OBSERVATIONS AND CALCULATIONS

Table 1. Results of flow through orifice experiment (Constant head)

S.No.	Head (m)	Time for H cm rise (T) - sec	Discharge (Q) m^3 / s		Coefficient of discharge, C_d
			Q_a	Q_{th}	

Diameter of orifice, d =

Dimensions of collecting tank, A =

Experiment No: Roll No:
Date :

1. DETERMINE THE DISCAHRGE FROM A GIVEN TANK PRESENET IN TATA CHEMICAL LABORATORY (using ORIFICE)

AIM

To determine the coefficient of discharge of orifice by constant head method

BASIC CONCEPT

An orifice is an opening having a closed perimeter, made in the walls or in the bottom of the tank containing fluid, through which fluid may be discharged. The discharging fluid from the tank through the orifice comes out in the form of a free jet. In the process, the total energy of the fluid in the tank is converted to kinetic energy as the jet issues out into the atmosphere. The shape of the jet is function of the geometry of the orifice. The jet cross-section contracts to minimal and then expands partly due to viscous resistance offered by the surrounding atmosphere and partly due to inertia of the fluid particles. The jet cross-sectional area at which it is having minimum area is known as "Vena Contracta".

The following formulae are employed to fine the coefficient of discharge of an orifice.

Theoretical discharge, $Q_{th} = a\sqrt{2gh}$

a = area of cross section of the orifice = $\frac{\pi}{4} \times d^2$

h = head of the liquid above the centre of the orifice in the tank

g = acceleration due to gravity

Actual discharge, Q_a = AH/T

A = Internal plan area of collecting tank

H = Rise of liquid in collecting tank

T = Time taken to collect liquid in the collecting tank

Coefficient of discharge, $C_d = Q_{at}/Q_{th}$

MODEL CALCULATIONS

APPARATUS

1 Orifice fitted to a tank
2 Piezometers
3 Meter scale
4 Calipers
5 Stop watch
6 Collecting tank fitted with a valve

PROCEDURE

1. The diameter of the orifice and the internal plan dimensions of the collecting tank are measured.
2. The supply valve of the orifice tank is regulated and water is allowed to fill the orifice tank to a constant head (h)
3. The out let valve of the collecting tank is closed tightly and the time taken for "H " rise of water in the collecting tank is noted.
4. The above procedure is repeated for different heads and the readings are tabulated.

GRAPHS

The following graph is drawn by taking Q_a on y – axis and $\sqrt{h}$ on x - axis.

Q_a vs $\sqrt{h}$

RESULT

The coefficient of discharge of orifice, C_d = -------------------

(From experiment)

The coefficient of discharge of orifice, C_d = ---------------------

(From Q_a vs $\sqrt{h}$ graph)

INFERENCE

OBSERVATIONS AND CALCULATIONS

Table 1. Results of flow through Mouthpiece experiment (Variable head)

S.NO	Head (m)		Time (t) sec	$\sqrt{h_1}-\sqrt{h_2}$ (m)	Coefficient of discharge, C_d
	h_1	h_2			

Diameter of Mouthpiece, d =

Dimensions of balancing tank =

Experiment No: Roll No:

Date :

2. DETERMINE THE DISCAHRGE FROM A GIVEN TANK PRESENET IN TATA CHEMICAL LABORATORY (using MOUTHPIECE)

AIM

To determine the coefficient of discharge of mouth piece by variable head method

BASIC CONCEPT

A mouth piece is a short tube fitted to a circular orifice provided to the bottom of the tank. The length of the tube is usually two to three times its diameter. It is usually required to know the actual flow rate and the time required for emptying a tank through a mouth piece

Time required for the liquid to descend from h_1 to h_2, (t) = $\dfrac{2A(\sqrt{h_1}-\sqrt{h_2})}{C_d a\sqrt{2g}}$

a = cross –sectional area of orifice

h_1 = initial liquid level in the orifice tank

h_2 = final liquid level in the orifice tank

g = acceleration due to gravity

A = internal plan area of the balancing tank = L x B =

C_d = coefficient of discharge of orifice

APPARATUS

Mouth piece fitted to a tank

Piezometer

Meter scale

Callipers

Stop watch

MODEL CALCULATIONS

PROCEDURE

1. The diameter of the mouth piece and the internal plan dimensions of the mouth piece tank are measured.
2. Water is allowed in to the mouthpiece tank so that the head above the centre of the mouth piece is h_1.
3. The supply valve is completely closed and the water level in the mouth piece tank is allowed to descend to h_2.
4. Note down the time taken (t) to descend the water level from h_1 to h_2
5. The above procedure is repeated for different values of h_1 and h_2.

GRAPHS

A graph is drawn by taking t on y - axis and $\sqrt{h_1} - \sqrt{h_2}$ on x-axis.

t vs ($\sqrt{h_1} - \sqrt{h_2}$)

RESULT

The coefficient of discharge of mouth piece, C_d=

(from experiment)

The coefficient of discharge of mouth piece, C_d=

(from graph)

INFERENCE

OBSERVATIONS AND CALCULATIONS

Table 1. Results of flow through Triangular/Rectangular notch

S.NO	Hook gauge reading (mm) at sill level during zero discharge in channel, h_o (m)	Hook gauge reading (mm) at free Surface, h_1 (m)	Head over the notch ($h=h_1-h_o$) m	Time for H cm rise, T sec	Discharge (Q) m^3/s		Coefficient of discharge (C_d)
					Q_{th}	Q_{act}	

Vertex angle of the triangular notch, θ =

Dimensions of collecting tank =

Experiment No: Roll No:
Date :

3. DETERMINE THE DISCHARGE PASSING THROUGH A PALAR RIVER (using TRIANGULAR / RECTANGULAR NOTCH)

AIM

To study the flow over a triangular notch and to calibrate it for the discharge measurement for a free surface flow.

BASIC CONCEPT

A weir is an obstruction placed across a free surface flow such that the flow takes place over it. The weir with a sharp edge is commonly referred to as a notch. Generally, notches are opening cut in metallic plates and installed in flumes to measure the discharge. The free surface flow taking place over it acquires steady state condition such that the discharge is uniquely related to the head over the crest of the notch and its geometry. In actual practice, the discharge over a notch is considerably less than the theoretical discharge. This is due to real – flow effects like viscosity, end-contraction, nappe suppression, ventilation of notches, etc. The actual discharge is obtained by multiplying the theoretical discharge by a factor called Coefficient of Discharge, C_d

The following formula is employed.

Theoretical discharge (Q_{th}) = $\frac{8}{15}\sqrt{2g}\tan\frac{\theta}{2}h^{5/2}$ (Triangular Notch)

h=head over the sill of the notch

θ = Vertex angle of the notch

g= acceleration due to gravity

Theoretical discharge (Q_{th}) = $\frac{2}{3}\sqrt{2g}Lh^{3/2}$ (Rectangular Notch)

L = length of the crest

h=head over the sill of the notch

g= acceleration due to gravity

Actual Discharge (Q_a) = AH/t

A= Internal plan area of the collecting tank

H= Time required for a rise of “H” cm in the collecting tank

t= time required for rise of ‘H’ cm in the collecting tank.

Coefficient of discharge for a triangular notch (C_d) = Q_a/Q_{th}

MODEL CALCULATIONS

APPARATUS

1. Flume with a Triangular / Rectangular notch
2. Hook gauge
3. Collecting tank.
4. Stop watch
5. Piezometer
6. Scale.

PROCEDURE

1. The internal plan dimensions of the collecting and the vertex angle of the notch are measured.
2. The supply valve is opened and the water is allowed to rise up to sill of the notch and then the supply valve is closed.
3. The tip of the pointer of the hook gauge is adjusted such that the tip coincides with free water surfaces.
4. The sill level of the notch (h_o) is noted in the hook gauge.
5. The supply valve is opened and the water is allowed to flow through. The tip of the pointer is adjusted to coincide with the water surface.
6. The reading of the hook gauge (h_1) is noted down.
7. The outlet valve of the collecting tank is closed and the time taken for a rise of "H" in the collecting tank is noted down.
8. The above procedure is repeated for different heads of flow.

GRAPHS

The following graphs is drawn with Q_a on y- axis and $(h)^{5/2}$ on x – axis, $Q_a$vs $(h)^{5/}$

RESULT

The coefficient of discharge of the Triangular / Rectangular notch, (C_d)=
(from experiment)
The coefficient of discharge of the Triangular / Rectangular notch, (C_d)=
(from Q_a vs $(h)^{5/2}$ (or) $(h)^{3/2}$graph)

INFERENCE

OBSERVATIONS AND CALCULATIONS

Table 1. Results of flow through Venturimeter

S.No.	Manometric reading in cm of mercury		Equivalent head in meters of water (h)	Time for H rise sec	Discharge (Q) m^3 / s		Coefficient of discharge, C_d
	h_1	h_2			Q_{act}	Q_{th}	

Diameter of inlet of venturimeter, d_1 =
Diameter of throat of venturimeter, d_2 =
Dimensions of collecting tank =

Table 2. Results of flow through Orificemeter

S.No.	Manometric reading in cm of mercury		Equivalent head in meters of water (h)	Time for H rise sec	Discharge (Q) m^3 / s		Coefficient of discharge, C_d
	h_1	h_2			Q_{act}	Q_{th}	

Diameter of pipe, d_1 =
Diameter of orificemeter, d_2 =
Dimensions of collecting tank =

Experiment No: Roll No:
Date :

4. ESTIMATE THE RATE OF FLOW FOR A PIPE LINE SUPPLYING WATER TO HOUSTON REFINERY, TEXAS (using Venturimeter / Orificemeter)

AIM

To determine the coefficient of discharge of given Venturimeter / Orificemeter

BASIC CONCEPT

Flow rate measurement is a fundamental necessity in almost all flow situation of engineering importance. For confined flows the main devices used are a class of meters called obstruction meters. The basic principle in all these obstruction meters is that the flow undergoes a change in its cross-sectional area as it passes along the channel. It results in creation of difference of pressure across the channel which is uniquely related to the flow rate and geometry of the obstruction together with the fluid properties. Venturimeter consists of a converging section, a cylindrical throat and a divergent cone. A differential mercury manometer is connected between the inlet section and the throat of venturimeter to measure the pressure difference between these two sections.

The following expressions are used to compute the discharge through a venturimeter.

Theoretical discharge, $Q_{th} = \dfrac{a_1 a_2 \sqrt{2gh}}{\sqrt{(a_1^{\,2} - a_2^{\,2})}}$

a_1 = Cross- sectional area of inlet

a_2 = Cross- sectional area of throat

g = acceleration due to gravity

h = Pressure head in terms of flowing liquid $= \dfrac{(h_1 - h_2)}{100}\left(\dfrac{s_m}{s_l} - 1\right)$

h_1 = Manometric level in one limb of manometer.

h_2 = Manometric level in another limb of manometer.

S_m= Specific gravity of manometric liquid (for Mercury = 13.6)

S_1 = Specific gravity of the flowing liquid (for Water = 1.0)

Actual discharge, Q_a = AH / t

A = Internal plan area of collecting tank.

H = Rise of water level in the tank

t = Time taken for rise of " H" cm in the collecting tank.

Coefficient of discharge of the venturimeter, $C_d = Q_a / Q_t$

MODEL CALCULATIONS

APPARATUS

1. Pipe fitted with Venturimeter / Orificemeter
2. Differential U – tube mercury manometer
3. Collecting tank fitted with piezometer and gate valve
4. Stop watch
5. Meter scale

PROCEDURE

1. The diameter of the inlet section, throat and internal plan dimensions of the collecting tank are measured.
2. The control valve in the pipe line is opened for maximum discharge.
3. The pressure difference between the inlet section and throat of the venturimeter is measured
4. The outlet valve of the collecting tank is closed and time taken for a rise of "H" cm in the collecting tank is noted down
5. The above procedure is repeated for different discharges by controlling the gate valve.

GRAPH

The following graph is drawn by taking Q_{act} on y – axis and $\sqrt{h}$ on x-axis
Q_{act} vs $\sqrt{h}$

RESULT

The coefficient of discharge of Venturimeter / Orificemeter (C_d) =
(from experiment)

The coefficient of discharge of Venturimeter / Orificemeter (C_d) =
(from Q_a vs $\sqrt{h}$ graph)

INFERENCE

OBSERVATIONS AND CALCULATIONS

Table 1. Results of Flow through pipes

S. No	Manometric Reading (cm)		Equivalent head of water (h) m	Time for 'H' cm rise T, sec	Discharge (Q) m^3/sec	Velocity (V) m/s	Friction factor, f
	h_1	h_2					

Diameter of the pipe, d =

Dimensions of the collecting tank =

Length of the tube, l =

Experiment No: Roll No:
Date :

5. DETERMINATION OF FRICTION FACTOR FOR A GIVEN PIPE LINE SUPPLYING WATER TO KONDAPALLI THERMAL POWER PLANT, VIJAYAWADA

AIM

To determine the friction factor of the pipe material

Basic concept

Transportation of fluids through pipes is frequently dealt by engineers. Distribution of water and gas to domestic consumers through conduits, supply of steam through pipes in thermal power plants and gases in process plants, offshore pumping of oil, etc are some of the examples of transportation of fluids through pipes. In order to design such systems, it is necessary to study the friction – flow characteristics through the pipes. The loss of head through the pipe is major loss and it is to be considered for designing pump capacity to supply the fluid. The prediction of frictional losses through the pipes lines enables the designer to estimate the power consumption and hence the type and size of the pumps required for a given application and length of the pipe.

When fluid flows through a pipe the frictional resistance offered to the flow depends on the roughness of the inner surface of the pipe carrying the liquid. The frictional resistance is mostly due to viscous resistance of fluid in case of laminar flow. In turbulent flow it is due to resistance offered by viscosity of the fluid and surface roughness of the pipe.

The following formula is employed

The head loss due to friction (h_f) = $fLV^2/(2gd)$

h_f = Pressure head in terms of flowing liquid = $\frac{(h_1 - h_2)}{100}\left(\frac{s_m}{s_l} - 1\right)$

h_1 = Manometric level in one of the limb of manometer.

h_2 = Manometric level in one of the other limb of manometer.

S_m= Specific gravity of manometric liquid (for Mercury = 13.6)

S_1 = Specific gravity of the flowing liquid (for Water= 1.0)

f = friction factor of the pipe material

L = length of pipe between the pressure taps

D = diameter of the pipe

V = Velocity of flow in the pipe (Q_a/a)

MODEL CALCULATIONS

Q_a = actual discharge (AH/t)

a = cross-sectional area of the pipe

H = rise of water level in the collecting tank

t = time taken for a rise "H" in the collecting tank

g = acceleration due to gravity

APPARATUS

1. Pipe fitted with gate valve
2. Differential U – tube mercury manometer
3. Collecting tank fitted with piezometer and gate valve
4. Stop watch
5. Meter Scale

PROCEDURE

1. The diameter of the pipe, internal plan dimensions of the collecting tank and the length of the pipe between the pressure tapping's are measured.
2. The gate valve is fully opened control valve in the pipe line is opened for maximum discharge.
3. The manometric heads in both the limbs of manometer are noted down.
4. The outlet valve of the collecting tank is closed and time taken for a rise of "H" cm in the collecting tank is noted down.
5. The above procedure is repeated for different discharges by controlling the gate valve and reading are noted down in table.

GRAPHS

The following graph is drawn by taking h_f on y – axis and V^2 on x-axis
h_f vs V^2

Result

The friction factor for the pipe material, (f) =
(from experiment)

The friction factor for the pipe material, (f) =
(from h_f vs V^2 graph)

INFERENCE