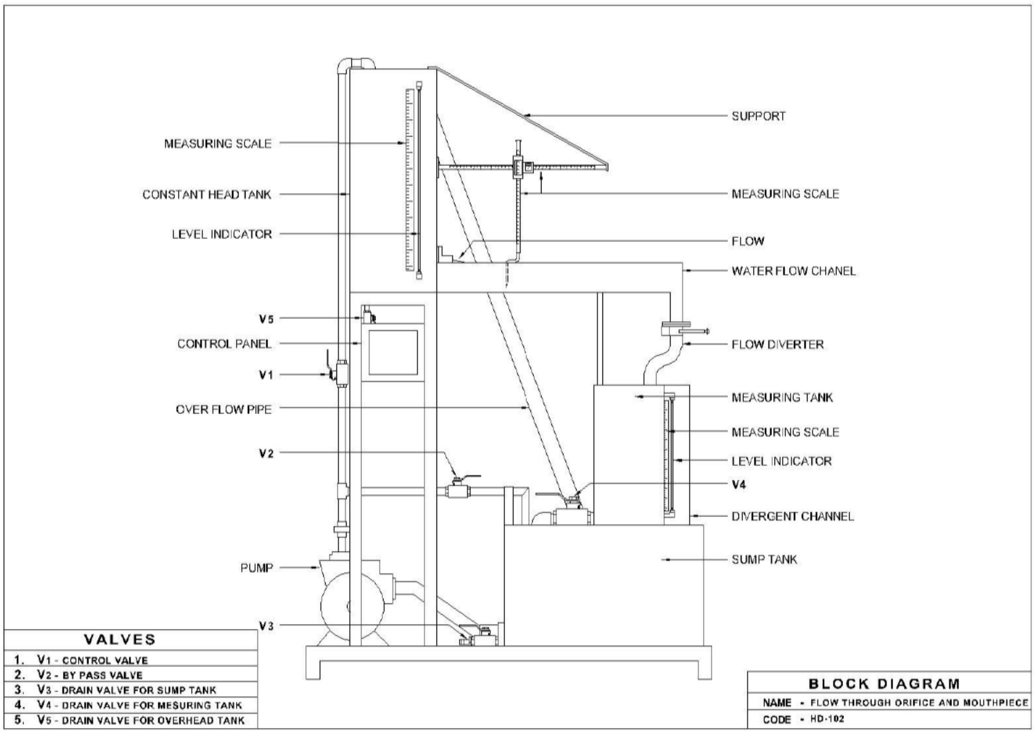
4 Always use clean water.

5 Always keep apparatus free from dust.

TROUBLESHOOTING:

1 If pump gets jammed, open the back cover of pump and rotate the shaft manually.

2 If pump gets heated up, switch off the main power for 30 minutes. Avoid closing the flow control valve V1 and by pass valve V2 at a time.



CALCULATION:

$$Q_a = \frac{A \times R}{t} \quad (\mathrm{m^3/sec})$$

$$x = \frac{x_1 - x_o}{100} \quad (\mathrm{m})$$

$$y = \frac{y_1 - y_o}{100} \quad (\mathrm{m})$$

$$a_1 = \frac{\pi}{4} d_1^2 \quad (\mathrm{m^2}) \quad \text{(For orifice)}$$

$$a_2 = \frac{\pi}{4} d_2^2 \quad (\mathrm{m^2}) \quad \text{(For mouthpiece)}$$

$$H = \frac{h}{100} \quad (\mathrm{m})$$

$$Q_t = a_1 \times \sqrt{2gH} \quad (\mathrm{m^3/sec}) \text{ (For orifice)}$$

$$Q_t = a_2 \times \sqrt{2gH} \quad (\mathrm{m^3/sec}) \text{ (For mouthpiece)}$$

$$C_d = \frac{Q_a}{Q_t}$$

$$C_V = \frac{x}{\sqrt{4yH}}$$

OBSERVATION & CALCULATION:

DATA:

Acceleration due to gravity g = 9.81 m/s^2

Area of measuring tank A = 0.077 m^2

Data

A, m2	d1, m	d2, m	L/D
0.077	0.01	0.015	1

Observation Table :

Run No.	xo, cm	yo, cm	h, cm	x1, cm	y1, cm	R1, cm	R2, cm	t, sec
1	4.2	8.8	40	38.5	18.7	9.5	5	20
2	4.2	8.8	35	35.5	18.5	8.4	5	20
3	4.2	8.8	25	27.8	18.2	7.8	5	20

Calculation Table :

Run No.	R, m	Qa, m3/sec	x, m	y, m	H, m	a, m2	Qt, m3/sec	Cd	Cv
1	0.045	1.73E-04	3.43E-01	0.099	4.00E-01	7.85E-05	2.20E-04	0.787	0.9

2	0.034	1.31E-04	3.13E-01	0.097	3.50E-01	7.85E-05	2.06E-04	0.636	0.8
3	0.028	1.08E-04	2.36E-01	0.094	2.50E-01	7.85E-05	1.74E-04	0.62	0.8

Data :

A, m2	d1, m	d2, m	L/D
0.077	0.015	0.01	1

Observation Table :

Run No.	xo, cm	yo, cm	h, cm	x1, cm	y1, cm	R1, cm	R2, cm	t, sec
1	4.6	8.8	45	40.5	19	9.9	5	20
2	4.6	8.8	35	34.7	18.7	9	5	20
3	4.6	8.8	25	27.7	18.4	8	5	20

Calculation Table :

Run No.	R, m	Qa, m3/sec	x, m	y, m	H, m	a, m2	Qt, m3/sec	Cd	Cv
1	0.049	1.89E-04	3.59E-01	0.102	4.50E-01	7.85E-05	2.33E-04	0.808	0.8
2	0.04	1.54E-04	3.01E-01	0.099	3.50E-01	7.85E-05	2.06E-04	0.748	0.8
3	0.03	1.16E-04	2.31E-01	0.096	2.50E-01	7.85E-05	1.74E-04	0.664	0.7

Data :

A, m2	d1, m	d2, m	L/D
0.077	0.015	0.01	2.5

Observation Table :

Run No.	xo, cm	yo, cm	h, cm	x1, cm	y1, cm	R1, cm	R2, cm	t, sec
1	6.1	8.8	45	40.5	18.9	10.7	5	20
2	6.1	8.8	35	35.3	18.5	9.6	5	20
3	6.1	8.8	25	28.2	18.3	8.5	5	20

Calculation Table :

Run No.	R, m	Qa, m3/sec	x, m	y, m	H, m	a, m2	Qt, m3/sec	Cd	Cv
1	0.057	2.19E-04	3.44E-01	0.101	4.50E-01	7.85E-05	2.33E-04	0.94	0.8
2	0.046	1.77E-04	2.92E-01	0.097	3.50E-01	7.85E-05	2.06E-04	0.86	0.8
3	0.035	1.35E-04	2.21E-01	0.095	2.50E-01	7.85E-05	1.74E-04	0.775	0.7

VENTURIMETER TEST RIG

OBJECTIVE:

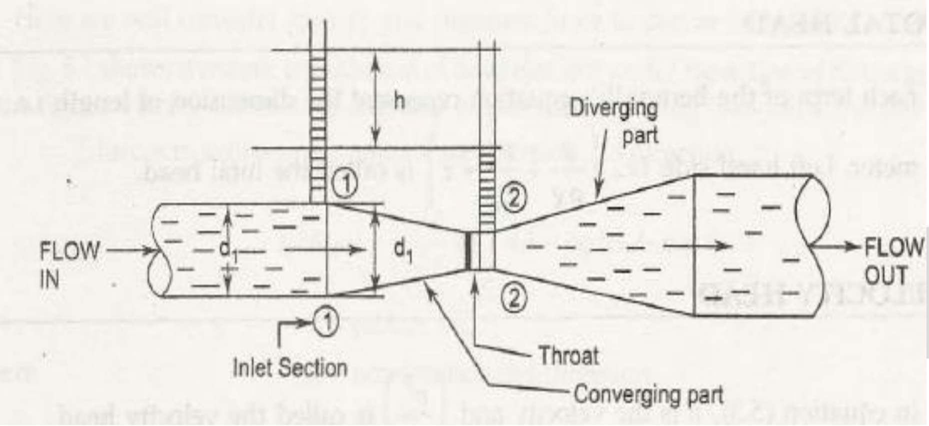
- To demonstrate the use of Venturimeter.

AIM:

- To determine the co-efficient of discharge Cd for Venturimeter.

INTRODUCTION:

If a constriction is placed in a closed channel carrying a stream of fluid, there will be increase in velocity, and hence increase in kinetic energy, at the constriction, from an energy balance, as given by Bernoulli's Theorem, there must be a corresponding reduction in pressure. Rate of discharge from the constriction can be calculated by knowing this pressure reduction, the area available for flow at the constriction, the density of fluid, and the co-efficient of discharge. The last named is defined as the ratio of actual flow to the theoretical flow.



Venturimeter

THEORY:

A Venturimeter consists of:

- An inlet section followed by a convergent cone.
- A cylindrical throat.
- A gradually divergent cone.

The inlet section of venturimeter is of the same diameter as that of the pipe, which is followed by a convergent cone. The convergent cone is a short pipe, which tapers from the original size of the pipe to that of the throat of the venturimeter. The Throat of the venturimeter is a short parallel side tube having its cross-sectional area smaller than that of the pipe. The divergent cone of the venturimeter is gradually diverging pipe with its cross-sectional area increasing from that of the Throat to the original size of the pipe. At inlet section & throat of the venturimeter, pressure taps are provided.

DESCRIPTION:

The apparatus consists of a venturimeter, fitted in the pipe. Pipe consists of flow control valve. Sump tank with centrifugal pump is provided for water circulation through pipes. The pressure tapings are provided at inlet and throat of venturi meter. Pressure tapings are connected to a differential manometer. Discharge is measured with the help of measuring tank & stop watch.

UTILITIES REQUIRED:

1 Electricity Supply: Single Phase, 220 V AC, 50 Hz, 5-15 Amp. combined socket with earth connection.

2 Water Supply (Initial Fill).

3 Floor Drain Required.

4 Floor Area Required: 1.5 m x 0.75 m.

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Close all the drain valves.

2 Fill sump tank ¾ with clean water and ensure that no foreign particles are there.

3 Open by-pass valve V1.

4 Ensure that On/Off switch given on the panel is at OFF position.

5 Open flow control valve of test section V2.

6 Switch ON the main power supply and then switch on the pump.

7 Open Valve V5 provided on the Manometer, slowly to release the air in manometer.

8 When there is no air in the manometer, close air release valve V5.

9 Adjust water flow rate with the help of control valve V1 & V2.

10 Record the manometer reading, in case of pressure above scale in any tube apply air pressure by hand pump to get readable reading.

11 Measure the flow of water, discharged through test section, using stop watch and measuring tank.

12 Repeat experiment for different flow rates of water, operating control valve V2 and by-pass valve V1.

CLOSING PROCEDURE:

1 When experiment is over, Switch off pump.

2 Switch off power supply to panel.

3 Drain the apparatus completely by drain valves V3 & V4 provided.

PRECAUTION & MAINTENANCE INSTRUCTIONS:

1 Never run the apparatus if power supply is less than 200 Volts and above 230 Volts.

2 Never fully close the flow control valve V2 and the by-pass valve V1 simultaneously.

3 To prevent clogging of moving parts, run pump at least once in a fortnight.

4 Always keep apparatus free from dust.

TROUBLESHOOTING:

1 If pump gets jammed, open the back cover of pump and rotate the shaft manually.

2 If pump gets heated up, switch off the main power for 30 minutes and avoid closing the flow control valve and by-pass valve at a time, during operation.

CALCULATION:

$$Q_a = \frac{A \times R}{t}, \text{ (m}^3\text{/sec)}$$

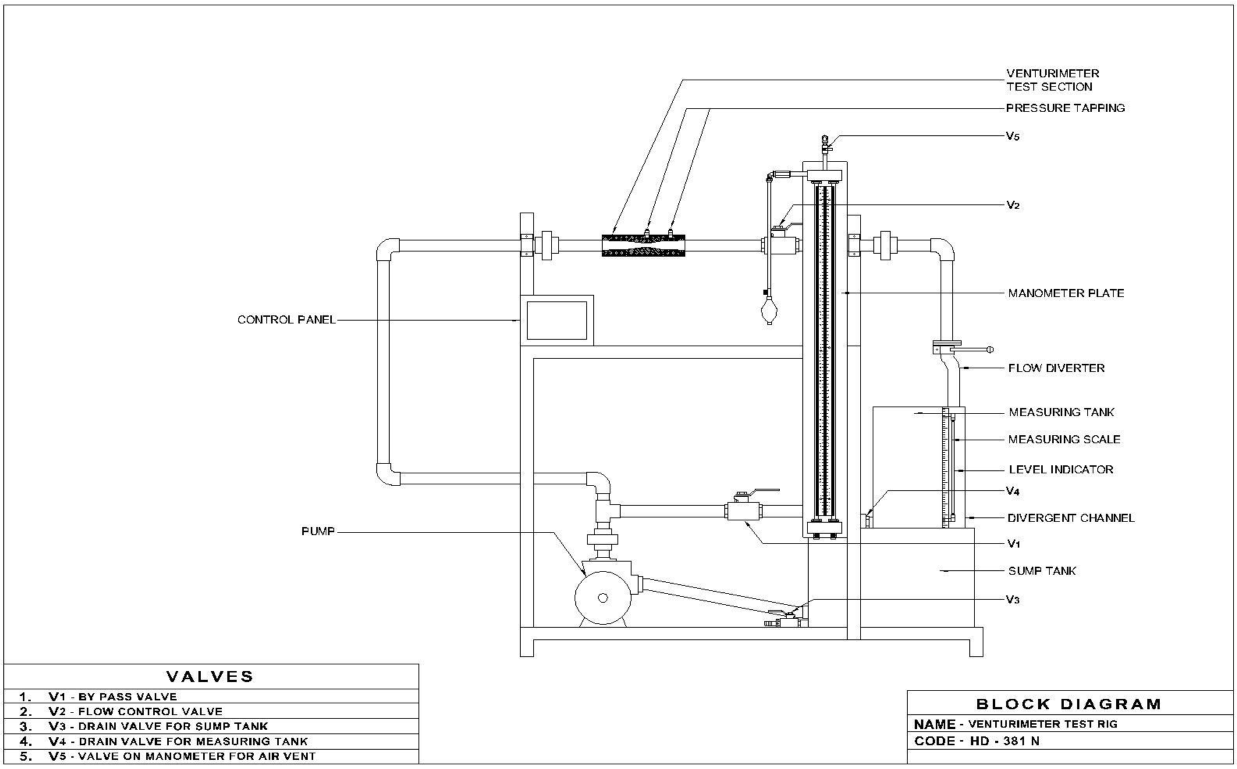
$$a_1 = \frac{\pi}{4} d_1^2 \text{ (m}^2\text{)}$$

$$a_2 = \frac{\pi}{4} d_2^2 \text{ (m}^2\text{)}$$

$$H = \frac{h_1 - h_2}{100} \text{ (m)}$$

$$Q_t = \frac{a_1 a_2 \sqrt{2gH}}{\sqrt{a_1^2 - a_2^2}} \text{ (m}^3\text{/sec)}$$

VENTURIMETER TEST RIG



Given Data

A, m2	d1, m	d2, m	a1, m2	a2, m2
0.120	0.028	0.014	0.0006158	0.000154

Observation Table

S.N.	h1, cm	h2, cm	R1, cm	R2, cm	t, sec
1	94	47.5	10.5	5	15.03
2	81.5	53.5	9	5	15.19
3	75	57.5	8.1	5	15.25
4	68.5	65.5	6.7	5	15.19

Calculation Table

S.N.	H, m	Qa, m3/sec	Qt, m3/sec	Cd
1	0.465	4.391E-04	4.802E-04	0.91
2	0.28	3.160E-04	3.726E-04	0.85
3	0.175	2.439E-04	2.946E-04	0.83
4	0.03	1.343E-04	1.220E-04	1.10

REYNOLD’S APPARATUS

OBJECTIVE:

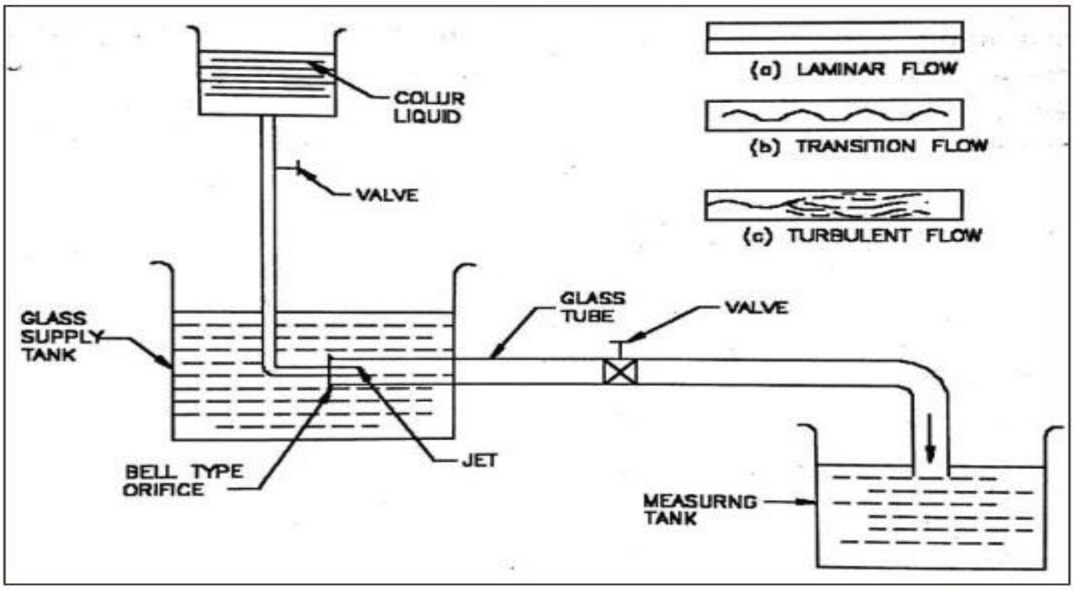
- To study different types of flow.

AIM:

- To determine the Reynold’s Number.

INTRODUCTION:

From an engineering viewpoint, many variables that affect velocity profile cannot be evaluated for all possible flow meters and for all pipe conditions. For this reason, steady flow and a fully developed flow profile as defined by a Newtonian, homogeneous fluid, are initially assumed. Co-efficient variation can then be predicted with the dimensionless Reynolds number. This number has been found to be an acceptable correlating parameter that combine the effects of viscosity, density and pipeline velocity.



THEORY:

In Reynolds experiments, the ratio of inertia to viscous forces was observed to be dimensionless and related to viscosity, average pipeline velocity, and geometrically similar boundary conditions. For a homogeneous Newtonian fluid, this dimensionless ratio is Re is expressed as:

$$Re = \rho VD / \mu$$

Where,

ρ= Density of fluid in kg/m^3

V = Average velocity of fluid flow in m/sec.

D = Diameter of glass tube in m

μ = Viscosity of fluid in N-sec/m^2

v = Kinematic viscosity of fluid, m^2/sec

Re < 2000 for laminar flow

Re > 4000 for turbulent flow

Re = 2000-4000 in transition zone

When the dye filament flows in the Reynolds experiment, it indicates critical state of flow, and the corresponding Reynolds number is called the critical reynolds number Re ≈ 2000, beyond which the flow is in transition state and then becomes turbulent. Depending upon the relative magnitudes of viscous and inertial forces, flow can occur in two different manners. Laminar flow is defined as a line, which lies in the direction of flow at every point at a given instant. Transition flow is defined as a flow in which the streamlines needs not be straight as the flow steady as long as this criterion is fulfilled. Eddies generated in the initial zone of instability spread rapidly throughout the fluid, thereby producing a disruption of the entire flow pattern. The result is fluid turbulence superimposed upon the primary motion of translation, producing what is called turbulent flow.

DESCRIPTION:

The apparatus consists of sump tank with centrifugal pump, a glass tube with one end having bell mouth entrance connected to a constant head tank. At the other end of the glass tube a valve is provided to regulate flow. Flow rate of water can be measured with the help of measuring cylinder and stop watch, supplied with the set-up. A needle is introduced centrally in the bell mouth. Dye is fed to the needle from a small container, placed at the top of constant head tank, through polythene tubing.

UTILITIES REQUIRED:

6.1 Electricity Supply: Single Phase 220 V AC, 50Hz, 5-15 Amp. combined socket with earth connection.

6.2 Water Supply (Initial Fill).

6.3 Floor Drain Required.

6.4 Floor Area Required: 1.5 m x 0.75 m

6.5 Chemical Required: Dye (KMnO4) - 10 gm

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Close all the valves V1 to V5.

2 Fill sump tank 3/4 with clean water and ensure that no foreign particles are there.

3 Prepare dye solution ($KMnO_4$ in water) in a beaker. Put this solution in Dye vessel after ensuring that there are no solid particles in solution.

4 Open by pass valve V2.

5 Ensure that On/Off switch given on the panel is at OFF position.

6 Switch ON the main power supply and then switch on the pump.

7 Open control valve V1 for water supply to constant head tank, partially close by pass valve V2 and wait till overflow occurs.

8 Regulate minimum flow of water through glass tube by partial opening of control valve V3 provided at the end of tube.

9 Then adjust the flow of dye through needle by knob, so that a fine colour thread is observed.

10 Note the flow pattern observed (laminar, transition or turbulent).

11 Measure flow Rate using measuring cylinder and stop watch.

12 Repeat the experiment for different flow rate.

CLOSING PROCEDURE:

1 Switch off pump.

2 Switch off power supply to panel.

3 Drain the apparatus completely by drain valves V4 & V5.

PRECAUTION & MAINTENANCE INSTRUCTIONS:

1 Never run the apparatus if power supply is less than 200 Volts and above 230 Volts.

2 Conduct the experiment when water gets stable.

3 Always use clean water.

4 To prevent clogging of moving parts, run pump at least once in a fortnight.

TROUBLESHOOTING:

1 If dye blocks the needle, remove the needle by disconnecting it from constant head tank and pass air at some pressure through it.

OBSERVATION:

Kinematic viscosity of water at ambient temp. v = 1.01E-06 m^2/sec

Dia. of glass tube D = 0.025 m

S.No.	Time (sec)	Qact(m^3/s)	Velocity(m/s)	Reynolds No.	Types of flow

CALCULATIONS:

Qact = Area of Tank x Rise /Time

Velocity =Qact/Area of pipe

Re = $\rho VD / \mu$

Data :

v, m^2/sec	d, m
1.01E-06	0.025

Observation Table :

Run No.	Vo, ml	t, sec	Flow Observed
1	270	19.97	Laminar Starting
2	430	12.25	Laminar Ending
3	690	10.34	Transition Starting
4	770	10.13	Transition ending
5	800	10.96	Turbulent Flow

Calculation Table :

Run No.	Q, m3/sec	a, m2	V, m/s	Re	Flow Types
1	1.35E-05	4.91E-04	0	684.475	Laminar
2	3.51E-05	4.91E-04	0.1	1777.07	Laminar
3	6.67E-05	4.91E-04	0.1	3378.319	Transition
4	7.60E-05	4.91E-04	0.2	3848.163	Transition
5	7.83E-05	4.91E-04	0.2	3962.883	Transition

MAJOR LOSSES APPARATUS

OBJECTIVE:

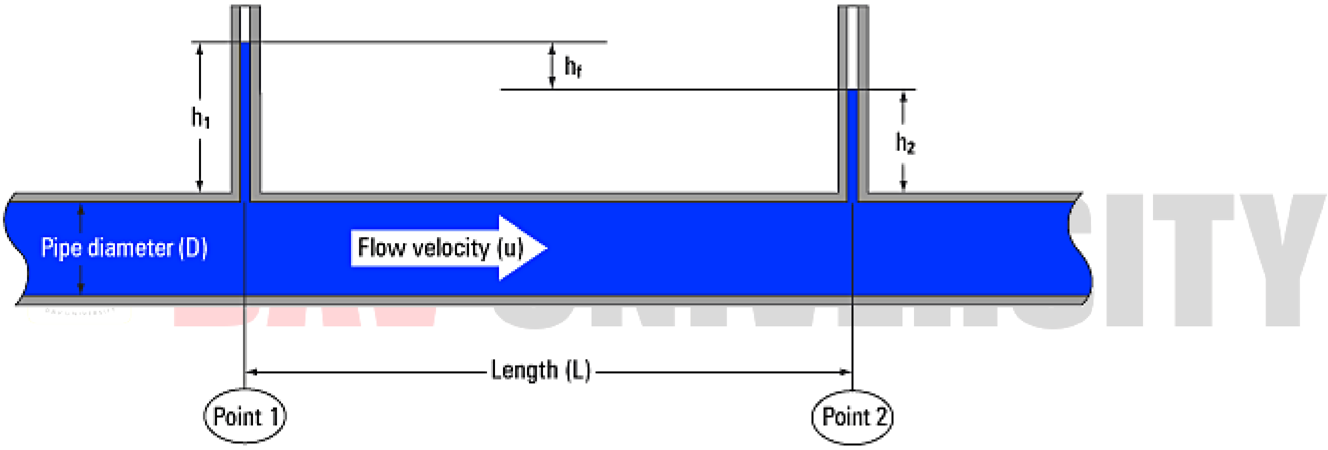
- To study the losses due to friction in pipes

AIM:

- To determine the friction factor for Darcy - Weisbach equation

INTRODUCTION:

When a fluid is flowing through a pipe, the fluid experiences some resistance due to which some of the energy of fluid is lost. This loss of energy in the pipelines comes under major energy losses and minor energy losses. In long pipelines the friction losses are much larger than the minor losses and hence, the latter are often neglected. The losses due to friction in the pipelines are known as major energy losses. The friction in the pipeline is due to a viscous drag between the stream bends of fluid. The stream bends of adjacent to the solid surface are always at rest relative to the wetted surface. The viscous drag is due to the molecular attractions between the molecules of the fluid.



Major Losses Diagram

THEORY:

It is found that the total friction resistance to fluid flow depends on the following:

4.1 The area of the wetted surface

4.2 The density of the fluid

4.3 The surface roughness

4.4 It is independent of the fluid pressure

4.5 It increase with the square of the velocity

The loss of head in pipe due to friction is calculated from Darcy-Weisbach equation which has been given by:

$$h_f = \frac{4fLV^2}{2gd}$$

Where hf = loss of head due to friction, f = Friction factor, L = distance between pressure point

V = mean velocity of fluid, d = diameter of pipe, g = Acceleration due to gravity

DESCRIPTION:

The apparatus consist of sump tank with centrifugal pump. Two pipes of different diameter for which common inlet connection is provided with control valve to regulate the flow, near the downstream end of the pipe. Pressure tapings are taken at suitable distance apart between which a manometer is provided to study the pressure loss due to the friction. Discharge is measured with the help of measuring tank and stopwatch.

UTILITIES REQUIRED:

1 Electricity Supply: Single Phase, 220 V AC, 50 Hz, 5-15 Amp. Combined socket with earth connection.

2 Water Supply (Initial Fill).

3 Floor Drain Required.

4 Floor Area Required: 1.5 m x 0.75 m.

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Close all the valves provided V1 to V6.

2 Fill sump tank ¾ with clean water and ensure that no foreign particles are there.

3 Open by-pass valve V3.

4 Ensure that On/Off switch given on the panel is at OFF position.

5 Switch on the main power supply.

6 Switch on the Pump.

7 Operate the Flow Control Valve V1 for ¾" pipe or V2 for ½" pipe and by pass valve V3 to regulate the flow of water in the desired Test Section.

8 Connect the pressure taps of related test section to manometer.

9 Open Valve V6 provided on the Manometer, slowly to release the air in manometer.

10 When there is no air in the manometer, close air release valve V6.

11 Adjust water flow rate in desired section with the help of control valve V1 & V2.

12 Record the manometer reading, in case of pressure above scale in any tube apply air pressure by hand pump to get readable reading.

13 Measure the flow of water, discharged through desired test section, using stop watch and measuring tank.

14 Repeat the experiment for different flow rates of water by operating control valve V1 or V2 and by-pass valve V3.

15 When experiment is over for one desired test section, open the by-pass valve V3 fully. Then close the flow control valve of running test section V1 or V2 and open the control valve of secondly desired test section V2 or V1

16 Repeat the same procedure for other test section.

CLOSING PROCEDURE:

1 When experiment is over, Switch off pump

2 Switch off power supply to panel.

3 Drain the tanks with the help of given drain valves V4 & V5.

PRECAUTION & MAINTENANCE INSTRUCTIONS:

1 Never run the apparatus if power supply is less than 200 Volts and above 230 Volts

2 Never fully close the delivery valve V1 & V2 and by-pass valve V3 at a time.

3 To prevent clogging of moving parts, run pump at least once in a fortnight.

4 Always use clean water.

5 Always keep the apparatus free from dust.

6 If apparatus is not in use for more than one month, drain the apparatus completely.

TROUBLESHOOTING:

1 If pump gets jammed, open the back cover of pump and rotate the shaft manually.

2 If pump gets heated up, switch off the main power for minutes and avoid closing the flow control valve V1 & V2 and by pass valve V3 at a time during operation.

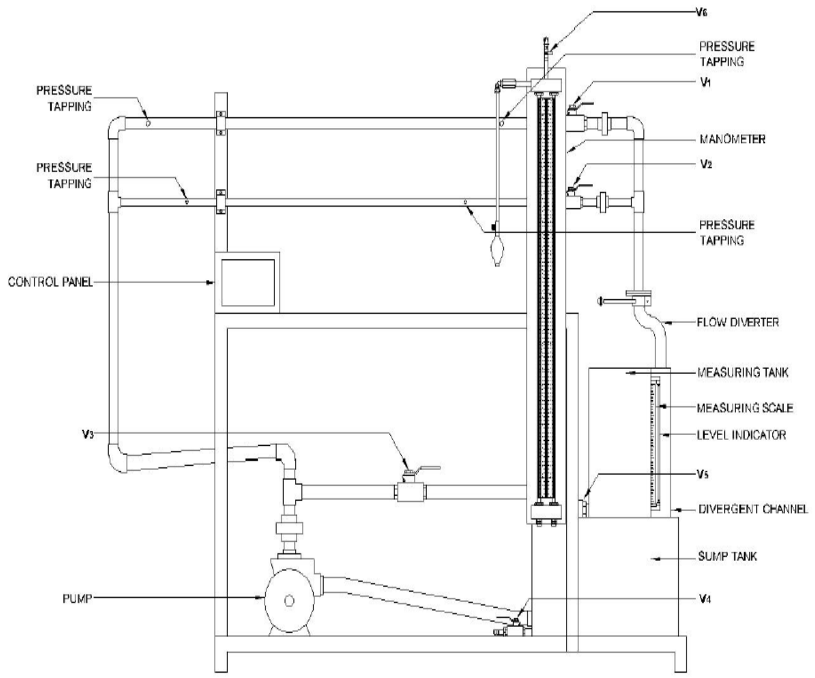
CALCULATIONS:

Qact = Area of Tank x Rise /Time

Velocity =Qact/Area of pipe

$$h_f = \frac{h_1 - h_2}{100} \text{ (m)}$$

$$f = \frac{h_f 2 g d}{4 L V^2}$$



PIPE FRICTION APPARATUS

Data

A, m2	d, m	a, m2	L, m
0.078	0.022	0.00038	1

Observation Table

S.N.	h1, cm	h2, cm	R1, cm	R2, cm	t, sec
1	59.5	58	8.5	5	15.12
2	66.5	56	13.8	5	14.93
3	73	57	16.5	5	15.19

Calculation Table

S.N.	H, m	Q, m3/sec	V, m/sec	f
1	0.015	1.806E-04	0.475	7.175E-03
2	0.105	4.597E-04	1.209	7.746E-03
3	0.16	5.905E-04	1.553	7.155E-03

PIPE FRICTION APPARATUS

Data

A, m2	d, m	a, m2	L, m
0.078	0.016	0.000201	1

Observation Table

S.N.	h1, cm	h2, cm	R1, cm	R2, cm	t, sec
1	60.5	57.5	6.1	5	10.47
2	72.5	51.5	9.8	5	15.15
3	86	49.5	12	5	15.34

Calculation Table

S.N.	H, m	Q, m3/sec	V, m/sec	f
1	0.03	8.195E-05	0.408	1.417E-02
2	0.21	2.471E-04	1.229	1.091E-02
3	0.365	3.559E-04	1.770	9.141E-03

METACENTRIC HEIGHT APPARATUS

OBJECTIVE:

- To study force balances in a static system.

AIM:

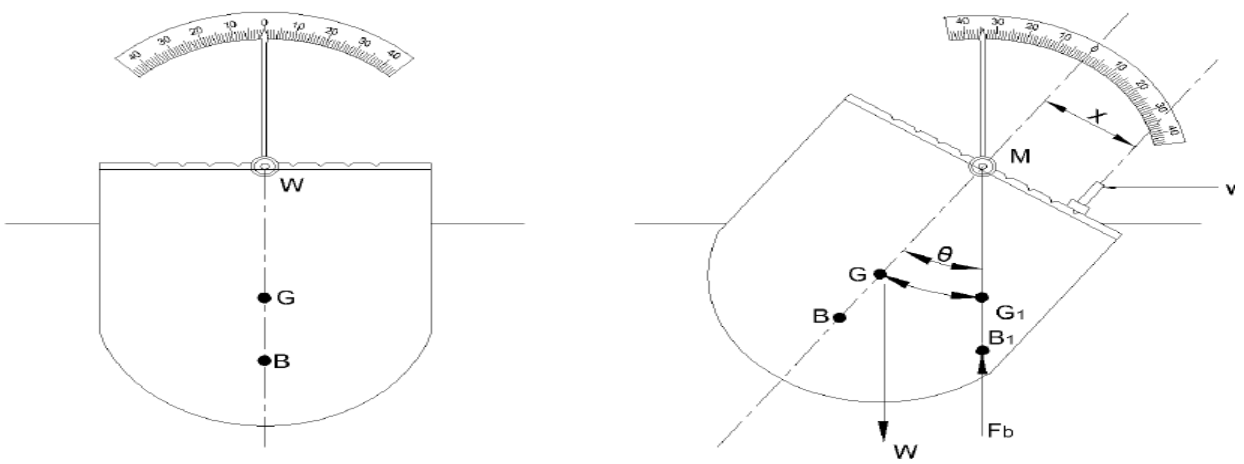
- To determine the meta-centric height with angle of ship model

INTRODUCTION:

Meta-Centre is defined as the point about which a body starts oscillating when the body is tilted by a small angle. The meta- centre may also be defined as the point at which the line of action of the force of buoyancy will meet the normal axis of the body when the body is given a small angular displacement. It is denoted by 'M'.The distance between the meta-centre (M) of a floating body and the centre of gravity (G) of the body is called meta-centric height.

DETERMINATION OF META-CENTRIC HEIGHT:

For a body to be in equilibrium on the liquid surface the two forces gravity force (W) and buoyant force (Fb) must lie in the same vertical line. If the point M is above G, the floating body will be in stable equilibrium. If slight angular displacement is given to the floating body in clockwise direction, the center of buoyancy shifts from B to B1 such that the line of action of Fb through B1 cuts the axis at M, which is called the meta-center and the distance GM is called the meta-centric height.



METACENTRIC HEIGHT APPARATUS

The buoyant force Fb through B1 and weight w through G constitute a couple acting in anti- clockwise direction and thus bringing the floating body in the original position. To determine the meta-centric height of a floating body, we know the center of gravity of floating body. Place the known weight (w) over the center of the body. The weight w is moved across the vessel towards right through a distance x. The body will be tilted. The angle of tilt □□is measured by means of a plumb line and a protractor attached on the body. The new center of gravity of the body will shift to G1 as the weight w has been moved towards the right the center of buoyancy will change to B1 as the body has tilted. Under equilibrium, the moment caused by the movement of the load w through a distance x must be equal to the moment caused by the shift of the center of gravity from G to G1.Thus The moment due to change of G,

$$GG_1 \times W = W \times GM\tan\theta$$

The moment due to movement of w,

$$wx = W\,GM\tan\theta$$

Hence,

$$GM = \frac{wx}{W\tan\theta}$$

Where,

W = Weight of body including w

G = Centre of gravity of body

B = Centre of buoyancy of the body

M = Meta-centre of the body

w = Applied weight

x = Distance moved by weight w

Ɵ = Angle of tilt

DESCRIPTION:

A ship model is allowed to float in a small tank having water. For tilting the model, a cross bar with movable hanger is fixed on the model. By means of a pendulum the angle of tilt can be measured on a graduated arc. Pendulum and graduated arc are suitably fixed at the center of the cross bar.

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Close the valve V1.

2 Fill tank the with clean water and ensure that no foreign particles are there.

3 Float the ship model in water and wait till it became stable.

4 Fix known weight to be applied at the hanger.

5 Apply weight with hanger at any side on the slot provided.

6 Measure the angle of tilt by the scale provided.

7 Repeat the experiment for different position of weight applied.

8 Repeat the experiment for different weights.

CLOSING PROCEDURE:

1 Remove the weight with hanger from the ship model.

2 Drain water from tank with the help of given drain valve V1.

PRECAUTION & MAINTENANCE INSTRUCTIONS:

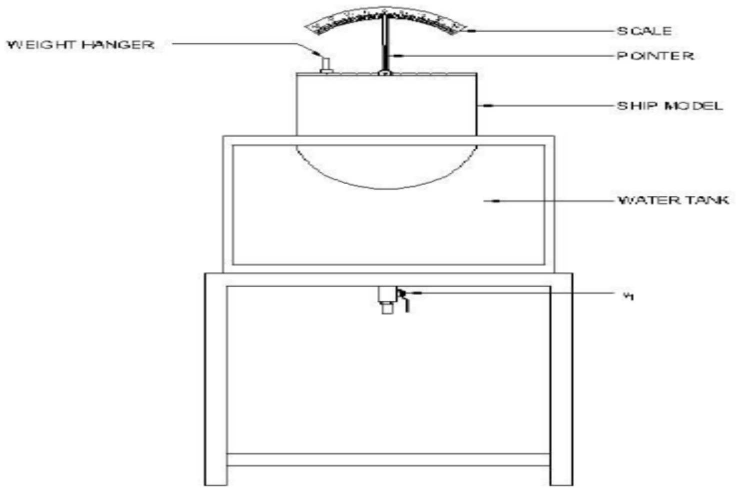
1 Always keep apparatus free from dust.

2 Drain the apparatus after experiment is over.

Calculations:

$$w = W_H + W_A \ \text{(kg)}$$

$$W = W_S + w \ \text{(kg)}$$



Metacentric Height Apparatus

METACENTRIC HEIGHT APPARATUS

Right Side

Data Table :

WH, kg	WS, kg
0.072	11.62

Observation Table :

Run No.	q	Wa, kg	x, cm
1	3	0.4	2.5
2	5	0.4	5
3	8	0.4	7.5
4	10	0.4	10
5	1	0.1	2.5
6	2	0.1	5
7	3	0.1	7.5
8	3	0.1	10

Calculation Table :

Run No.	w, kg	W, kg	h, cm
1	0.472	12.092	1.862
2	0.472	12.092	2.231
3	0.472	12.092	2.083
4	0.472	12.092	2.214
5	0.172	11.792	2.089
6	0.172	11.792	2.088
7	0.172	11.792	2.087
8	0.172	11.792	2.783

Data Table : Left Side

WH, kg	WS, kg
0.072	11.62

Observation Table :

Run No.	q	Wa, kg	x, cm
1	3	0.4	2.5
2	5	0.4	5
3	7	0.4	7.5
4	9	0.4	10
5	1	0.1	2.5
6	2	0.1	5
7	2	0.1	7.5
8	3	0.1	10

Calculation Table :

Run No.	w, kg	W, kg	h, cm
1	0.472	12.092	1.862
2	0.472	12.092	2.231
3	0.472	12.092	2.384
4	0.472	12.092	2.465
5	0.172	11.792	2.089
6	0.172	11.792	2.088
7	0.172	11.792	3.133
8	0.172	11.792	2.783

PITOT TUBE APPARATUS

OBJECTIVE:

- To measure the velocity of flow at different points along the cross section in a pipe

AIM:

- To find the point velocity at the center of a tube for different flow rates.
- To find the co- efficient of Pitot tube.
- To plot velocity profile across the cross section of pipe.

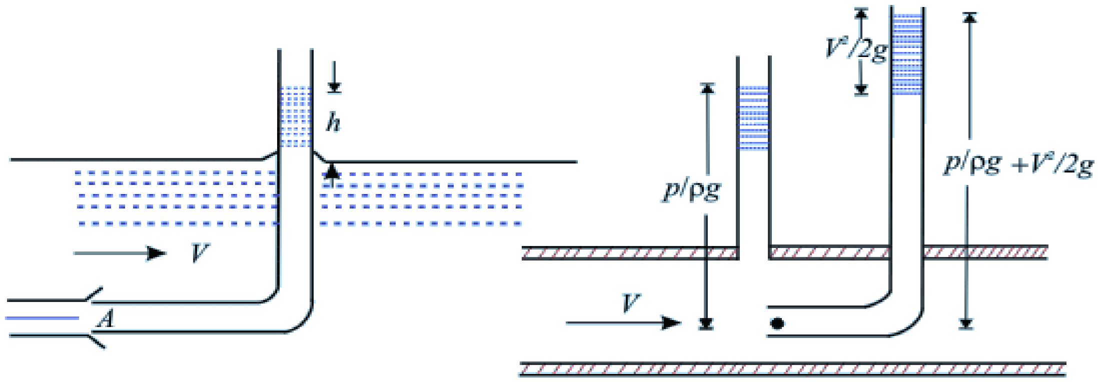
INTRODUCTION:

It is a device used for measuring the velocity of flow at any point in a pipe. It is based on the principle that if the velocity of flow at a point becomes zero, there is increase in pressure due to the conversion of the kinetic energy into pressure energy. The Pitot tube consists of a capillary tube, bend at right angle. The lower end is directed in the upstream direction. The liquid rises up in the tube due to conversion of kinetic energy into pressure energy. The velocity is determined by measuring the rise of liquid in the tube.

4. THEORY:

When a Pitot tube is used for measuring the velocity of flow in a pipe or other closed conduit the Pitot Tube may be inserted in the pipe. Since a Pitot tube measures the stagnation pressure head (or the total head) at its dipped end. The pressure head may be determined directly by connecting a differential manometer between the Pitot tube and pressure taping at the pipe surface. Consider two points 1 and 2 at the same level in such a way that point 1 is at the inlet of the Pitot tube and point 2 is at the outlet. At point 1 the pressure is p1 and the velocity of the stream is v1. However, at point 2 the fluid is brought to rest and the energy has been converted to pressure energy. Therefore the pressure at 2 is p2, the velocity v2 is zero and since 1 and 2 are in the same horizontal

plane, so z1 = z2.



Applying Bernoulli's equation at points (1) and (2)

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2$$

But $z_1 = z_2$ as points (1) and (2) are on the same line and $v_2 = 0$.

$$\frac{p_1}{\rho g} = \text{pressure head at (1)} = H$$

$$\frac{p_2}{\rho g} = \text{pressure head at (2)} = (h + H)$$

Substituting these values, we get

$$\therefore \quad H + \frac{v_1^2}{2g} = (h + H) \quad \therefore \quad h = \frac{v_1^2}{2g} \quad \text{or} \quad v_1 = \sqrt{2gh}$$

Actual velocity is given by $\mathbf{V_{act} = Cv\ (2gh)^{1/2}}$

DESCRIPTION:

The apparatus consists of sump tank with centrifugal pump. A pitot tube made of copper provided in the test section made of acrylic connected to pipeline with flow control valve. The pointer gauge is provided to measure the vertical position of Pitot tube in test section. A manometer is provided to determine the pressure difference. Discharge is measured with the help of measuring tank and stopwatch.

UTILITIES REQUIRED:

1 Electricity Supply: Single Phase, 220V AC, 50Hz, 5-15 Amp. Combined socket with earth connection.

2 Water Supply (Initial Fill).

3 Floor Drain Required.

4 Floor Area Required: 1.5 x 0.75 m.

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Close all the drain valves.

2 Fill sump tank ¾ with clean water and ensure that no foreign particles are there.

3 Open by-pass valve V2.

4 Ensure that ON/OFF switch given on the panel is at OFF position.

5 Switch ON the main power supply and then switch ON the pump.

6 Open flow control valve V1 and allow water to flow through test section by partially closing valve V2.

7 Open the air release valve V5 provided on the manometer, slowly to release the air from manometer.

8 When there is no air in the manometer, close the air release valve.

9 Set the position of Pitot tube at the centre of the test section by adjusting the pointer to zero by knob provided.

10 Adjust water flow rate with the help of control valve V1 and by pass valve V2.

11 Record the manometer reading, in case of pressure above scale in any tube, apply air pressure by hand pump to get readable reading.

12 Measure the flow of water, discharged, using stop watch and measuring tank.

13 Repeat the experiment for different flow rates of water, operating control valve V1 and by-pass valve V2.

14 Record the manometer reading for different position of Pitot tube (change by knob) at particular discharge for determination of velocity profile.

CLOSING PROCEDURE:

1 Switch off pump.

2 Switch off power supply to panel.

3 Drain the apparatus completely by drain valves V3 & V4 provided.

PRECAUTION & MAINTENANCE INSTRUCTIONS:

1 Never run the apparatus if power supply is less than 200 Volts and above 230 Volts

2 Never fully close the control valve V1 and by pass valve V2 simultaneously.

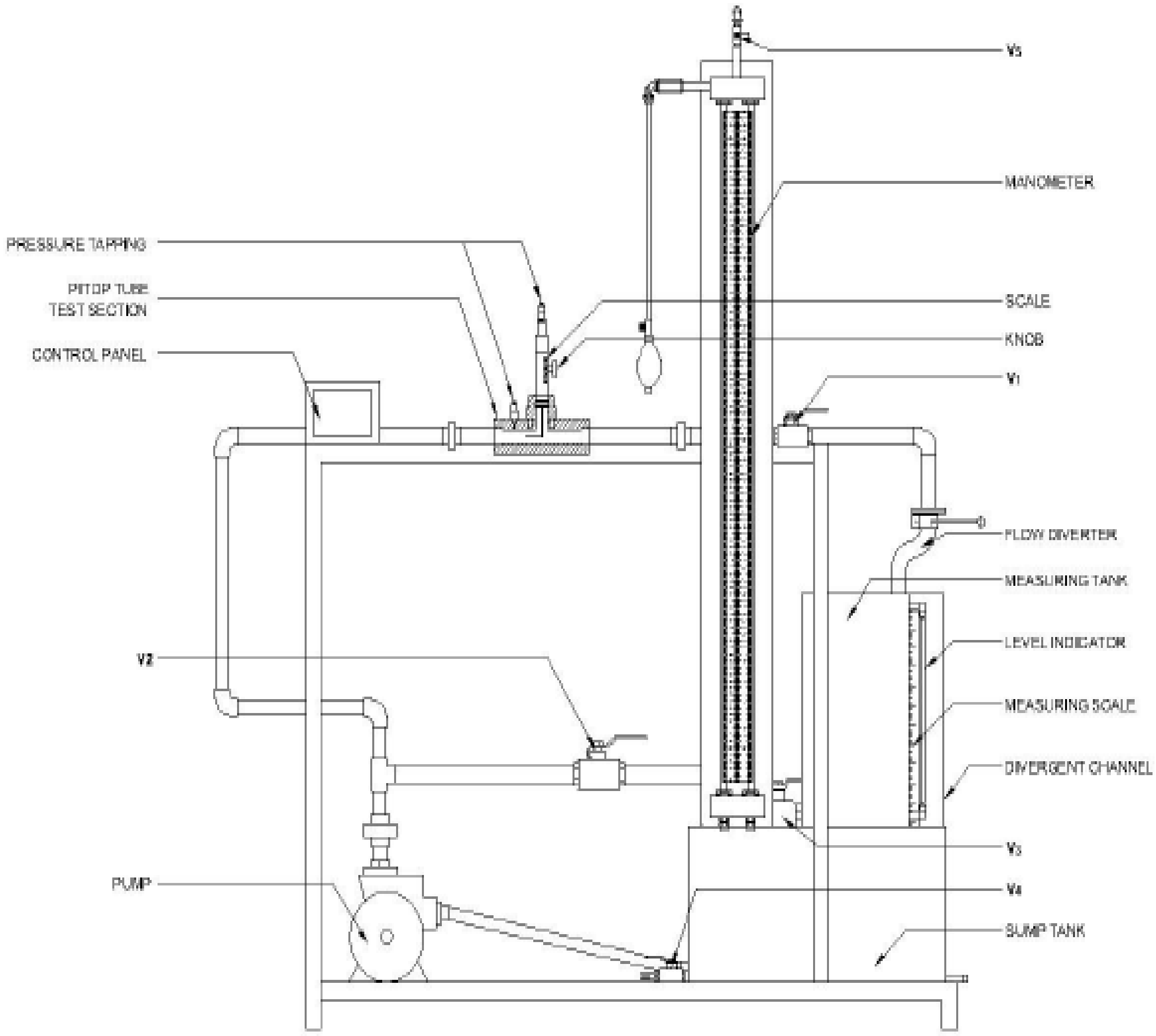
3 To prevent clogging of moving parts, run pump at least once in a fortnight.

4 Always keep apparatus free from dust.

TROUBLESHOOTING:

1 If pump gets jam, open the back cover of pump and rotate the shaft manually.

2 If pump gets heated up, switch off the main power for 30 minutes and avoid closing the flow control valve V1 and by-pass valve V2 at a time, during operation.



Given Data

A,m2	D,m	a, m2
0.077	0.028	0.000616

Observation Table

S.N.	h1, cm	h2, cm	R1, cm	R2, cm	t, sec
1	61.5	51.5	25.8	5	25
2	58	51	22	5	25.34
3	55	49.5	20.5	5	25.19
4	48	45	15.9	5	25.25

Calculation Table

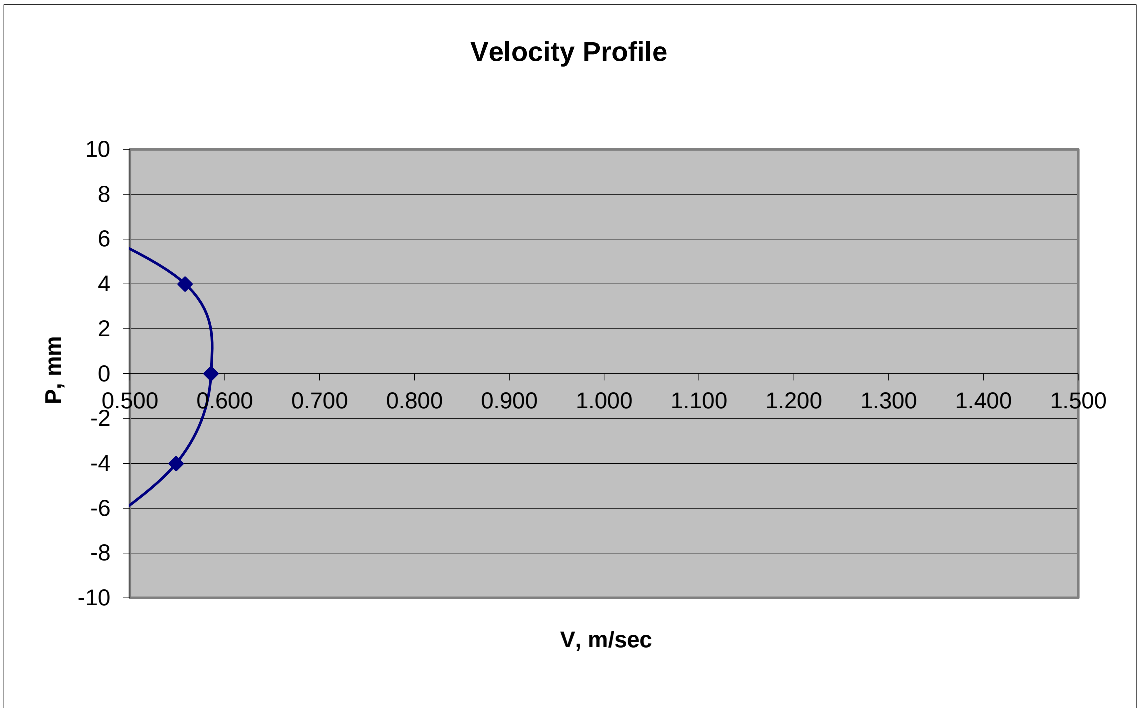
S.N.	H, m	Q, m3/sec	Va, m/sec	Vt m/sec	Cv
1	0.100	6.423E-04	1.043	1.401	0.74
2	0.070	5.179E-04	0.841	1.172	0.72
3	0.055	4.750E-04	0.771	1.039	0.74
4	0.030	3.333E-04	0.541	0.767	0.71
				Average Cv	0.73

Observation Table (Velocity Profile)

P, mm	h1, cm	h2, cm	R1, cm	R2, cm	t,sec
8	42.5	41.1	16.1	5	25.21
4	41.5	38.5			
0	40.8	37.5			
-4	39.5	36.6			
-8	38.5	36.7			

Calculation Table (Velocity Profile)

P, mm	H, m	Vt, m/sec	Q, m3/sec
8	0.014	0.381	0.00034
4	0.03	0.558	
0	0.033	0.585	
-4	0.029	0.549	
-8	0.018	0.432	



Minor Losses Apparatus

OBJECTIVE:

- To study the losses of head due to various fittings in pipelines.

AIM:

- To determine the loss of head in the fittings at the various water flow rates.
- To determine the loss co-efficient for the pipefittings.

INTRODUCTION:

Loss of head due to change in cross-section, bends, elbows, valves and fittings of all types fall into the category of minor losses in pipe lines. In long pipe lines the friction losses are much larger than these minor losses and hence the latter are often neglected. But, in shorter pipelines their consideration is necessary for the correct estimate of losses.

Diagram:

THEORY:

When there is any type of bend in pipe, the velocity of flow changes, due to which the separation of the flow from the boundary and also formation of eddies, takes place. Thus the energy is lost. The losses of head due to fittings in pipe:

The minor losses in contraction can be expressed as:

The minor losses in enlargement can be expressed as:

Where

hL = Minor loss or head loss

KL = Loss coefficient

V = Velocity of fluid.

V1 = Velocity of fluid in pipe of small Diameter.

V2 = Velocity of fluid in pipe of large Diameter.

DESCRIPTION:

The apparatus consists of two pipes with different fittings. Bend, sudden expansion, sudden contraction and elbow are provided at pipe 1. Ball valve and gate valve are provided at pipe 2. Pressure tapings are provided at inlet and outlet of these fittings at suitable distance. A differential manometer fitted in the line gives head loss due to fittings. Supply to the pipeline is made through centrifugal pump, which deliver water from sump tank. The flow of water in pipes can be regulated by the valve provided at the end for pipe 1 and gate valve fitting for pipe 2. Discharge is measured with the help of measuring tank and stop watch.

UTILITIES REQUIRED:

1 Electricity Supply: Single Phase, 220 V AC, 50 Hz, 5-15 Amp. combined socket with earth connection.

2 Water Supply (Initial Fill).

3 Floor Drain Required.

4 Floor Area Required: 1.5 m x 0.75 m.

EXPERIMENTAL PROCEDURE:

STARTING PROCEDURE:

1 Close all the valves provided (V1 to V7).

2 Fill sump tank ¾ with clean water and ensure that no foreign particles are there.

3 Open by-pass valve V1.

4 Connect the pressure taps of related test section to manometer.

5 Ensure that On/Off Switch given on the panel is at OFF position.

6 Switch ON the main power supply and switch ON the pump.

7 Open flow control valve V2 of pipe 1 for bend, sudden enlargement, sudden contraction and elbow fitting or gate valve V3 and ball valve V4 of pipe 2 for ball valve & gate valve fitting.

8 Open Valve V7 provided on the Manometer, slowly to release the air in manometer.

9 When there is no air in the manometer, close air release valve V7.

10 Record the manometer reading, in case of pressure above scale in any tube apply air pressure by hand pump to get readable reading.

11 Measure the flow of water, discharged through desired test section, using stop watch and measuring tank.

12 Repeat same procedure for different flow rates of water, operating control valve (V2 or V3, V4) and by pass valve V1.

13 Repeat the experiment for other fittings of selected pipe.

14 When experiment is over for fittings of selected pipe, open the by-pass valve V1 fully. Then close the flow control valve of pipe and open the control valve of other pipe (V3, V4 or V2) and by pass valve V1.

15 Repeat same procedure for selected test section and so on.

CLOSING PROCEDURE:

1 When experiment is over, Switch off pump

2 Switch off power supply to panel.

3 Drain the apparatus completely with the help of drain valves provided (V5 & V6).

PRECAUTION & MAINTENANCE INSTRUCTIONS:

1 Never run the apparatus if power supply is less than 200 Volts and above 230 Volts.

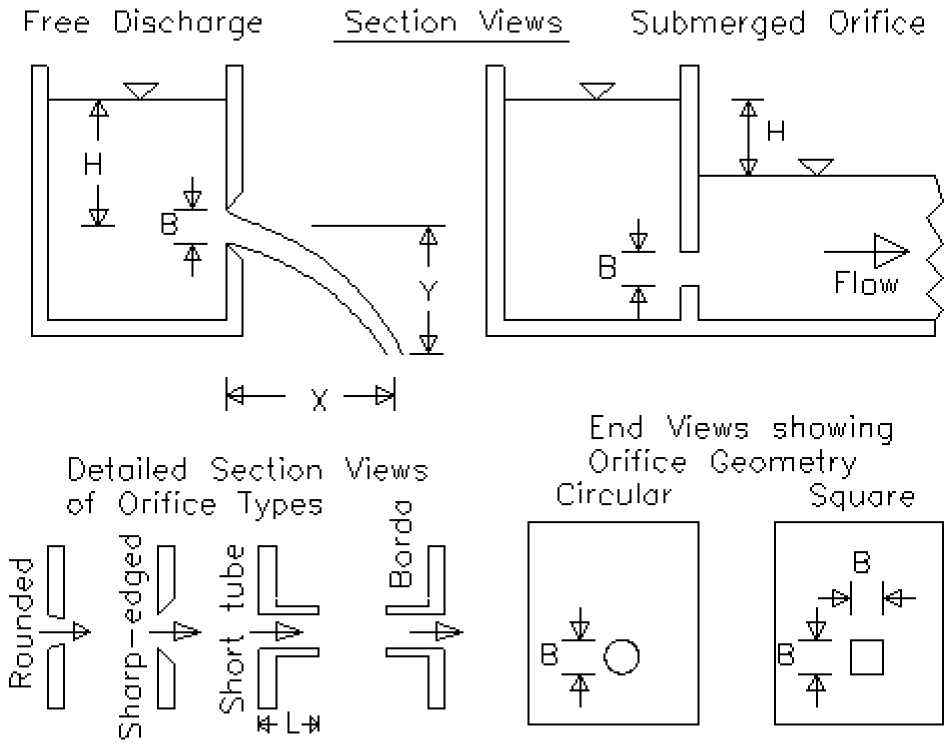
2 Never fully close the flow control valves (V2 or V3, V4) and by-pass valve V1 simultaneously.

3 To prevent clogging of moving parts, Run Pump at least once in a fortnight.

TROUBLESHOOTING:

1 If pump gets jammed, open the back cover of pump and rotate the shaft manually.

2 If pump gets heated up, switch off the main power for 30 minutes, avoid closing the flow control valve (V2 or V3, V4) and by-pass valve V1 simultaneously, during operation.



Free Discharge
Section Views
Submerged Orifice
H
B
Y
X
H
B
Flow
Detailed Section Views
of Orifice Types
Rounded
Sharp-edged
Short tube
L
Borda
End Views showing
Orifice Geometry
Circular
Square
B
B
B

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