

DEPARTMENT OF AEROSPACE ENGINEERING



ACS COLLEGE OF ENGINEERING

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FLUID MECHANICS Lab Manual

(21ASL33)

(Prescribed for III- Semester Aerospace Engineering)

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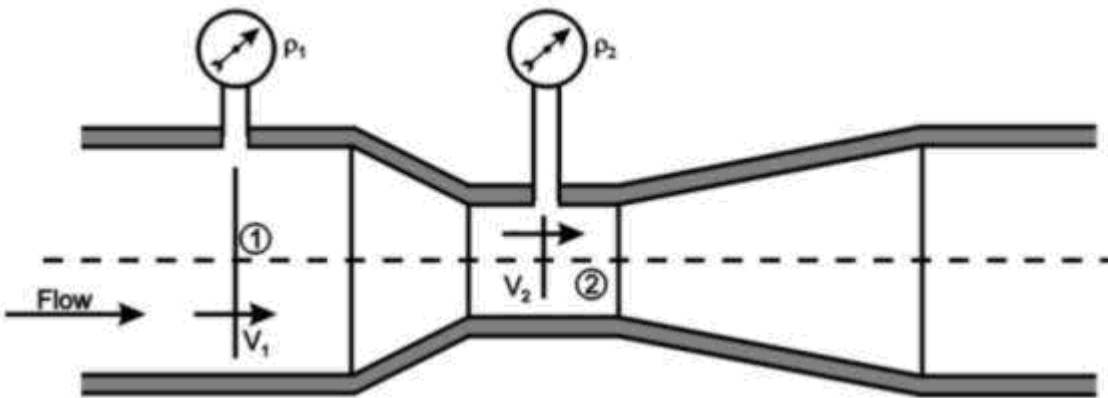
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EXPERIMENT :I

CALIBRATION OF VENTURIMETER

AIM: To calibrate the venturimeter

APPARATUS: Venturimeter experimental set up, stop watch.



THEORY: Venturimeter is a simple and reliable device used for measuring the rate of flow of a fluid flowing particularly in large sized pipe and is efficient in measuring large flow rates. It is based on the principle of Bernoulli's equation. It was invented by Clemens Hershel in 1887 and has been named in the honor of an Italian engineer Venturi. A Venturimeter consists of three parts. 1) A short converging cone 2) Throat and 3) Diverging cone.

The convergent cone is a short pipe, which tapers from the original size of the pipe to smaller section of the venturimeter known as the throat.

The convergent cone has a sharp angle of about 20° , while the divergent cone has a relatively flat angle of about 5° to 7° . This results in the convergent cone of the venturimeter being smaller than its diverging cone. The throat is a short parallel-sided pipe, which is the smallest section of the venturimeter. In order to avoid the phenomenon of cavitations to occur, the diameter of the throat section can be reduced only unto a certain limited value. In general the diameter of the throat section may vary from $1/3$ to $3/4$ of the pipe diameter and more commonly it is kept equal to $1/2$ of the pipe diameter. The diverging cone of the venturimeter is a gradually diverging pipe with cross-sectional area increasing from that of the throat section back to the original size of the pipe.

Coefficient of discharge is defined as the ratio of actual discharge to the theoretical discharge.

PROCEDURE:

1. Note down the diameter of the pipe, d_1 (i.e., the diameter of the venturimeter at the throat) to which the given venturimeter is connected, and also note down the diameter of the throat, d_2 .
2. Connect the pressure tapings to the U- tube manometer (if not connected) and expel any air entrapped in the system.
3. Open the control valve to get some discharge, note down the deflection in mercury level (x) in the U-tube manometer and also note down the time taken (T) for 'R' m rise of water level in the measuring tank.
4. Increase the discharge in steps by adjusting the flow control valve and note down the readings x & T .
5. Repeat the above procedure for pipes of different diameters (if you wish).

FORMULAE:

Theoretical discharge through a venturimeter is given by,

$$Q_t = a_1 a_2 \sqrt{2gh} / \sqrt{(a_1^2 - a_2^2)} = K \sqrt{h}$$

$$\text{Where } K = a_1 a_2 \sqrt{2g} / \sqrt{(a_1^2 - a_2^2)}$$

Where

a_1 = cross-sectional area of the pipe = $\pi d_1^2/4$ in m^2

a_2 = cross-sectional area of throat = $\pi d_2^2/4$ in m^2

d_1 = diameter of the pipe (diameter of the venturimeter at the mouth) in 25m

d_2 = diameter of the throat in 16 m

h = difference of pressure head (equivalent head of water in U-tube manometer)
= 12.6x in m

x = deflection in mercury level in manometer in m

Actual discharge $Q_a = AR/T$ m³/s

A = cross-sectional area of the measuring tank in m^2

R = rise of water level in m

T = time taken for R m rise in water level in s

CALCULATIONS:

OBSERVATIONS:

1. Pipediameter, $d_1=25\text{mm}$

Fluid Mechanics Lab

2. Throat diameter, $d_2 = 16\text{mm}$
3. Measuring tank length, $L = 60\text{cm}$
4. Measuring tank breadth, $B = 30\text{cm}$
5. Density of water, $\rho_w = 1000\text{kg/m}^3$
6. Density of mercury, $\rho_m = 13600\text{kg/m}^3$
7. Rise of water level in the measuring tank $H = 10\text{cm}$ (may be varied)

TABULAR COLUMN:

S no	X m of Hg			h m of H ₂ O	T in S	Q _a m ³ /s	Q _a m ³ /s	C _d = Q _a /Q _t
	LHS	RHS	DIFF					

GRAPHS:

Draw the following graph;

$$\sqrt{h} \text{ v/s } Q_a$$

RESULT:

Experiment : 02

Title : FLOW THROUGH ORIFICE METER APPARATUS

AIM: To determine the coefficient of discharge for a given Orifice.

EXPERIMENTSETUP:

It is a closed circuit system. It has collecting and sump tanks with pump unit. The Orifice meter is introduced in a pipe line and is provided with differential manometer for measurement of pressure across orifice.

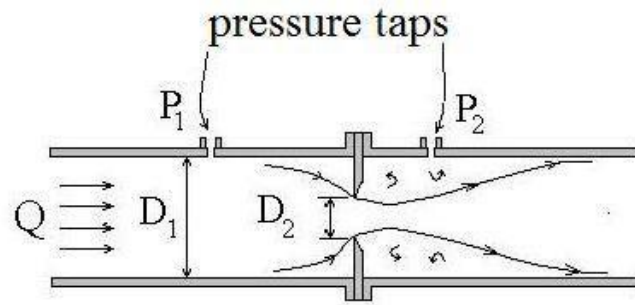
THEORY:

An Orifice meter or orifice plate is a simple and reliable device used for measuring the rate of flow of a fluid flowing particularly in large sized pipe and is efficient in measuring large flow rates. It is based on the principle of Bernoulli's equation. It works on the same principle as Venturimeter it consists of a flat circular plate which has a circular shaped hole called orifice. It is an opening in the side or bottom of a vessel or a tank through which liquid will flow under the condition that the liquid surface is always above the top edge of the opening. The orifice diameter is 0.5 times the diameter of pipe. A differential manometer is connected at inlet pipe which is at a distance of about 1.5 to 2 times the pipe diameter upstream from the orifice plate and at outlet which is at a distance of about half the diameter of the orifice on the downstream side from orifice plate.

Coefficient of discharge is defined as the ratio of actual discharge to the theoretical discharge.

PROCEDURE:

1. Note down the diameter of the pipe, d_1 (i.e., the diameter of the pipe) to which the given Orifice meter is connected, and also note down the diameter of the orifice plate, d_2 .
2. Connect the pressure tapings to the U-tube manometer (if not connected) and expel any air entrapped in the system.
3. Open the control valve to get some discharge, note down the deflection in mercury level (x) in the U-tube manometer and also note down the time taken (T) for 'R' m rise of water level in the measuring tank.
4. Increase the discharge in steps by adjusting the flow control valve and note down the readings x & T .
5. Repeat the above procedure for pipes of different diameters (if you wish ☐)



Orifice Meter Parameters

OBSERVATION:

❖ Cross-sectional area of the measuring tank = 0.64 m^2

1. Orifice diameter, $d = 20 \text{ mm}$
2. Measuring tank length, $L = 60 \text{ cm}$
3. Measuring tank breadth, $B = 30 \text{ cm}$
4. Density of water, $\rho = 1000 \text{ kg/m}^3$
5. Density of mercury, $\rho = 13600 \text{ kg/m}^3$
6. Rise of water level in the measuring tank $H_w = 10 \text{ cm}$ (may be varied)

TABULAR COLUMN:

S no	X m of Hg			h m of H₂O	T in S	Q_a m³/s	Q_a m³/s	C_d= Q_a/Q_t
	LHS	RHS	DIFF					

GRAPHS:

Draw the following graph;

$$\sqrt{h} \text{ v/s } Q_a$$

RESULT

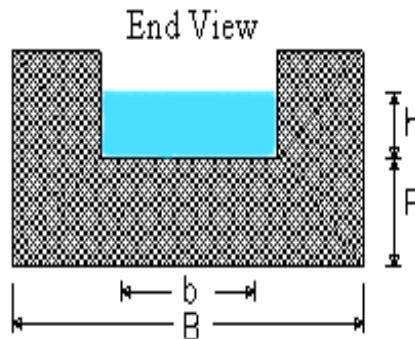
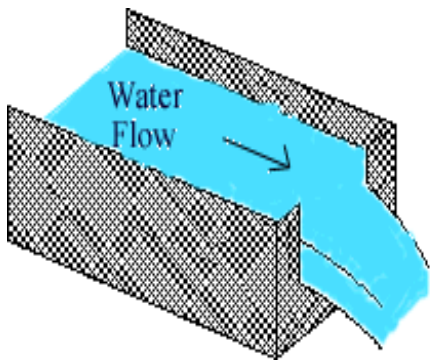
Experiment : 03

CALIBRATION OF RECTANGULAR NOTCH

AIM: To Calibrate the rectangular notch.

APPARATUS:

Rectangular and triangular notches' experimental setup, stop watch.



THEORY:

A notch is a device used for measuring the rate of flow of a liquid through a small channel or a tank. It may be defined as a small structural opening (generally metallic) with sharp edge. The intention of providing a sharp edge is to minimize the friction. A notch is provided in the side of a tank or a small channel in such a way that the liquid surface in the tank or channel is below the top edge of the opening.

The notches are classified as;

1. According to the shape
 - a) Rectangular notch b) Triangular notch c) Trapezoidal notch d) stepped notch etc.,
2. According to the effect of the sides on the nappe
 - a) Notch with end contraction b) Notch without end contraction or suppressed notch

Note: Nappe- The sheet of water flowing through a notch is called Nappe or Vein.

Crest- the bottom edge of a notch, over which water flows, is known as Crest or Sill.

PROCEDURE:

1. Note down the initial reading on the hook gage which is the level of water in the channel at the sill.
2. Allow some water to flow through the channel and wait till flow becomes steady and take final reading on the hook gage. Initial reading minus final reading of the hook gage gives head over the sill
- Note down time taken for 'R'
3. Repeat steps 2&3 for different discharge of water.

FORMULA:

Actual discharge $Q_a = AR/T \text{ m}^3/\text{s}$

Theoretical discharge $Q_t = \frac{2}{3} \times L \times (\sqrt{2g}) \times H^{3/4} \text{ m}^3/\text{s}$ (for rectangular notch)

Where

L = length of the rectangular notch in m

H = head of water over the crest in m

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

$C_d = \text{Actual discharge} / \text{Theoretical discharge} = Q_a / Q_t$

OBSERVATIONS:

- ❖ Area of the measuring tank = 0.64 m^2
- ❖ Length of the rectangular notch = 0.20 m
- ❖ [Rise of water level in the measuring tank =m]

TABULAR COLUMN:

Sl.No	H in m (I.R-F.R)	T in seconds	Actual discharge $Q_a \text{ m}^3/\text{s}$	Theoretical discharge $Q_t \text{ m}^3/\text{s}$	$C_d = Q_a/Q_t$	$\ln(H)$	$\ln(Q_a)$
1							
2							
3							
4							
5							
6							

RESULT:

EXPERIMENT NO:04

VERIFICATION OF BERNOULLI'S EQUATION

AIM:- To verify the Bernoulli's theorem.

APPARATUS USED:- A supply tank of water, a tapered inclined pipe fitted with no. of piezo meter tubes point, measuring tank, scale, stop watch.

THEORY:- Bernoulli's theorem states that when there is a continuous connection between the particle of flowing mass liquid, the total energy of any sector of flow will remain same provided there is no reduction or addition at any point.

FORMULA USED:

$$H_1 = Z_1 + P_1/w + V_1^2/2g$$

$$H_2 = Z_2 + P_2/w + V_2^2/2g$$

PROCEDURE:-

1. Open the inlet valve slowly and allow the water to flow from the supply tank.
2. Now adjust the flow to get a constant head in the supply tank to make flow in and out flow equal.
3. Under this condition the pressure head will become constant in the piezometer tubes.
4. Note down the quantity of water collected in the measuring tank for a given interval of time.
5. Compute the area of cross-section under the piezometer tube.
6. Compute the area of cross-section under the tube.
7. Change the inlet and outlet supply and note the reading.
8. Take at least three readings as described in the above steps.

	1	2	3	4	5	6	7	8	9	10
Reading of piezo metric tubes										
Area of cross section under the foot of each point										
Velocity of water under foot of each point										
$V^2/2g$										
p/ρ										
$V^2/2g + p/\rho$										

RESULT:

EXPERIMENT NO: 05

DETERMINATION OF COEFFICIENT OF LOSS OF HEAD IN SUDDEN CONTRACTION AND FRICTION FACTOR

AIM: To determine the coefficient of loss of head in sudden contraction and friction factor in a given pipe.

APPARATUS: Major and minor losses experimental setup, stop watch etc.

THEORY: The loss of head or energy due to friction in a pipe is known as major loss, while the loss of head or energy due to change of velocity of flowing fluid in magnitude or direction is called minor loss. The minor loss of energy or head includes the following cases.

1. Loss of head due to sudden enlargement.
2. Loss of head due to sudden contraction.
3. Loss of head at the entrance to a pipe.
4. Loss of head at the exit of a pipe.
5. Loss of head due to bend in the pipe.
6. Loss of head due to an obstruction in a pipe.
7. Losses of head in various pipe fittings.

In case of long pipe the above losses are small as compared with the loss of head due to friction and hence they are called minor losses and even may be neglected without serious error. But in case of short pipe, these losses are comparable with the loss of head due to friction.

PROCEDURE:

1. Note down the diameter of the test pipe.
2. Check whether the levels of mercury in both left-hand limb and right-hand limb of the U-tube manometer are same. If not make them at same level.
3. Connect the manometer limbs to pressure tapings at the bend, for the long pipe section, at sudden expansion and at sudden contraction.
4. Open the cocks of the tapings for the required portion and all other connections of the manometer stand must be closed.
5. Open the corresponding control valve of the test pipe and allow some water to flow through it.
6. Note down the deflection of mercury in the manometer and also note down time taken for 'R' meter rise of water level in the measuring tank.
7. Repeat steps 5 & 6 for different discharge of water.
8. Repeat steps 4, 5 & 6 for different portions of the pipe.

FORMULA:

$$\text{Actual discharge } Q_a = AR/T \text{ m}^3/\text{s}$$

Where A = area of the measuring tank in m^2

R = rise of water level in the measuring tank

T = time taken for 'R' in seconds.

$$\text{Actual velocity } V_a = Q_a/a \text{ in m/s}$$

Where a = cross-sectional area of the pipe at the entry.

a) Loss of energy due to sudden contraction

$$h_L = 0.375 \frac{V^2}{2g}$$

b) Loss of energy due to friction

a) Darcy-Weisbach Formula $h_f = \frac{4fLV^2}{2gd}$

Where,

h_f = loss of head due to friction
 f = co-efficient of friction which is a function of Reynolds number.

$$= \frac{16}{R_e} \text{ for } R_e < 2000$$

$$= \frac{0.079}{R_e^{1/4}} \text{ for } R_e \text{ varying from } 4000 \text{ to } 10^6$$

L = length of pipe

V = mean velocity of flow

d = diameter of pipe.

b) Chezy's formula $V = C\sqrt{mi}$

Where,

C = Chezy's Constant

m for pipe is always equal to $\frac{d}{4}$

i = loss of head due to friction/unit length of pipe.

OBSERVATIONS:

❖ Diameter of the test pipe =----- m;

❖ Area of the measuring tank =----- m²;

❖ Rise of water level in the measuring tank =-----m

❖ Time taken for 'R' = ----- sec

TABULAR COLUMN:

Type	Difference in Mercury level	Discharge Q (m ³ /s)	Velocity V (m/s)	Loss of head in m
Sudden contraction.				
Friction (flow in long pipes)				

RESULT:

Experiment NO: 6

FRICTION FACTOR IN PIPE

AIM: To determine the loss of head of water flowing in a pipe due to friction.

APPARATUS: A number of horizontal pipes of different diameters connected at two sections (a known as Distance apart), to the limbs of a V-tube Hg manometer, a valve fitted with each pipe to Regulate the flow, a measuring tank fitted with a piezometer tube and a graduated scale.

THEORY

The head lost due to friction is given by the Darcy-Weibach equation.

$$h_f = (4 f L V^2) / (2 g d)$$

or

$$f = (h_f g d) / (2 L V^2)$$

Where

f = friction factor

L = length of pipe section (connected to U-tube manometer),

V = velocity of flow in pipe, m/s

d = inside diameter of pipe,

g = acceleration due to gravity, m/

PROCEDURE:

After noting carefully the diameter of pipe and the length between the section attached to the limbs of U-tube manometer, the valve is opened to allow water to flow in that pipe only. Vent the manometer. Note down the manometer readings. Record the rise in water level in the measuring tank for a known interval of time ($t = 60\text{s}$) and the discharge is determined. Velocity of flow in the pipe is calculated using the discharge and cross sectional area of pipe.

Thus the head lost due to friction can be calculated using the above formula. The above procedure is repeated for different velocities of flow and different diameter of the Horizontal pipes

OBSERVATIONS

1. Length of measuring tank, $l = \text{-----m}$
2. Breadth of measuring tank, $b = \text{----- m}$
3. Area of the measuring tank, $A = \text{-----m}^2$
4. Inside diameter of pipe, $d = \text{----- m}$
5. Inside area of the pipe (cross section), $a = (\pi \times d^2/4) = \text{----- m}^2$
6. Length between sections connected to U-tube manometer, $L = \text{----- m}$
7. Time Taken for collecting water, $t = \text{-----sec.}$

TABULAR COLUMN

[illegible]

SPECIMEN CALCULATIONS:

(1) Head loss due to friction (h_f)

Monometer reading in left limb, h_1 =----m

Monometer reading in right limb, h_2 =----m

Difference, $h = h_2 + h_1$ =----m

$h_f = (12.6 \times h)$ =-----m of water

(2) Discharge (Q)

Time duration of water collection in the measuring

tank, t = seconds

Initial water level = IR =----m

Final water level = FR =----m

Difference of water levels, $H = FR - IR$ = --m

$Q = (l \times b \times H/t)$ = ----- m^3/s

3) Velocity of flow, (V)

$V = Q/a$ = ----- m/s

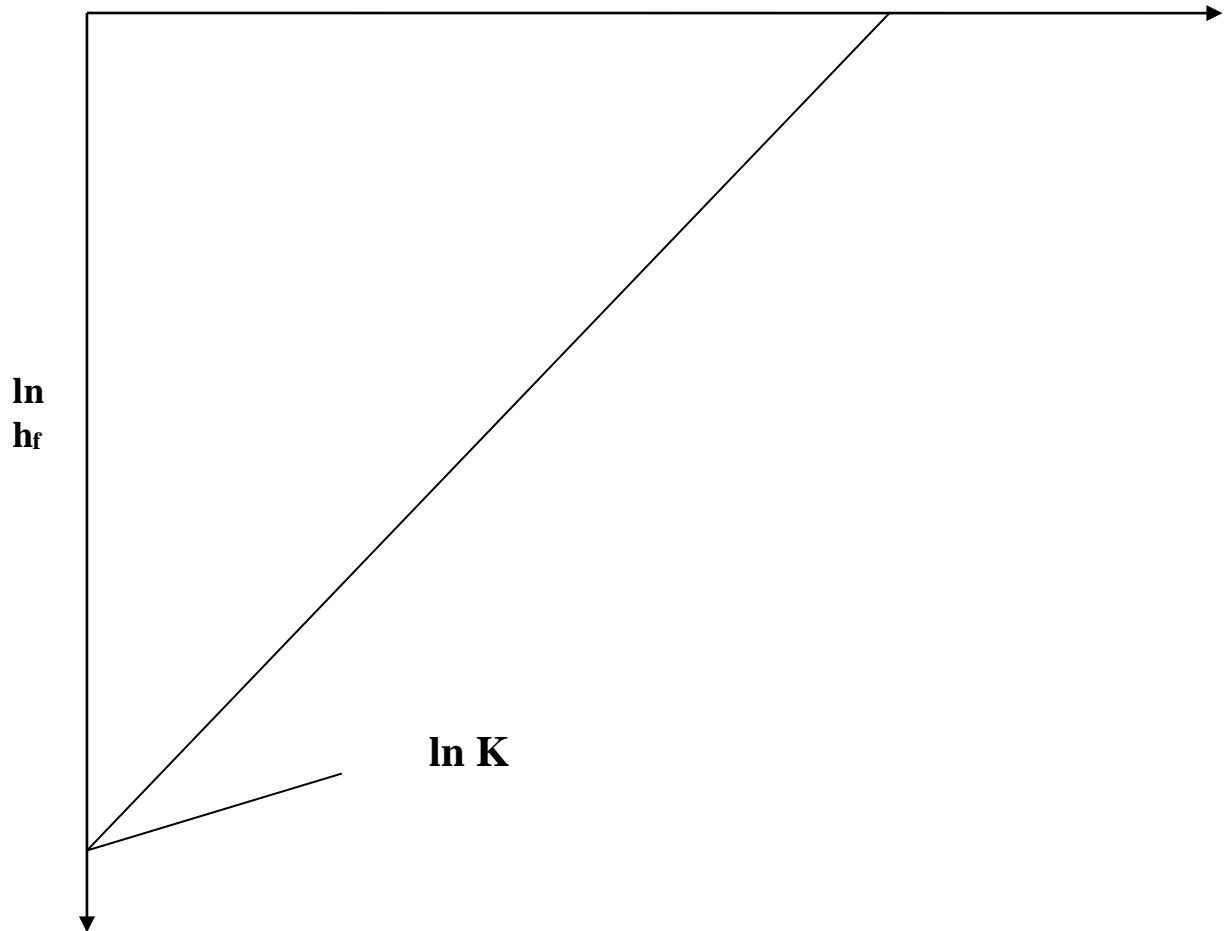
4) Theoretical friction factor, (f_{the})

$f_{the} = (h_f \times g \times d)/(2 L V^2)$

5) Actual friction factor, (f_{actual})

$f_{graph} = (2 \times g \times d \times K) / 4 L$

Nature of graph



RESULT:

1. Theoretical friction factor, $f_{\text{the}} = \text{-----}$
2. Actual friction factor, $f_{\text{actual}} = \text{-----}$

The coefficient of friction $K = \text{--}$

Experiment NO. 7

MINOR LOSSES IN PIPES

AIM

To find the loss of head due to sudden contraction, expansion, elbow and bend during flow through a pipe.

APPARATUS

An arrangement for uniform supply of water, pipe fittings consisting of sudden enlargement, sudden contraction, elbow and bend, measuring tank with a piezometer and a scale, manometer.

THEORY

(a) Loss of head due to sudden enlargement is given by

$$h_e = \frac{K_e \times (V_1 - V_2)^2}{2g}$$

where

V_1 = Velocity at inlet.

V_2 = Velocity at outlet.

K_e = Coefficient of enlargement.

g = Acceleration due to gravity.

(b) Loss of head due to sudden contraction is given by

$$h_c = \frac{0.5 \times K_c \times (V_2^2)}{2g}$$

Where K_c = coefficient of contraction
 V_2 = velocity of exit.

(c) Loss of head due to elbow is given by

$$h_{el} = \frac{K_{el} \times V^2}{2g}$$

where

V = velocity of flow

K_{el} = coefficient of elbow

(d) Loss of head due to bend is given by

$$h_b = \frac{K_b \times V^2}{2g}$$

where

V = velocity of flow.

K_b = coefficient of bend

PROCEDURE:

Uniform water flow through a pipe fitting is made. The outlet through the pipe fitting is collected in a measuring tank. The amount of water collected during a definite period of time ($t = 60$ s) is noted. Manometer readings in the two limbs connected on either side of the pipe fitting is noted. Calculate the velocity of flow and head loss due to various fittings, calculate the different coefficients of various fittings. The above procedure is repeated for different flow rates and for different diameters of the pipe for different pipe fittings.

[illegible]

(a) SPECIMEN CALCULATIONS FOR SUDDEN ENLARGEMENT

1. Manometer head (h_f) in m of water

$$h_{fe} = (12.6) \times h = \dots\dots\dots \text{ m}$$

$$h = h_1 + h_2$$

Where

2. Discharge, $Q = l \times b \times H / 60 = \dots\dots\dots \text{ m}^3/\text{s}$

3. Velocity at inlet of sudden enlargement pipe =

$$V_1 = Q / a_1 = \dots\dots\dots \text{ m/s}$$

4. Velocity at exit of sudden enlargement pipe =

$$V_2 = Q / a_2 = \dots\dots\dots \text{ m/s}$$

5. Coefficient of enlargement(K_e)

$$K_e = \frac{h_{fe} 2 g}{(V_1 - V_2)^2}$$



OBSERVATION SUDDEN CONTRACTION :

Length of the measuring tank, L = mm

Breadth of the tank, B = mm

Pipe diameter, $d_1 = \dots\dots\dots$ mm,

Pipe diameter, $d_2 = \dots\dots\dots$ mm,

area, $a_1 = \dots \text{m}^2$

area, $a_2 = \dots \text{m}^2$

TABULAR COLUMN FOR SUDDEN CONTRACTION

[illegible]

(b) SPECIMAN CALCULATIONS FOR SUDDEN CONTRACTION

1.Manometer head (h_f) in m of water

$$h_{fc} = (12.6) \times h = \dots\dots\dots \text{ m}$$

Where $h = h_1 + h_2$
e

2.Discharge, $Q = l \times b \times H / 60 = \dots\dots\dots \text{m}^3/\text{s}$

3.Velocity of flow, $V = Q / a_2 = \dots\dots\dots \text{m/s}$

4.Coefficient of contraction(K_c)

$$K_c = \frac{2g h_{fc}}{0.5 (V_2^2)} -$$



Observation for an Bend :

Length of the measuring tank, L =mm

Breadth of the tank, B = mm

Bend diameter, d =.....mm,

Area of the bend a =m²

TABULAR COLUMN FOR SUDDEN BEND

[illegible]

(a) SPECIMAN CALCULATIONS FOR AN BEND

1. Manometer head (h_{be}) in m of water

$$h_{fb} = (12.6) \times h = \dots\dots\dots m$$

Where

$$h = h_1 + h_2$$

2. Discharge, $Q = l \times b \times H / 60 = \dots\dots\dots m^3/s$

3. Velocity of flow, $V = Q / a = \dots\dots\dots m/s$

4. Coefficient of bend (K_b)

$$K_b = \frac{h_{fb} \times 2 \times g}{V^2}$$



n

n

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[illegible]

SPECIMEN CALCULATIONS FOR AN BEND

1. Manometer head (h_{fe1}) in m of water

$$h_{fe1} = (12.6) \times h = \dots\dots\dots m$$

Where

$$h = h_1 + h_2$$

2. Discharge, $Q = l \times b \times H / 60 = \dots\dots\dots m^3/s$

3. Velocity of flow, $V = Q / a = \dots\dots\dots m/s$

4. Coefficient of elbow (K_{el})

$$K_{el} = \frac{h_{fe1} \times 2 \times g}{V^2}$$

RESULTS:

- | | | |
|-------------------------------|---|---------------------|
| 1. Coefficient of Contraction | = | $K_c =$ |
| 2. Coefficient of enlargement | = | $K_e =$ |
| 3. Coefficient of elbow | = | $K_{el} =$
..... |
| 4. Coefficient of bend | = | $K_b =$
..... |

Answer the following:

1. What do you mean by major energy loss?
 2. List down the type of minor energy losses.
 3. What is compound pipe?
 4. What do you mean by equivalent pipe
 5. Derive Darcy -weisback's equation.
-

Experiment No: 8

Impact of jets

AIM:

To determine the coefficient of impact of jet on

- Flat,
- Inclined
- Hemispherical vanes

APPARATUS:

Nozzle, different types of vanes, a stop watch, dead weights, a measuring tank and a lever arm with a hanger.

THEORY:

The impact of jet vanes has a wide range of applications in rotodynamic machines. Theoretical impact force on different vanes is

a) For a flat vane:

$$F_{th} = \rho a V^2 \dots\dots\dots N$$

b) For an inclined vane

(at an angle θ to the direction of flow of jet)

$$F_{th} = \rho a V^2 \sin^2 \theta \dots\dots\dots N$$

c) For a symmetrical conical vane

$$F_{th} = \rho a V^2 (1 + \cos \theta)$$

Where ρ = density of water

a = area of jet (nozzle) in

m^2 V = jet velocity in m/s

d) For a hemispherical vane

$$\begin{aligned} F_{th} &= \rho a V^2 (\cos \alpha + \cos \beta) \\ &= 2\rho a V^2 \end{aligned}$$

PROCEDURE:

The nozzle is fixed in position. The vane under test is fixed above the nozzle. The weight is adjusted such that the arm is in horizontal position, when there is no load on the hanger. Find the lever ratio by measuring the distance between the hanger and fulcrum (L1) and distance between the vane support and the fulcrum (L2). Weight of about (50 to 100 grams) is put on the hanger and the control valve is opened. Flow rate is adjusted such that the impact of jet makes the lever horizontal.

Calculate the actual force on the vane due to jet by multiplying the weight placed on the hanger and the lever ratio.

The discharge water is collected for 60 seconds time duration.

Calculate the actual and theoretical force of impact in the direction of jet.

Then calculate the coefficient of impact.

Repeat the experiment for different weights and different types of vanes.

OBSERVATIONS:

Length of measuring tank,	l	=_____m
Breadth of measuring tank,	b	=_____m
Area of measuring tank,	A	=_____m ²
Diameter of nozzle,	d	=_____m
Area of the jet,	$a = \pi d^2/4$	_____

Length from hanger to fulcrum, L_1 =__m
Length from vane support to fulcrum, L_2 =__m
Lever arm ratio, $L_1/L_2 = 2$
Weight used in experiments, $W=50\text{gm}$ and $W=75\text{gm}$

TABULAR COLUMN

[illegible]

SPECIMEN CALCULATIONS:

1. Actual force(F_{act})

$$F_{act} = W_1 (L_1/L_2) = \text{_____} \text{N}$$

where W_1 = weight in N

2. Discharge(Q)

$$Q = A h/60 = \text{_____} \text{m}^3/\text{s}$$

3. Velocity of jet(V)

$$V = Q/a = \text{_____} \text{m/s}$$

4. Theoretical force(F_{theory})For flat vane

$$F_{th} = \rho a V^2 \text{N}$$

For inclined vane

$$F_{th} = \rho a V^2 \sin^2 \theta \text{N}$$

For symmetrical conical vane

$$F_{th} = \rho a V^2 (1 + \cos \theta)$$

Where ρ = density of water

a = area of jet (nozzle) in m^2

V = jet velocity in m/s

For hemispherical vane

$$\begin{aligned} F_{th} &= \rho a V^2 (\cos \alpha + \cos \beta) \\ &= 2\rho a V^2 \end{aligned}$$

7. Coefficient of impact = F_{act}/F_{th} = _____

RESULT:

Coefficient of impact of jet on

- | | |
|-----------------------|---------|
| 1. Flat vane | = _____ |
| 2. Inclined vane(30°) | = _____ |
| 4. Hemispherical vane | = _____ |
| 5. Conical vane | = _____ |

Work for practice

