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Fluid Mechanics Lab (ME-216-F)

List of Experiments

1. To determine the coefficient of discharge C_d, velocity C_v, and contraction C_c of various types of orifices

2. Determine of discharge coefficients of: V-notch Rectangular notch

3. To determine the minor head loss coefficient for different pipe fittings.

4. To study the variation of friction factor f. For turbulent flow in rough and smooth commercial pipes

5. To obtain the Reynolds number in different flow conditions.

6. To calibrate Venturimeter and to study the variation of coefficient of discharge with the Reynolds number.

7. To calibrate an orifice meter and to study the variation of coefficient of discharge with the Reynolds number

8. To verify the Bernoulli's theorem experimentally.

9. To determine Meta centric height of a floating body

10. To verify the momentum equation experimentally & Comparison of change in force exerted due to shape of the vane for different targets.

EXPERIMENT – 1

Title:-Conducting orifice test apparatus C_c, C_v, C_d

Objective:-to determine the coefficient of discharge C_d, velocity C_v, and contraction C_c of various types of orifices.

Apparatus: - Water supply

The experimental set up consists of a supply tank with overflow arrangement and gauge glass tube for water level measurement in the tank. There is also provision for fixing the various orifices and mouthpieces (interchangeable) installed in the vertical plan of the tank side. A set of orifice consisting of 10mm diameter and 15mm diameter orifice is provided with the apparatus. Further a set of mouth piece is also provided which consists of(1) 10mm diameter × 25mm length,(2)10mm diameter × 40mm length, (3) 10mm × 25mm ×25mm long divergent and (4) 25 ×10 ×25 mm long convergent mouthpiece. Arrangement is made such that the water passes only through this attached opening. Water comes out of the opening in the form of jet.

A horizontal scale on which is mounted a vertical scale with a hook gauge is attached to supply tank. Thus hook gauge can be moved horizontally as well as vertically in x and y direction and its corresponding movement can be read on horizontal and vertical scales respectively. A collecting tank is used to find the actual discharge of water through the jet.

Precautions:-

1. Apparatus should be in leveled condition.
2. Reading must be taken in steady or nearby steady conditions. And it should be noted that water level in the inlet supply tank must be constant.
3. There should not be any air bubble in the piezometer.
4. Orifice must be free dirt and kept clean.

Theory:-

An orifice is an opening in the wall of a tank, while a mouthpiece is a short pipe fitted in the same opening. A mouthpiece will be running full if its length does not exceed two to three times the diameter. Both orifice and mouthpiece are used for discharge measurement. The jet approaching the orifice continues to converge beyond the orifice till the streamline become parallel. This section of jet is then a section of minimum area and is known as vena contracta.

If V_c is the true horizontal velocity at the vena contracta, then the properties of jet trajectory give the following relationship:

$Y = \overline{2 \quad 2} \; .x^2$

$V_c = \{gx^2/2y\}^{1/2}$

The theoretical velocity in the plane of the vena contracta v_0 is given by

$V_0^2/2g=h$

i.e. $v_0 = (2gh)^{1/2}$

now coefficient of velocity C_v = actual velocity/theoretical velocity.

$C_v = x/2\sqrt{yh}$

In which h is the const. head in the supply tank and x and y are coordinates of jet with respect to centre of opening

The actual discharge q when divided by $(a\sqrt{2gh})$ yield the coefficient of discharge C_d

Here a is the area of x-section of the orifice (mouthpiece) & g is the acc. due to gravity.

Once C_d & C_v are known the coefficient of contraction C_c can be obtained by dividing C_d with C_v,

$C_c = C_d/C_V$

The coefficient of discharge can be also computed by falling head method in which the supply is kept closed after filling the tank to a suitable level & fall in the head from h_1 to h_2 in time T is noted.

The coefficient of discharge is then obtained from

$$C_d = \frac{2}{.\ \sqrt{2}}[h_1^{1/2}-h_2^{1/2}]$$

Suggested experimental works:

Step1: Note down the relevant dimension as area of collecting tank and supply tank.

Step2: Attach a orifice/mouthpiece and note down its dia.

Step3: The water supply was admitted to the supply tank and condition was allowed steadying to give a constant Head. The lowest pt. of the orifice and mouthpiece is used as the datum for the measurement of h and y.

step4: the discharge flowing through the jet is recorded together with the water level in the supply tank.

Step5: a series of readings of dimensions x & y was taken along the trajectory of the jet.

Step6: the above procedure is repeated by means of flow control valve.

Step7: the above procedure is repeated for other types of orifice/mouthpiece.

Data of experiment:-

Size and shape of the mouthpiece =10mm diameter × 25mm length

=10mm diameter × 40mm length

=10mm × 25mm ×25mm long divergent

=25mm × 10mm ×25mm long convergent

Area of x-sec. of mouthpiece, a, cm^2 = 0.7854

Size and shape of the orifice 10mm diameter

Area of x-sec. of orifice a, cm2 = .7854

Size and shape of orifice 15 mm diameters

Area of x-sec. of orifice a, cm= 1.7672

Area of x-sec. of collecting tank cm^2 = 30×40

Area of x-sec. of supply tank A cm^2 =30×30

OBSERVATION TABLE:

Name of experiment: determination of coefficient of discharge C_d, velocity C_v and contraction c_c of various types of orifice/mouthpiece.

Size and shape of the mouthpiece/orifice.

Area of x-section of mouthpiece/orifice, a, cm^2

Area of x- section of collecting tank cm^2

Area of x-section of supply tank A, cm2

Reading on the piezometer at the level on the centre of mouthpiece/orifice h_0

A. Constant head method:

Determination of C_d

tube	Reading on the piezometer a1(cm)	Value of h $h=a_1-h_0$ (cm)	Discharge measurement				$C_d=Q/a\sqrt{2gh}$
			Initial (cm)	Final (cm)	Time (sec.)	Discharge(Q) (Cm3/sec.)	

Average C_d

1. Determination of C_v

Reading of horizontal scale at exit of orifice/mouthpiece x_0

no.				x_0(cm)	(cm)	

Average C_v

Therefore $C_c = C_d/C_v$

A. Falling head method :

reading on the piezometer at the level on the centre of mouthpiece/orifice h_0

$k=2A/a\sqrt{2g}$

Run no.	Piezometer reading (cm)		$H_1=a_1-h_0$(cm)	$H_2=a_2-h_0$ (cm)	Time in lowering the water T (sec)	$C_d=k/T(\sqrt{h1}-\sqrt{h2})$
	Initial (a1)	Final(a2)				

Average value of C_d

Result and discussion

Fill up the data sheet

Calculate the C_{d}, C_v & C_c

EXP

ERIMENT – 2

AIM: - NOTCH APPARATUS TO CALIBRATE RACTANGUAR AND V –NOTCH

OBJECTIVE:- Determine of discharge coefficients of: V-notch Rectangular notch

EXPERIMENT SET UP:-

The experiment set up consists of a tank of whose inlet section is provided with 2 nos. of baffles for streamline flow. While at the downstream portion of the tank one can fix a notch of either rectangular or V-notch. A point gauge is used to measure the head of water over the model. A collecting tank is used to find the actual discharge through the notch.

THEORY:-

Different types of models are available to find discharge in an open channel as notch, weir etc. for calibration of rectangular notch, trapezoidal notch or V notch some flow is allowed in the flume. Once the flow become steady, uniform discharge coefficients can be determined for any model.

In general sharp crested notches are preferred were highly accurate discharge measurements are required. For example in hydraulic laboratories, industry and irrigation pilot schemes, which do not carry debris and sediments.

Notches are those or flow structures whose length or crest in the direction of flow is accurately shaped. They may be rectangular, trapezoidal, V notch etc. The V notch is one of the most precise discharge measuring device suitable for a wide range of flow. Making the following assumptions as to the flow behavior can develop the relationship can develop between discharge and head over the weir.

a) Upstream of the weir, the flow is uniform and the pressure varies with depth according to the hydrostatic equation $p = \rho g h$.
b) The free surface remains horizontal as far as the plane of the weir, an all particles passing over the weir move horizontally.
c) The pressure throughout the sheet of liquid or nappe, which passes over the crest of the weir, is atmospheric.
d) The effect of viscosity and surface tension are negligible.
e) The viscosity in the approach channel is negligible.

A triangular or v notch is having triangular or V shaped opening provided in its body so that water is discharged through this opening only. The line which bisects the angle of notch should be vertical and at the same distance from both side of the channel.

SUGGESTED EXPERIMENTAL WORK:-

Step 1: The notch under test was positioned at the end of the tank, in a vertical plane, and with sharp edge on the upstream side.

Step 2: The tank was filled with water up to the crest level and subsequently note down the crest level of the notch by the help of a point gauge.

Step 3: The flow regulating value was adjusted to give the maximum possible discharge without flooding the notch.

Step 4: Condition were allowed to steady before the rate of discharge and head H were recorded.

Step 5: The flow rate is reduced stages and the readings discharge and H were taken.

Step 6: The above procedure is repeated for other type of notches.

OBSERVATION TABLE:-

(a) Triangular or V notch

Apex angle of notch, θ =

Crest level of notch, H_1, cm =

Area of collecting tank, a cm^2 =

S. NO.	Discharge measurement				Final reading of water level above the notch H_2 (cm)	**Head over notch $H=H_1-H_2$** (cm)	$c_d = \frac{\quad}{\sqrt{\quad}}$
	Initial h_1 (cm)	Final h_2 (cm)	Time (sec)	Discharge Q (cm^3/sec)			

(b) Rectangular notch

Width of notch, B cm =

Crest level of notch, H_1 cm =

Area of collecting tank, a cm^2 =

S. NO.	Discharge measurement				Final reading of water level above the notch H_2 (cm)	**Head over notch $H=H_1-H_2$** (cm)	$c_d = \frac{\quad}{\frac{2}{3}\sqrt{2}\quad \frac{3}{2}}$
	Initial h_1 (cm)	Final h_2 (cm)	Time (sec)	Discharge Q (cm^3/sec)			

<u>RESULTS AND DISCOUSSIONS FOR V NOTCH:-</u>

1. Note down the apex angle of V notch and width of rectangular notch.
2. Calculate the discharge and head over the notch.
3. Find out the coefficient of discharge C_d of each notch.

<u>RESULTS AND DISCUSSIONS FOR RECTANGULAR:-</u>

1. Reading must be taken in steady or near steady conditions.
2. For the measurement of correct discharge there must not be any leakage near the notch and take care that notch is not running in over flow condition.
3. For measurement of correct head over the notch the point gauge must be installed little distance away from the creast of notch.
4. Discharge must be varied vary gradually from a higher value to smaller values.

EXP

ERIMENT – 3

AIM: - To determine the minor head loss coefficient for different pipe fittings.

EXPERIMENTAL SET UP:-The experimental set up consists of a pipe circuit of a 25 mm diameter fitted with followings fittings with means of varying flow rate.

Large band

Sudden enlargement to 50 mm dia.

Small bend

Sudden contraction from 50 mm dia. to 25 mm dia.

Pressure tapping are provided on up-stream and down-stream ends of each of these fittings to enable the measurement of pressure head difference across the fittings to compute the head loss through the fittings. The pressure tapping are connected to differential manometer. A collecting tank is used to find the actual discharge of water through the pipe fittings.

SAFETY PRECAUTIONS:-

Apparatus should be in levelled condition.

Reading must be taken in steady or nearby steady condition.

There should be no air bubble in the manometer.

THEORY :- In long pipes, the major loss of energy in pipe flow is due to friction while the minor losses are those, which are caused on account of the change in the velocity of flowing fluid (either in magnitude or direction).Losses due to change in cross-section, bends, valves & fittings of all types are categorized as minor losses. In short pipes, above losses may sometimes outweigh the friction losses.

The minor energy head loss h_L in terms of the velocity head can be expressed as

$h_L =$

Where, k is loss coefficient, which is practically constant at high Reynolds's number for a particular flow geometry, V is velocity of flow in the pipe and g is acceleration due to gravity.

However, for sudden enlargement of the section, the simultaneous application of continuity, Bernoulli's and momentum equation shows that

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$h_L =$

Where V and V_1 are velocities of in smaller and larger diameter pipes respectively.

SUGGESTED EXPERIMENTAL WORK:-

Note down the relevant dimension of each individual fittings, area of collecting tank etc.

Pressure tappings of a fitting are kept open while for other fittings it is kept closed.
The flow rate is adjusted to its maximum valve.
By maintaing suitable amount of steady flow in the pipe circuit, these establish a steady non-uniform flow in the circuit. Time is allowed to stabilize the levels in the two limbs of manometer.
The flowing in the circuit is recorded together with the water levels in the two limb of a manometer.
The flow rate is reduced in stages by means of flow control valve and the discharge & readings of manometer are recorded.
This procedure is repeated by closing the pressure tappings of this fitting, together with other two fittings and for opening of another left fitting.

OBSERVATION TABLE:-

TABLE -1

Type of fitting:

Run. No.	Manometer Reading			Discharge measurement				$V = \frac{Q}{\alpha}$ (cm/sec)	Loss coefficient $k=2gh_L/v^2$
	Left Limb h_1 (cm)	Right Limb h_2 (cm)	Diff of Head in terms water $h_{L=}$ 12.6	Initial (cm)	Final (cm)	Time (sec)	Discharge Q (cm^3/sec)		

Average loss coefficient, k =

TABLE – 2

Type of fitting: Sudden Enlargement

Diameter of smaller pipe =

Area of smaller pipe =

Diameter of bigger pipe =

Area of bigger pipe =

Area of collecting tank=

Run. No.	Manometer Reading	Discharge measurement	$V = \frac{Q}{\alpha}$ (cm/sec)	Loss coefficient, $k= 2gh_L/(v-v_1)^2$

	Left Limb h_1 (cm)	Right Limb h_2 (cm)	Diff of Head in terms of water H_L =12.6	Initial (cm)	Final (cm)	Time (sec)	Discharge Q (cm^3/sec)		

RESULT AND DISCOUSSION:

Fill up the data sheet.

Calculate the discharge difference of manometer reading and ‘k’ coefficient for different pipes for different sets of reading.

Find the average friction factor ‘k’.

EXPERIMENT: - 4

OBJECTIVE:-To study the variation of friction factor f. For turbulent flow in rough and smooth commercial pipes

APPARATUS:- Apparatus consists a pipe circuit through which four pipes of G.I. of different diameters viz 15 mm. 25 mm and 32 mm diameter are provided with means of varying flow rate. One pipe of brass of 25 mm diameter is also connected with means of varying flow rate to the rate to the circuit. Each pipe is provided with two pressures tapping at certain distance apart. A U-tube differential manometer is provided to find the difference of head between two pressure tappings. The tapping may be connected to a manometer turn by turn. A collecting tank is used to find the discharge of water through the pipes.

THEORY:- When liquid flows through a pipe under pressure , some head is lost in overcoming the friction between the pipe wall and flowing fluid. The frictional resistance offered to flow depends on type of flow. Mostly the flow of fluid in pipes lies in turbulent zone. On the basis of the experimental observations the law of fluid friction for turbulent flow is as under:

The frictional resistance in the case of turbulent flow is Proportional to $(\text{velocity})^n$ where n varies from 1.72 to 2.0. Independent of pressure. Proportional to density of flowing fluid. Slightly affected by variation of temperature of the fluid.

Proportional to area of surface in contact, dependent on the nature of the surface in contact.

The generally accepted formula governing turbulent flow in pipes may be summarized as follows by Darcy-Weisbach formula for head loss due to friction.

$$h_1 = \frac{\quad^{2}}{2}$$

$$h_1 = \frac{8 \quad ^{2}}{^{2} \quad ^{5}}$$

Where f is known as friction factor which is a dimensionless quantity, l is length of pipe. V is mean velocity of flow in pipe. Q is discharge through. g is acceleration due to gravity and D is diameter of pipe.

EXPERIMENTAL SET –UP:-

Step 1: Note down the relevant diameter of pipe, length of pipe between the pressure tapping, area of collecting tank etc.

Step 2: pressure tapping of a pipe are kept open while for other pipe it is kept closed.

Step 3: open the inlet flow control valve and regulate the valve to allow a steady flow through the pipe. Check if there is any air bubble in the manometer tube. If so remove the same.

Step 4: The flow rate was adjusted to its maximum value by maintaining suitable amount of steady flow or near of study flow in the pipe circuit, there established a steady non-uniform flow in the circuit. Time is allowed to stabilize the level in the manometer tube.

Step 5: The discharge flowing in the circuit is recorded together with the water levels in the left and right limbs of manometer tube.

Step 6: The flow rate is reduced in stages by means of flow control valve and the discharge & readings of manometer are recorded.

Step :7 This procedure is repeated by closing the pressure tappings of this pipe and for opening of another pipe.

RESULTS AND DISCOUSSIONS:-

Fill up the data sheet.

Calculate the data sheet, difference of manometer reading of ‘f’ friction factor for different pipes for different sets readings.

Find the average friction factor ‘f’.

The observation shows that the coefficient f is not a constant but its value depends on the roughness condition of the pipe surface and the Reynolds’s number of the flow.

SAMPLE DATA SHEET:-

Name of Experiment: To study the variation of friction factor, f turbulent flow in rough and smooth commercial pipes.

Material of pipe =

Diameter of pipe, D, cm =

Length of pipe between two pressure tappings, L, cm =

Area of collecting tank, a, cm^2 =

Temperature of water, $^{\circ}C$ =

Kinematic viscosity of water, ύ, m^2/sec =

Run. No.	Manometer Reading			Discharge Measurement				
	Left limb h_1 (cm)	Right limb h_2 (cm)	Diff. of head in terms of water h_1=12.6 (h_1-h_2)(cm)	Initial (cm)	Final (cm)	Time (sec)	Discharge Q (cm^3/sec)	$h_1 = \frac{8 \quad , \; ^{2}}{^{2} \quad ^{5}}$

RESULTS AND DISCOUSSIONS:-

Fill up the data sheet.

Calculate the discharge, difference of manometer reading and 'f' friction factor for different pipes for different sets of readings.

Find the friction factor 'f'.

The observation shows that the coefficient f is not a constant but its value depends on the roughness condition of the pipe surface and Reynolds's number of the flow.

EXP

ERIMENT: - 5

REYNOLDS TEST APPARATUS

OBJECTIVE:-

1. To study different flow conditions.
2. To obtain the Reynolds number in different flow conditions.

THEORY:-

Depending upon the relative magnitudes of viscous and inertial force, flow can occur in two different manner viz. laminar flow and turbulent flow. In laminar flow viscous effect are more predominant than the inertial effects. But when shear and normal stress are added with the increase in velocity of flow a dimensionless parameter is being utilizes which is a measure of the relative importance of inertial force and viscous force prevailing in the flow of fluid, which is known as Reynolds number. It is equal to the ratio of inertial force to the viscous force per unit volume. This means that a large value of Reynolds number signifies less viscous effects and vice versa. For determine the different flow conditions, equipment first used by Professor Osborne Reynolds after whose name Reynolds number exists.

The motion is laminar or turbulent according as the value of Re is less than or greater than a certain value. If a liquid such as water is allowed to flow through a glass tubes, and if one of the liquid filament is made visible by means of dye, then by watching this filament we may get insight into the actual behavior of the liquid as it moves along. After the water in the supply tank has stood for several hours to allow it to come completely to rest. The outlet valve is slightly opened. The central thread of dye carried along by the slow stream of in the glass tube is seen to be nearly as steady and well defined as the indicating column in an alcohol thermometer. But when, as a result of further opening of valve, the water velocity passes a specific limit, a change occurs, the rigid thread of dye begins to break up and to group momentarily ill- defined. The moment the dye deviated from its straight line pattern corresponds to the condition when the flow in the conduit is no longer in laminar conditions. The discharge, Q flowing in the conduit at this moment is measured and the Reynolds number $4Q/\pi d\nu$ (in which d is the diameter of the conduit and ν is the kinematics viscosity of water is computed. This is the lower critical Reynolds number. Finally, at high velocities the dye mixes completely with the water and the colored mixture fills the tube.

EXPERIMENTAL SET UP:-

Apparatus consist of storage cum supply tank, which has the provision for supplying colored dye through jet. A Perspex tube is provided to visualize the different flow condition. The entry of water in Perspex tube is through elliptical bell mouth to have smooth flow at the entry. A regulating valve is provided on the downstream side of the tube to regulate the flow. The discharge must be varied very gradually from a smaller to larger value. A collecting tank is used to find the actual discharge through the Perspex tube.

EXPERIMENTAL WORK:-

Step 1:- Note down the relevant dimensions as diameter of Perspex tube, area of collecting tank, room temperature etc.
Step 2:- by maintaining suitable amount of steady flow in the Perspex tube, open inlet of the dye tank so that the dye stream moves as a straight line in the tube.
Step 3:- the discharge flowing in the Perspex tube is recorded.
Step 4:- this procedure is repeated for other values of discharge.
Step 5:- by increasing the velocity of flow in the Perspex tube, again open the inlet of the dye tank so that the dye stream begins to break up in the tube, which shows the fluid is no more in the laminar conditions. Hence transition stage occurs.
Step 6:- this discharge flowing in the Perspex tube is recorded.
Step 7:- this procedure is repeated for other values of discharge.
Step 8:- on further increase in the velocity of flow in the Perspex tube, again open the inlet of dye tank so that the dye mixes completely in the tube which shows fluid is no more in the transition stage. Hence turbulent flow occurs in the tube.
Step 9:- the discharge flowing in the Perspex tube is recorded.
Step 10:- this procedure is repeated for other values of discharge.

OBSERVATION TABLE:-

Inner diameter of conduit d, mm =25mm
Room temperature, θ □C =
Kinematics viscosity of water, V cm^2/sec =

S.No	Discharge measurement				
	Initial (cm)	Final (cm)	Time take (sec)	Discharge (cm^3/sec)	Re=4Q/πdν

Area of collecting tank, cm^2 =

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RESULT AND DISCOUSSION:-

Calculate the discharge in different flow conditions.

Also calculate the Reynolds number for different flow conditions.

EXP

ERIMENT: - 6
FLOW MEASUREMENT APPARATUS

OBJECTIVE:-

To calibrate Venturimeter and to study the variation of coefficient of discharge with the Reynolds number.

PRECATIONS:-

Remove all entrapped air from two limbs of manometer.

Maintain constant discharge for one set.

Take a number of reading to obtain accurate result.

EXPERIMENTAL SET UP:-

The experiment set up consist of a circuit through which the water circulated continuously. The circuit having two parallel pipelines of 25mm diameter. A pipeline is connected with a Venture meter while other is connected with an orifice meter. Venture meter and Orifice meter are having a d/D=0.6 and are provide with two pressures taping one at upstream and other at downstream side (throat). A U tube different manometer is providing to measure the pressure different between two section of Venture meter and Orifice meter. A regulating valve is provided on the downstream side of each pipe to regulate the flow. A collecting is used to find the actual discharge through the circuit.

THEORY

Venturimeter and Orifice meter are devices used for measurement of rate of flow of fluid a pipe. The basic principle on which venture meter and orifice meter works is that by reducing the cross-sectional area of flow passage, a pressure difference is created and the measurement of the pressure difference enables the determination of the discharge through the pipe.

A venturimeter consists of (1) an inlet section followed by a convergent cone, (2) a cylindrical throat and (3) a gradually divergent cone. Since the cross-sectional area of the throat is smaller than the cross-sectional area of the inlet section, the velocity of flow at the throat will become greater than the inlet section. According to continuity equation the increase in the velocity of flow at the throat results in the decrease in the pressure at this section. A pressure difference is created between the inlet section which can be determined by connecting a differential U-tube manometer between the pressure taps provide at these section. The measurement of pressure difference between these sections enables the rate of flow of fluid (Q) to be calculated as

$$\mathbf{Q=C_{d.}\, a\, (2g\Delta h)^{1/2} / \{1-(a/A)^{2}\}^{1/2}}$$

Where (a) is the area of cross-section of throat , (A) is the area of cross-section of inlet , g is the acceleration due to gravity , h is the difference of head in terms of water and C_d is the coefficient of discharge of venture meter .

The coefficient C_d accounts for viscous effects of the flow and depends upon the Reynolds number, Re (which is equal to Vd/v. Where V= Q/a, d is the diameter of throat) and the ratio d/D. For the given experimental set up d/D is fixed. Usually C_d varies between 0.96 and 0.99 for Reynolds number grater then 10^5.

SUGGESTED EXPERIMENTAL WORK:-

Step 1 –Note down the relevant dimension as diameter of the pipe, diameter of throat, area of collecting tank, room temperature etc.

Step 2- Regulating valve of a pipeline is kept open while for other it is closed.

Step 3- Pressure taping of a venture meter is kept open while for orifice meter are kept closed.

Step 5- the flow rate was adjusted to its maximum valve. By maintaining suitable amount of steady flow or nearby steady flow in the pipe circuits , there established a steady non-uniform flow in the circuit and time is allowed to stabilized the level in the manometer tube.

Step 6- The discharge flowing in the circuit is recorded together with the water level in left and right limbs of manometer tube.

Step 7 the flow is reduced in stages by means of flow control valve and the discharge & reading of manometer are recorded for every stage.

OBSERVATION TABLE:-

Type of flow meter = Venture meter

Diameter of pipe line ‘D’ cm = 2.5

Cross –section area of the pipe line ‘A’cm ^{2} = $\prod/4*D^2$

Diameter of throat /orifice section cm (d/D=0.6) = 1.5

Cross section area of the throat /orifice section ‘A’cm^2 = $\prod/4*d^2$

Area of collecting tank cm =

Temperature of water =

Kinematics viscosity of water ‘v’ cm^2/sec=

Run. No.	Manometer Reading			Discharge Measurement				$C_d = \frac{\cdot\{\ -(-)\ \}^{-}}{\cdot(\ \Delta\ )^{-}}$
	Left limb h_1 (cm)	Right limb h_2 (cm)	Diff. of head in terms of water $\Delta h = 12.6\,(h_1 - h_2)$(cm)	Initial (cm)	Final (cm)	Time (sec)	Discharge Q (cm^3/sec)	

<u>RESULTS AND DISCOUSSIONS:-</u>

Plot C_d V_s R_e for the observed data.

EXPERIMENT: - 7

FLOW MEASUREMENT APPARATUS

OBJECTIVE:-

To calibrate an orifice meter and to study the variation of coefficient of discharge with the Reynolds number.

PRECATIONS:-

Remove all entrapped air from two limbs of manometer.

Maintain constant discharge for one set.

Take a number of reading to obtain accurate result.

EXPERIMENTAL SET UP:-

The experiment set up consist of a circuit through which the water circulated continuously. The circuit having two parallel pipelines of 25mm diameter. A pipeline is connected with Orifice meter having a d/D=0.6 and are provide with two pressures taping one at upstream and other at downstream side. A U tube different manometer is providing to measure the pressure different between two sections of Orifice meter. A regulating valve is provided on the downstream side of each pipe to regulate the flow. A collecting is used to find the actual discharge through the circuit.

THEORY:-

An orifice meter is a arrangement for measurement of discharge through pipes and its installation requires a smaller length as compared with other flow measuring. The opening in the form of orifices is provided at the center of the plate.

An orifice meter consist of a flat circular plate with a circular hole called orifice with is concentric with the pipe axis. The upstream face of the plate is be leveled at an angle lying between 30 and 45. The plate is clamped between the two pipe flanges with be leveled surface facing downstream. Two pressuring tapings are provided one on the upstream side of plate and other on the downstream side of the orifice plate. The pressure difference exists between two sections which can be measured by connecting a differential manometer to the two pressure taps. The discharge coefficient can be calculated using formula

$$\mathbf{Q=C_{d.}\, a_0a_1(2g\Delta h)^{1/2}/(a_1^2-a_0^2)^{1/2}}$$

SUGGESTED EXPERIMENTAL WORK:-

Step 1 –Note down the relevant dimension as diameter of the pipe, diameter of throat, area of collecting tank, room temperature etc.

Step 2- Regulating valve of a pipeline is kept open while for other it is closed.

Step 3- Pressure taping of a venture meter is kept open while for orifice meter are kept closed.

Step 5- the flow rate was adjusted to its maximum valve. By maintaining suitable amount of steady flow or nearby steady flow in the pipe circuits , there established a steady non-uniform flow in the circuit and time is allowed to stabilized the level in the manometer tube.

Step 6- The discharge flowing in the circuit is recorded together with the water level in left and right limbs of manometer tube.

Step 7 the flow is reduced in stages by means of flow control valve and the discharge & reading of manometer are recorded for every stage.

Step 8- Pressure taping of a orifice meter are kept open while for venture meter are kept closed

Step 9- Open the inlet flow control valve and regulate the valve to allow a steady flow through the pipe.

Step 10- The flow rate was adjusted to its maximum valve. By maintaining suitable amount of steady flow or nearby steady flow in the pipe circuits , there established a steady non-uniform flow in the circuit and time is allowed to stabilized the level in the manometer tube.

Step 11- The discharge flowing in the circuit is recorded together the levels in left and right limbs of manometer tube.

Step12 – The flow rate is reduced in stage by means of flow control valve and the discharge & reading of manometer recorded for every stage.

OBSERVATION TABLE:-

Type of flow meter = Orifice meter

Diameter of pipe line ‘d_1’ cm = 2.5

Cross –section area of the pipe line ‘a_1’cm^2 = $\prod/4*d_1^2$

Diameter of throat /orifice section cm (d/D=0.6) = 1.5

Cross section area of the throat /orifice section ‘A’cm^2 = $\prod/4*d_0^2$

Area of collecting tank cm =

Temperature of water =

Kinematics viscosity of water ‘v’ cm^2/sec=

Run. No.	Manometer Reading			Discharge Measurement				$C_d = \frac{\sqrt{\quad - \quad}}{\sqrt{\quad \Delta}}$
	Left limb h_1 (cm)	Right limb h_2 (cm)	Diff. of head in terms of water $\Delta h = 12.6\,(h_1 - h_2)$ (cm)	Initial (cm)	Final (cm)	Time (sec)	Discharge Q (cm^3/sec)	

<u>RESULTS AND DISCOUSSIONS:-</u>

Plot C_d V_s R_e for the observed data.

EXPERIMENT: - 8

VERIFICATION OF BERNOULLI'S THEORM

OBJECTIVE:- To verify the Bernoulli's theorem experimentally.

SAFETY PRECAUTIONS:-

- Apparatus should be in leveled condition.
- Reading must be taken in steady or nearby steady conditions and it should be noted that water level in the inlet supply tank should reach the overflow condition.
- There should not be any air bubble in the piezometer and in the Perspex duct.
- By closing the regulating valve, open the control valve slightly such that the water level in the inlet supply tank reaches the overflow conditions. At this stage check that pressure head in each piezometer tube is equal. If not adjust the piezometer to bring it equal.

EXPERIMENTAL SET UP:-

The experimental set up consists of a horizontal Perspex duct of smooth variable cross-section of convergent and divergent type. The section is 40mm × 20mm at middle. The total length of duct is 90cm. The piezometric pressure P at the locations of pressure tapings is measured by means of 11 piezometer tubes installed at an equal distance of 7.5cm along the length of conduit. The duct is connected with supply tanks at its entrance and exit end with means of varying the flow rate. A collecting tank is used to find the actual discharge.

THEORY:-

Considering friction less flow along a variable are duct, the law of conservation of energy states "for and in viscid, incompressible, irrigational and steady flow along a stream line the total energy (or head) remains the same". This is called Bernoulli's equation.

The total head of flowing fluid consists of pressure head, velocity head and elevation head. Hence

$$P_1/\omega + V_1^2/2g + Z_1 = P_2/\omega + V_2^2/2g + Z_2$$

EXPERIMENTAL WORKS:-

Step 1:- Note down the piezometer distance from inlet section of the Perspex duct.

Step 2:- Note down the cross sectional area of Perspex duct at each of the piezometer taping point.

Step 3:- the datum head is treated as constant throughout the duct.

Step 4:- By maintaining suitable amount of steady head or nearby steady head conditions in the supply tanks there establish a steady non-uniform flow in the conduct.

Step 5:- the discharge flowing in the conduit is recorded together with the water levels in each piezometer tubes.

Step 6:- The procedure is repeated for other value of discharge.

OBSERVATION TABLE:-

Area of collecting tank, cm =
Increase in depth of water, cm =
Time, sec =
Discharge, cm^3/sec =

Tube	Distance from inlet section(cm)	Area of c/s of conduit (cm^2)	Velocity flow V=Q/A	Pressure head m)	Datum head Z (cm)	Total head $-+\ ^2/2g+z$ *(cm)*	

<u>RESULT AND DISCOUSSIONS:-</u>

If V is the velocity of flow at a particular section of the duct and Q is the discharge then by continuity equation:

V= Q/area of section

1. Calculate velocity head and total head..
2. Plot piezometric head (P/ω+Z), velocity head ($V^2/2g$), and total head (P/ω + Z + $V^2/2$ g) Vs distance of piezometer tubes from same reference point.

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EXP

ERIMENT: - 9

META CENTRIC HEIGHT

TITLE: To determine Meta centric height of a floating body.

EXPERIMENTAL SET UP: The experimental set up consists of a pontoon which is allowed to float in a M.S tank having a transparent side. Removable steel strips are placed in the model for the purpose of changing the weight of model. By means of a pendulum (consisting of a weight suspended to a long pointer) the angle of tilt can be measured on a graduated arc. For tilting the ship model of a cross bar with two movable hangers is fixed on the model. Pendulum and graduated arc are suitably fixed at the centre of the cross bar.

SAFETY PRECAUTIONS:

- Apparatus should be in levelled condition.
- Reading must be taken in steady condition of water.
- Unbalanced mass should be disturbed by taking care that water should be distributed at minimum.

THEORY: When the pontoon has been tilted through an angle θ, the centre of gravity of a body G is usually remains unchanged in its position, but B i.e. centre of buoyancy will generally change its position, thus W_C and F_B forms a couple. The line of action F_B in the new position cuts the axis if the body at M, which called the Meta centric and the distance GM is called the Meta centric height. The Meta centric height is a measure of the static stability of the floating bodies.

The Meta centric height can be obtained by equating righting couple and applied moment

$$= \frac{.}{(\quad + \quad)}$$

Here W_c is the weight of the pontoon, W_m the weight of the unbalanced mass causing moment on the body, X_d is the distance of the unbalanced mass from the centre of cross bar.

EXPERIMENTAL PROCEDURE:

1. Note down the relevant dimension as area of collecting tank, mass density of water etc.
2. Note the water level in the tank when pontoon is not in the tank.

3. Pontoon is allowed to float in the tank, Note down the reading of water level in the tank. Mass of pontoon can be obtained by the help of Archmidie's principle.
4. Position of unbalanced mass, weight of unbalanced mass, the angle of heel can be note down. Calculate the Meta Centric Height of the pontoon.
5. The procedure is repeated for other position and valve of unbalanced mass. Also the procedure is repeated while changing the number of strips in the pontoon.

OBSERVATION AND COMPUTATION SHEET:

Area of tank A=

Water level (without pontoon) y_1 =

Unit weight of water w=

Reading on tank with pontoon y_2 (cm)	Mass of pontoon (gm) $W_c = (y_2 - y_1)A_w$	Unbalanced mass (gm) W_M	Angle of heel θ (degree)	Distance of unbalanced mass X_d (cm)	Meta centric height (cm) (+)	Average

EXPERIMENTAL NO .10
Impact of jet

OBJECTIVE:-

1 To verify the momentum equation experimentally

2. Comparison of change in force exerted due to shape of the vane for different targets.

PRECAUTION:-

1 Apparatus should be in leveled condition

2 Reading must be taken in steady condition

3 Discharge be varied very gradually form a higher to smaller value

EXPERIMENTAL SET UP:-

The experimental set up primarily consists of a nozzle through which a water jet immerges vertically in a such a way that it may be conveniently observed through the transparent cylinder .It strikes the target vane positioned above it .The force applied on the vane by jet can be measured by applying weight to counteract the reaction of the jet. Vanes are interchangeable i.e flat or curved

Arrangement is made for the movement of the plate under the action of the and also because of the weight placed on the loading pan. A scale is provided for carrying the vanes to its original position i.e as before the jet strikes the vanes .A collecting tank is used find the actual discharge and velocity through the nozzle.

THEORY:-

Momentum equation is based on Newton's 2^{nd} law of motion which states that the algebraic sum of external forces applied to control volume of fluid in any direction is equal to the rate of change of momentum in that direction . The external forces include the components of the weight of the fluid and of the forces exerted externally upon the boundary surface of the control volume.

If a vertical water jet moving with velocity v is made to strike a target which is free to move in the vertical direction then a force will be exerted on the target by the impact of jet According to momentum equation this force (which is also equal to the force required to bring the target in tits position) must be equal to the rate of change of momentum of the jet floe in the direction

Applying momentum equation in x direction

$-F_x = \rho Q\,[V_{x\,out} - V_{x\,in}]$

$= \rho Q\,[V\cos\beta - V]$

$F_x = \rho QV[1-\cos\beta]$

For the flat plate, $\beta = 90^0$

$F_x = \rho QV$

For hemispherical cup, $\beta = 180^0$

$F_x = 2\rho QV$

Here ℓ is the mass density ,Q is the discharge through the nozzle , V is the velocity at the exist of nozzle and a is the area of cross section of nozzle.

$F_X = \rho Q^2/a$

SUGGESTION EXPERIMENTAL WORKES;

step1; Note down the relevant dimension as area of collecting tank mass density of water and diameter of nozzle.

Step2: the flat plate is installed

Step3: when jet is not running note down the position of upper disc.

Step4: the water supply is admitted to the nozzle and the flow rate adjusted to its maximum value.

Step5: As the jet strikes the vane, position of upper disc is changed. Now place the weight to bring back the upper disc to its original position

Step6: At this position find out the discharge as well as note down the weight placed on the upper disc

Step7: The procedure is repeated for each value of flow rate by reducing the water supply in steps

Step8: The procedure is repeated with the installation of curved vane in the apparatus.

OBSERVATION TABLE:-

Diameter of the nozzle, mm=

Mass density of water

Area of collecting tank=

Area of nozzle, a=

HORIZONTAL FLAT VALUE

When jet is not running, position of upper disc=

Run	Discharge measurement				Balancing		Theoretical Force F $\rho Q^2/a$(dyne)	Error in %=
	Initial (cm)	Final (cm)	Time (sec)	Discharge (cm^3/sec)Q	Mass W (gm)	Force F (dyne)		

Curved vane

When jet is not running, Position of upper disc=

Run	Discharge measurement				Balancing		Theoretical Force F $2\rho Q/a$(dyne)	Error in %= F-F/F'
	Initial (cm)	Final (cm)	Time (sec)	Discharge (cm3/sec)Q	Mass W (gm)	Force F (dyne)		

RESULTS AND DISCOUSSIONS:

1 If V is the velocity of flow at a particular section of the duct and Q is the discharge then by continuity equitation:

2 Find the theoretical force and the error in between balancing and theoretical force

3 The main source of error in the experiment is in assessing the exit velocity component .Also hemispherical cup require more force to balance than the flat plate