

EXPERIMENT No.1

FLOW MEASUREMENT BY ORIFICEMETER

1.1 AIM: To determine the co-efficient of discharge of the orifice meter

1.2 EQUIPMENTS REQUIRED: Orifice meter test rig, Stopwatch

1.3 PREPARATION

1.3.1 THEORY

An orifice plate is a device used for measuring the volumetric flow rate. It uses the same principle as a Venturi nozzle, namely Bernoulli's principle which states that there is a relationship between the pressure of the fluid and the velocity of the fluid. When the velocity increases, the pressure decreases and vice versa. An orifice plate is a thin plate with a hole in the middle. It is usually placed in a pipe in which fluid flows. When the fluid reaches the orifice plate, with the hole in the middle, the fluid is forced to converge to go through the small hole; the point of maximum convergence actually occurs shortly downstream of the physical orifice, at the so-called *vena contracta* point. As it does so, the velocity and the pressure changes. Beyond the *vena contracta*, the fluid expands and the velocity and pressure change once again. By measuring the difference in fluid pressure between the normal pipe section and at the *vena contracta*, the volumetric and mass flow rates can be obtained from Bernoulli's equation. Orifice plates are most commonly used for continuous measurement of fluid flow in pipes. This experiment is process of calibration of the given orifice meter.

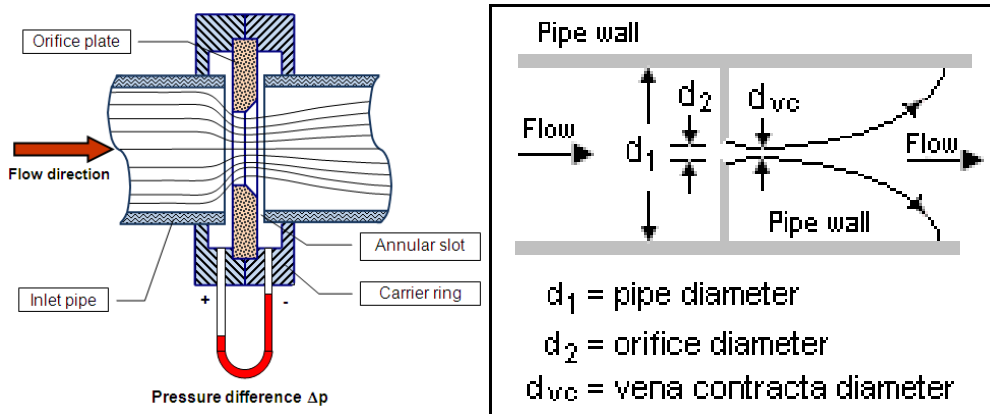


Fig.1. Orifice Plate

1.3.2 PRE-LAB QUESTIONS

1.3.2.1 Write continuity equation for incompressible flow?

1.3.2.2 What is meant by flow rate?

1.3.2.3 What is the use of orifice meter?

1.3.2.4 What is the energy equation used in orifice meter?

1.3.2.5 List out the various energy involved in pipe flow.

1.4 PROCEDURE

N.B.: Keep the delivery valve open while start and stop of the pump power supply.

- 1.4.1 Switch on the power supply to the pump
- 1.4.2 Adjust the delivery flow control valve and note down manometer heads (h_1 , h_2) and time taken for collecting 10 cm rise of water in collecting tank (t). (i.e. Initially the delivery side flow control valve to be kept fully open and then gradually closing.)
- 1.4.3 Repeat it for different flow rates.
- 1.4.4. Switch off the pump after completely opening the delivery valve.

1.5 OBSERVATIONS

1.5.1 FORMULAE / CALCULATIONS

1.5.1.1 The actual rate of flow, $Q_a = A \times h / t$ (m^3/sec)

Where A = Area of the collecting tank = length \times breadth (m^2)

h = Height of water(10 cm) in collecting tank (m),

t = Time taken for 10 cm rise of water (sec)

1.5.1.2 The Theoretical discharge through orifice meter,

$$Q_t = (a_1 a_2 \sqrt{2g H}) / \sqrt{(a_1^2 - a_2^2)} \quad \text{m}^3/\text{sec}$$

Where, H = Differential head of manometer in m of water

$$= 12.6 \times h_m \times 10^{-2} \text{ (m)}$$

g = Acceleration due to gravity ($9.81\text{m}/\text{sec}^2$)

Inlet Area of orifice meter in m^2 , $a_1 = \pi d_1^2 / 4$,

Area of the throat or orifice in m^2 , $a_2 = \pi d_2^2 / 4$

1.5.1.3 The co-efficient of discharge,

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

1.5.2 TABULATION

Size of Orifice meter :

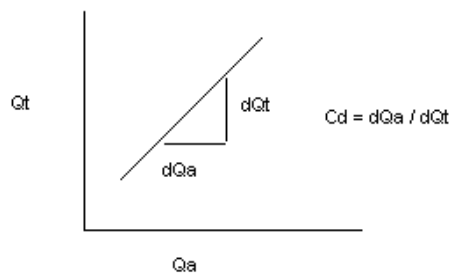
Inlet Dia. $d_1 = 25 \text{ mm}$,

Orifice dia $d_2 = 18.77 \text{ mm}$,

Measuring area in collecting tank $A = 0.3 \times 0.3 \text{ m}^2$

Sl. No.	Manometer Reading (cm)			Manometer Head H	Time for 10 cm rise t	Actual Discharge Q_a	Theoretical Discharge Q_t	Co-eff. of discharge C_d
	h_1	h_2	$h_m = h_1 - h_2$	m	sec	m^3/sec	m^3/sec	
1.								
2.								
3.								
4.								
5.								
6.								
Average C_d value								

1.5.3 GRAPH:



Draw Q_a Vs Q_t .

Find C_d value from the graph and compare it with calculated C_d value from table.

1.6 POST-LAB QUESTIONS

- 1.6.1 How do you find actual discharge?
- 1.6.2 How do you find theoretical discharge?
- 1.6.3 What do you meant by co-efficient of discharge?
- 1.6.4 Define vena-contracta?
- 1.6.5 List out the Bernoulli's applications.

1.7 INFERENCES

1.8 RESULT

The co-efficient of discharge of orifice meter = From Calculation

The co-efficient of discharge of orifice meter = From Graph

EXPERIMENT No.2

FLOW MEASUREMENT BY VENTURIMETER

2.1 **AIM:** To determine the co-efficient of discharge of the venturimeter

2.2 **EQUIPMENTS REQUIRED:** Venturimeter test rig, Stopwatch

2.3 **PREPARATION**

2.3.1 **THEORY**

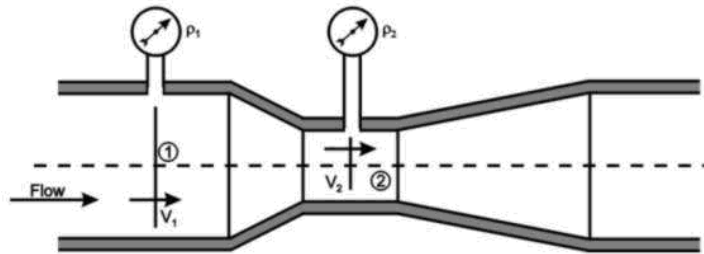


Fig.2. Venturimeter

In a Venturi meter there is first a converging section in which the cross sectional area for flow is reduced. Then there is a short section at the reduced diameter, known as the throat of the meter. Then there is a diverging section in which the cross sectional area for flow is gradually increased to the original diameter. The velocity entering the converging section is where the pressure is P_1 . In the converging section the velocity increases and the pressure decreases. The maximum velocity is at the throat of the meter where the minimum pressure P_2 is reached. The velocity decreases and the pressure increases in the diverging section. There is a considerable recovery of pressure in the diverging section. However, because of frictional effects in the fluid, the pressure leaving the diverging section is always less than P_1 , the pressure entering the meter.

2.3.2 **PRE-LAB QUESTIONS**

2.3.2.1 Differentiate mass and volume flow rate?

2.3.2.2 Which property is remains same in the incompressible flow?

2.3.2.3 What is meant by discharge?

2.3.2.4 What is the use of venturimeter?

2.4 **PROCEDURE:**

N.B.: Keep the delivery valve open while start and stop of the pump power supply.

2.4.1. Switch on the power supply to the pump

2.4.2. Adjust the delivery flow control valve and note down manometer heads (h_1 , h_2) and time taken for collecting 10 cm rise of water in collecting tank (t). (i.e. Initially the delivery side flow control valve to be kept fully open and then gradually closing.)

2.4.3. Repeat it for different flow rates.

2.4.4. Switch off the pump after completely opening the delivery valve.

2.5 OBSERVATIONS

2.5.1 FORMULAE / CALCULATIONS

2.5.1.1 The actual rate of flow, $Q_a = A \times h / t$ (m^3/sec)

Where A = Area of the collecting tank = length x breadth (m^2)

h = Height of water (10 cm) in collecting tank (m),

t = Time taken for 10 cm rise of water (sec)

2.5.1.2 The Theoretical discharge through venturimeter,

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

Where, H = Differential head of manometer in m of water

$$= 12.6 \times h_m \times 10^{-2} \text{ (m)}$$

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

Inlet Area of venturimeter in m^2 , $a_1 = \pi d_1^2 / 4$,

Area of the throat in m^2 , $a_2 = \pi d_2^2 / 4$

2.5.1.3 The co-efficient of discharge,

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

2.5.2 TABULATION:

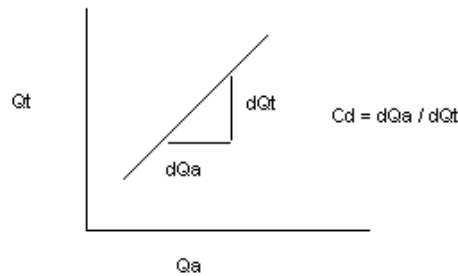
Inlet Dia. of Venturimeter (or) Dia of Pipe $d_1 = 25 \text{ mm}$

Throat diameter of Venturimeter $d_2 = 18.79 \text{ mm}$

Area of collecting tank, $A = \text{Length} \times \text{Breadth} = 0.3 \times 0.3 m^2$

Sl. No.	Manometer Reading (cm)			Mano-meter Head H	Time for 10 cm rise t	Actual Discharge Q_a	Theoretical Discharge Q_t	Co-eff. of discharge C_d
	h_1	h_2	$h_m = h_1 - h_2$	m	sec	m^3/sec	m^3/sec	
1.								
2.								
3.								
4.								
5.								
Average C_d value								

2.5.3 GRAPH:



Draw Q_a Vs Q_t .

Find C_d value from the graph and compare it with calculated C_d value from table.

2.6 POST-LAB QUESTIONS

- 2.6.1 How do you find actual and theoretical discharge?
- 2.6.2 What do you mean by throat of the venturimeter?
- 2.6.3 List out the practical applications of Bernoulli's equation?
- 2.6.4 What is the use of U-tube manometer?

2.7 INFERENCES

2.8 RESULT

The co-efficient of discharge of Venturi meter = From Calculation

The co-efficient of discharge of Venturi meter = From Graph

EXPERIMENT No.3

VERIFICATION OF BERNOULLIS THEOREM

3.1 AIM: To verify the Bernoulli's theorem

3.2 EQUIPMENTS REQUIRED: Bernoulli's Theorem test set-up, Stopwatch

3.3 PREPARATION

3.3.1 THEORY

Bernoulli's Theorem

According to Bernoulli's Theorem, in a continuous fluid flow, the total head at any point along the flow is the same. $Z_1 + P_1/\rho g + V_1^2/2g = Z_2 + P_2/\rho g + V_2^2/2g$, Since $Z_1 - Z_2 = 0$ for Horizontal flow, $h_1 + V_1^2/2g = h_2 + V_2^2/2g$ (Pr. head, $h = P_1/\rho g$). Z is ignored for adding in both sides of the equations due to same datum for all the positions.

3.3.2 PRE-LAB QUESTIONS

3.3.2.1 State Bernoulli's theorem?

3.3.2.2 What is continuity equation?

3.3.2.3 What do you mean by potential head?

3.3.2.4 What do you mean by pressure head?

3.3.2.5 What do you mean by kinetic head?

3.4 PROCEDURE

N.B.: Keep the delivery valve open while start and stop of the pump power supply.

3.4.1 Switch on the pump power supply.

3.4.2 Fix a steady flow rate by operating the appropriate delivery valve and drain valve

3.4.3. Note down the pressure heads ($h_1 - h_8$) in meters

3.4.4. Note down the time taken for 10 cm rise of water in measuring (collecting) tank.

3.4.5. Switch off the power supply.

3.5 OBSERVATIONS

3.5.1 FORMULAE / CALCULATIONS

3.5.1.1 Rate of flow $Q = Ah / t$.

Where

A: Area of measuring tank = Length x Breadth (m^2)

h: Rise of water in collecting tank (m) .. (i.e. $h = 10$ cm)

t: Time taken for 10 cm rise of water in collecting tank (sec)

3.5.1.2 Velocity of flow, $V = Q/a$,

Where a – Cross section area of the duct at respective peizometer positions ($a_1 - a_8$)

3.5.1.3 Hydraulic Gradient Line (HGL): It is the sum of datum and pressure at any point

$$HGL = Z + h$$

3.5.1.4 Total Energy Line (TEL): It is the sum of Pressure head and velocity head

$$TEL = Z + h + V^2/2g$$

3.5.2 TABULATIONS

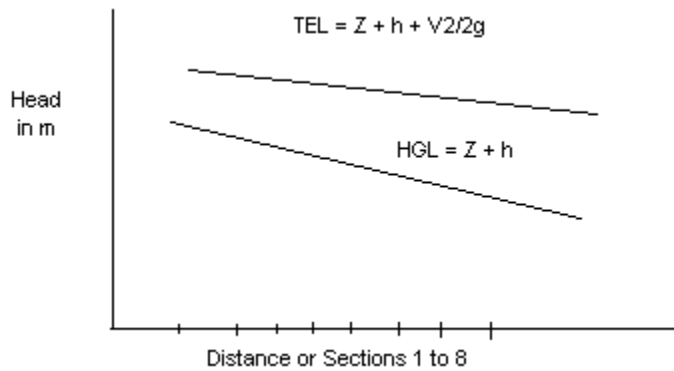
Area of measuring tank = $0.3 \times 0.3 \text{ m}^2$

Assume Datum head $Z = 0$

Diameter at the sections of the channel d	Cross – Section Area $a = \pi d^2/ 4$	Time for 10 cm rise t	Discharge $Q=Ah/t$	Velocity $V=Q/a$	Velocity Head $V^2/2g$	Piezometer Reading i.e. Pr. Head $(h=P/\rho g)$	Total Head $Z +h+ V^2/2g$
<i>m</i>	$\times 10^{-3} \text{ m}^2$	sec	m^3/sec	m/sec	m	m	m
$d_1 = 0.04295$	1.448						
$d_2 = 0.03925$	1.209						
$d_3 = 0.03555$	0.992						
$d_4 = 0.03185$	0.796						
$d_5 = 0.02815$	0.622						
$d_6 = 0.02445$	0.469						
$d_7 = 0.02075$	0.338						
$d_8 = 0.01705$	0.228						

3.5.3 GRAPH

Draw the graph: Distance of channel (Locations 1-8) Vs HGL, TEL



3.6 POST-LAB QUESTIONS

- 3.6.1 What do you mean by velocity head?
- 3.6.2 What do you mean by HGL?
- 3.6.3 What do you mean by datum head?
- 3.6.4 What is the use of piezometer?
- 3.6.5 Define TEL?
- 3.6.6 What is the reason for the slight decrease in the total energy head between the successive locations in the duct?

3.7 INFERENCES

3.8 RESULT

The Bernoulli's theorem is verified.

EXPERIMENT No.4

DETERMINATION OF PIPE FRICTION FACTOR

4.1 AIM: To determine the friction factor for the given pipe.

4.2 EQUIPMENTS REQUIRED: Pipe friction EQUIPMENTS, Stop watch

4.3 PREPARATION

4.3.1 THEORY

The major loss in the pipe is due to the inner surface roughness of the pipe. There are three pipes (diameter 25 mm, 20 mm and 15 mm) available in the experimental set up. The loss of pressure head is calculated by using the manometer. The apparatus is primarily designed for conducting experiments on the frictional losses in pipes of different sizes. Three different sizes of pipes are provided for a wide range of experiments.

4.3.2 PRE-LAB QUESTIONS

4.3.2.1. What do you mean by friction and list out its effects?

4.3.2.2 What do you mean by major loss in pipe?

4.3.2.3 Write down the Darcy-Weisbach equation?

4.3.2.4 What are the types of losses in pipe flow?

4.4 PROCEDURE

N.B.: Keep the delivery valve open while start and stop of the pump power supply.

4.4.1. Switch on the pump and choose any one of the pipe and open its corresponding inlet and exit valves to the manometer.

4.4.2. Adjust the delivery control valve to a desired flow rate. (i.e. fully opened delivery valve position initially)

4.4.3 Take manometer readings and time taken for 10 cm rise of water in the collecting tank

4.4.4 Repeat the readings for various flow rates by adjusting the delivery valve. (i.e. Gradually closing the delivery valve from complete opening)

4.4.5 Switch off the power supply after opening the valve completely at the end.

4.5 OBSERVATIONS

4.5.1 FORMULAE/ CALCULATIONS

4.5.1.1 The actual rate of flow $Q = A \times h / t$ (m³/sec)

Where A = Area of the collecting tank = length x breadth (m²)
 h = Height of water(10 cm) in collecting tank (m),
 t = Time taken for 10 cm rise of water (sec)

4.5.1.2 Head loss due to friction, $h_f = h_m (S_m - S_f) / (S_f \times 100)$ in m

$h_f = h_m (13.6 - 1) \times 10^{-2}$ (m)
 Where S_m = Sp. Gr. of manometric liquid , Hg =13.6 ,
 S_f = Sp. Gr. of flowing liquid, H₂O = 1
 h_m = Difference in manometric reading = (h₁-h₂) in cm

4.5.1.3 The frictional loss of head in pipes (Darcy-Weisbach formula)

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

Where f = Co-efficient of friction or friction factor for the pipe (to be found)
 L = Distance between two sections for which loss of head is measured = 3 m
 V = Average Velocity of flow = Q/a (m/s),
 Area of pipe a= $\pi d^2 / 4$ (m²),
 d = Pipe diameter = 0.015 m
 g = Acceleration due to gravity = 9.81 m/sec²

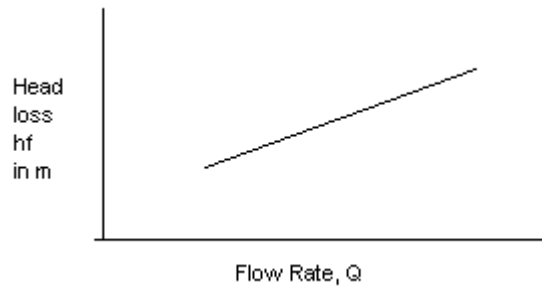
4.5.2 TABULATION

Length between Pressure tapping, L = 3 m
 Pipe Diameter, d = 0.015 m,
 Measuring tank area, A= 0.6 x 0.3m².

Sl.No.	Pipe Dia	Manometer Reading			Head Loss	Time for 10 cm rise	Discharge	Velocity	Frictional factor
	d	h ₁	h ₂	h _m = (h ₁ -h ₂)	h _f	T	Q	V=Q/a	f
	m	cm			M	Sec	m ³ /s	m/s	
1									
2									
3									
4									
5									
Average friction factor, f									

4.5.3 GRAPH

Draw the graph: **Q Vs hf**



4.6 POST-LAB QUESTIONS

- 4.6.1 What is the relationship between friction head loss and pipe diameter?
- 4.6.2 What is the relationship between friction head loss and flow velocity?
- 4.6.3 What is the relationship between friction head loss and pipe length?
- 4.6.4 How is the flow rate and head loss related?
- 4.6.5 If flow velocity doubles, what happens to the frictional head loss?

4.7 INFERENCES

4.8 RESULT

The friction factor for the given pipe diameter of m is = _____

EXPERIMENT No.5

DETERMINATION OF MINOR LOSSES DUE TO PIPE FITTINGS

9.1 AIM: To study the various losses due to the pipe fittings

9.2 EQUIPMENTS REQUIRED: Minor losses test rig, Stopwatch

9.3 PREPARATION

9.3.1 THEORY

The various pipe fittings used in the piping applications are joints, bends, elbows, entry, exit and sudden flow area changes (enlargement and contraction) etc. The energy losses associated with these types of pipe fittings are termed as the minor losses due its lesser values compared to the major loss (pipe friction) in the pipe. The loss of head is indicated by the manometer connected across the respective pipe fitting.

9.3.2 PRE-LAB QUESTIONS

9.3.2.1 List out the various types of pipe fittings?

9.3.2.2 What do you meant by minor losses?

9.3.2.3 What are the types of losses in pipe flow?

9.3.2.4 What do you meant by entry loss?

9.3.2.5 What do you meant by exit loss?

9.4 PROCEDURE

N.B.: Keep the delivery valve open while start and stop of the pump power supply.

9.4.1 Switch on the pump. Adjust the delivery valve to a desired steady flow rate.

9.4.2 Note down the time taken for 10 cm rise of water level in the collecting tank.

9.4.3 Choose any one of the pipe fittings (2 bends, one enlargement and one contraction). e.g. Bend-1

9.4.4 Open the levers (cocks) of respective pipe fitting to the manometer. Ensure other fitting levers should be closed. e.g. Open the entry and exit levers of Bend-1(left & right side cocks at the top of the panel)

9.4.5 Note down the manometer head levels (e.g. h_1 & h_2 for bend-1)

9.4.6 Now open the other two entry and exit levers of next pipe fitting. Then close the levers of first chosen pipe fitting. (e.g. Open the 2nd left & right levers for Bend-2 and close the top levers of Bend-1)

9.4.7 Note down the manometer for the second pipe fitting. (e.g. h_1 & h_2 for bend-2)

- 9.4.8 Repeat this procedure by opening the respective levers of sudden enlargement fitting after closing other levers(i.e. for sudden enlargement by opening the next down left & right cocks of sudden enlargement and then close the previous left & right cocks of Bend-2).
- 9.4.9 Repeat this procedure by opening the respective levers of sudden contraction fitting after closing other levers(i.e. for sudden contraction by opening the next down left & right cocks of sudden contraction and then close the previous left & right cocks of Sudden enlargement).
- 9.4.10 Ensure the readings taken for all pipe fittings and then switch off the pump.

9.5 OBSERVATIONS

9.5.1 FORMULAE / CALCULATIONS

9.5.1.1. Discharge, $Q = (A \times h) / t \dots\dots (m^3/s)$

A = Area of tank in m^2 ,

h = 0.10 m // Rise water level in collecting tank (m),

t = Time taken for the 10 cm rise of water in collecting tank (sec)

9.5.1.2. Velocity, $V = \text{Discharge} / \text{Area of pipe} = Q/A\dots (m/s)$

Where $A = \pi d^2/4$, d – Dia of pipe in m

9.5.1.3. Actual loss of head, $h_f = (h_1 - h_2) \times 12.6 \times 10^{-2} \dots (m)$

9.5.1.4. Theoretical Velocity loss heads for pipe fittings

Velocity head loss for bend and elbow $h_v = V^2 / (2g)$

Velocity head loss for sudden enlargement $h_v = (V_1 - V_2)^2 / (2g)$

Velocity head loss for sudden contraction $h_v = 0.5 (V_2)^2 / (2g)$

Where $V_2 =$ velocity of smaller pipe

9.5.1.5. Loss co-efficient $K = \text{Theoretical Velocity head} / \text{Actual loss of head} = h_v / h_f$

9.5.2 TABULATION

Collecting Tank area, $A = 0.6 \text{ m} \times 0.3 \text{ m}$, Pipe Diameter, $d = 0.02 \text{ m}$

Pipe fittings	Manometer Reading (cm)			Time for 10 cm rise (sec)	Discharge (m^3/s)	Velocity (m/s)	Actual Loss of head, (m)	Loss of head (Theoretical) (m)	Loss coefficient K
	h_1	h_2	h_m	t	Q	V	h_f	h_v	h_v / h_f
Bend-1									
Bend-2									
Sudden Enlarge (20-40 mm)									
Sudden Contraction (40-20 mm)									

9.5 POST-LAB QUESTIONS

- 9.6.1 What is the equation for head loss due to sudden enlargement?
- 9.6.2 What is the equation for head loss due to sudden contraction?
- 9.6.3 What is the equation for head loss due to bend?
- 9.6.4 What is the equation for head loss at entry of pipe?
- 9.6.5 What is the equation for head loss at exit of pipe?
- 9.6.6 Which Newton's law is applicable to impulse turbine?

9.7 INFERENCES

9.8. RESULT

The various minor losses in pipe fittings are determined.

EXPERIMENT No.6
IMPACT OF JET OF WATER ON VANES

13.1 AIM: To determine the coefficient of impact of water jet on different vanes

13.2 EQUIPMENTS REQUIRED: Jet on vane apparatus, Weighing machine, Flat vane, Flat vane with oblique impact, Conical vane, stop watch

13.3 PREPARATION

13.3.1 THEORY

Water turbines are widely used throughout the world to generate power. In the type of water turbine referred to as a Pelton wheel, one or more water jets are directed tangentially on to vanes or buckets that are fastened to the rim of the turbine disc. The impact of the water on the vanes generates a torque on the wheel, causing it to rotate and to develop power. Although the concept is essentially simple, such turbines can generate considerable output at high efficiency. To predict the output of a Pelton wheel, and to determine its optimum rotational speed, we need to understand how the deflection of the jet generates a force on the buckets, and how the force is related to the rate of momentum flow in the jet. In this experiment, we measure the force generated by a jet of water striking a flat plate or a hemispherical cup, and compare the results with the computed momentum flow rate in the jet.

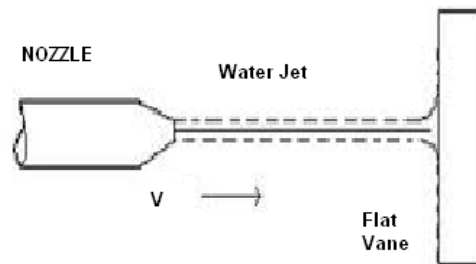


Fig. Impact of Water jet on flat vane

13.3.2 PRE-LAB QUESTIONS

- 13.3.2.1 What is the water jet?
- 13.3.2.2 What is the effect of water jet on vanes?
- 13.3.2.3 What do you meant by impact?
- 13.3.2.4 List out different types of vanes?

13.4 PROCEDURE

13.4.1 Switch on the power supply.

13.4.2 Open the gate valve and note down the reading from the weight balance.

13.4.3 Then note the time for 'h' m rise in collecting tank.

13.4.4 Repeat the procedure for different gate valve openings.

13.4.5 Take readings for different vanes and nozzles also.

13.5 OBSERVATIONS

13.5.1 FORMULAE / CALCULATIONS

13.5.1.1 Actual discharge, Q = Volume of collecting tank/ time taken = $A h / t$

Where, A - Area of collecting tank = length x breadth

h - Water level rise in the collecting tank = 10 cm

t - Time taken for 'h' cm rise of water in the tank in sec

13.5.1.2 Theoretical force F_t = $(\rho A_N V^2) / g$

Density of water, $\rho = 1000 \text{ kg/m}^3$

Area of nozzle, $A_N = \pi d^2/4$

Gravity, $g = 9.81 \text{ m/s}^2$

13.5.1.3 Velocity V = $Q / [Cc. A_N]$

13.5.1.4 Co-efficient of Impact, C_i = F_a / F_t

Where F_a = Actual force acting on the Disc shown from Dial Gauge.

13.5.2 TABULATION

Measuring area in tank = $0.5 \times 0.4 \text{ m}^2$

Dia of jet = 15mm

Type of vane = Flat vane / Conical vane

Co-efficient of Contraction, $C_c = 0.97$

Sl. No.	Type of Vane	Time for 10 cm rise of water (sec)	Actual force, F_a in kg	Theoretical Force, F_t in kg	Co-efficient of impact, C_i
1					
2					
3					
4					
5					
6					

13.5 POST-LAB QUESTIONS

13.6.1 How do you compare different vanes?

13.6.2 What do you meant by co-efficient of impact?

13.6.3 How do you measure the force of the jet?

13.6.4 How do you measure actual flow rate?

13.6.5 How do you measure theoretical flow rate?

13.7 INFERENCES

13.8 RESULT

The co-efficient of impact of the given vane = _____

EXPERIMENT No.7

FLOW VISUALIZATION - REYNOLDS APPARATUS

14.1 AIM: To demonstrate the flow visualization – laminar or turbulent flow.

14.2 EQUIPMENTS REQUIRED: Reynolds Experimental set up, stop watch

14.3 PREPARATION

14.3.1 THEORY

The flow of real fluids can basically occur under two very different regimes namely laminar and turbulent flow. The laminar flow is characterized by fluid particles moving in the form of lamina sliding over each other, such that at any instant the velocity at all the points in particular lamina is the same. The lamina near the flow boundary move at a slower rate as compared to those near the center of the flow passage. This type of flow occurs in viscous fluids, fluids moving at slow velocity and fluids flowing through narrow passages. The turbulent flow is characterized by constant agitation and intermixing of fluid particles such that their velocity changes from point to point and even at the same point from time to time. This type of flow occurs in low density fluids, flow through wide passage and in high velocity flows.

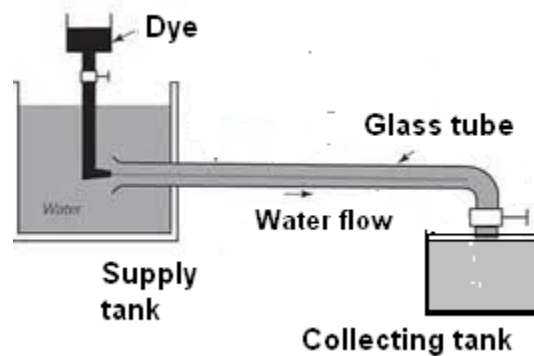


Fig. Reynolds Experimental Set-up

Reynolds conducted an experiment for observation and determination of these regimes of flow. By introducing a fine filament of dye in to the flow of water through the glass tube, at its entrance he studied the different types of flow. At low velocities the dye filament appeared as a straight line through the length of the tube and parallel to its axis, characterizing laminar flow. As the velocity is increased the dye filament becomes wavy throughout indicating transition flow. On further increasing the velocity the filament breaks up and diffuses completely in the water in the glass tube indicating the turbulent flow. There are two different types of fluid flows laminar flow and Turbulent flow. The velocity at which the flow changes laminar to Turbulent is called the 'Critical Velocity'.

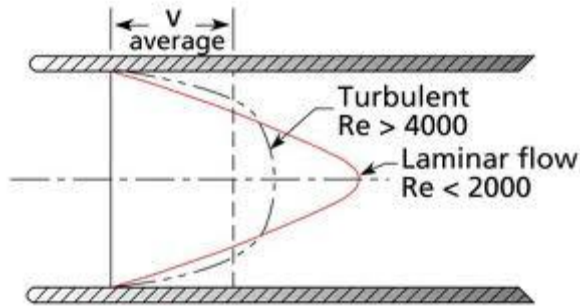


Fig. Types of internal (pipe) flow

Reynolds number determines whether any flow is laminar or Turbulent. Reynolds number corresponding to transition from laminar to Turbulent flow is about 2,300.

14.3.2 PRE-LAB QUESTIONS

- 14.3.2.1 What do you meant by fluid?
- 14.3.2.2 What are the types of flow?
- 14.3.2.3 Define Reynolds number?
- 14.3.2.4 What is laminar flow?
- 14.3.2.5 What is turbulent flow?

14.4 PROCEDURE

1. Switch on the power supply. Adjust the water inflow slowly by flow control valve (delivery valve).
2. Inject a filament of dye into the water stream by opening the value from dye tank.
3. When the flow is laminar, the colored stream of dye does not mix with the stream of water and is apparent long the whole length of the pipe. Increase the velocity of the stream gradually by opening the flow control valve, to see the turbulent flow. The stream of dye begins to oscillate and then diffused. This velocity of water in the pipe is 'Critical Velocity'.

14.5 OBSERVATIONS

14.5.1 FORMULAE/ CALCULATIONS

Discharge, $Q = (A h) / t$ (m^3/sec)

Where A- Collecting tank area = $l \times b$ in m^2 ,

t - time for 10 cm rise of water level in the collecting tank (sec)
 h – Rise of water level in the collecting tank = 0.10 m

Reynolds number for pipe flow, $Re = (V D)/ \nu$

Where V= Velocity of the fluid (m/s),

D= diameter of the pipe (m)

ν = Kinetic viscosity of the fluid (m²/s)

14.5.2 TABULATION

Internal plan area of collecting tank = 0.3 x 0.3m²

Diameter of pipe D = 32 mm , Kinematics viscosity of fluid (water) = 1.01 x 10⁻⁶ m²/sec

Sl. No.	Time taken for 10 cm rise t sec	Discharge Q m ³ /sec	Velocity V m/s	Reynolds number Re	Remarks (Laminar/ Turbulent flow)
1					
2					
3					
4					

14.5 POST-LAB QUESTIONS

- 14.6.1 What do you meant by stream and streak lines?
- 14.6.2 Mention the Reynolds no for laminar and turbulent flow?
- 14.6.3 What do you meant by steady and unsteady flow?
- 14.6.4 What do you meant by path line?
- 14.6.5 What do you meant by uniform and non-uniform flow?

14.7 INFERENCES

14.8 RESULT

The flow visualization test is conducted.