CE - 2122

27/01/2020

Fluid Mechanics Sessional

① Orifice → small ছিদ্র of a cross sectional area.

② Mouthfice → orifice এর আগে pipe থাকে (standard থেকে বেশি dia)

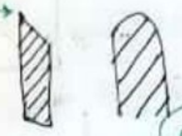
③ Cv by co-ordinate method

④ Venturimeter

⑤ V-notch

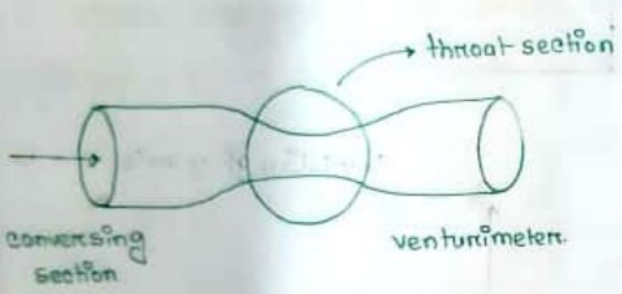
⑥ Sharp crested wire
(জুড়া)

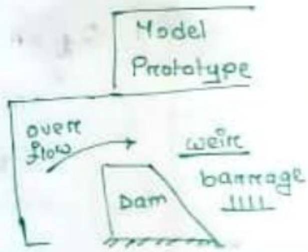
Sharp crested

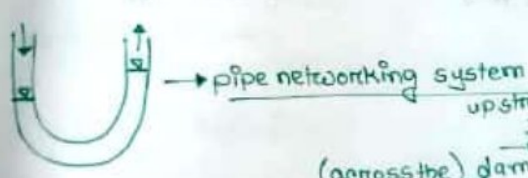


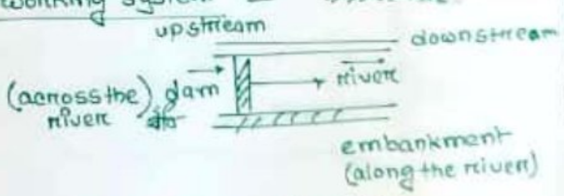
ori → $C_d = 0.61 \sim 0.65$

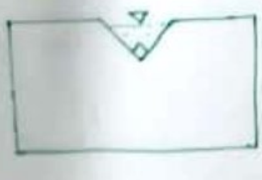
math → $C_d = 0.81 \sim 0.9$











open flow → atmosphere এ open

→ V-noch

measure the rate of flow of liquid

Q = rate of flow

close flow

$y = mx + c$

$y = mx$

$y = ax^2 + 2$

Variation of y axis w.r.to x axis

$Q_t = A\sqrt{2gH}$

$= A\sqrt{2g}\ H^{1/2}$

$= K\ H^{1/2}$

01/02/2020

Exp. no: 01

Exp. Name: Determination of co-efficient of discharge of an orifice.

① Theory:

orifice: Orifice is an small opening of any cross section (circular, triangular, rectangular etc.) on the side or at the bottom of a tank or a vessel through which the fluid is flowing.

time এর respect এ hydrolic property change হবেনা, steady flow:

$$\frac{\partial y}{\partial t} \neq 0$$

$$\frac{\partial v}{\partial t} \neq 0$$

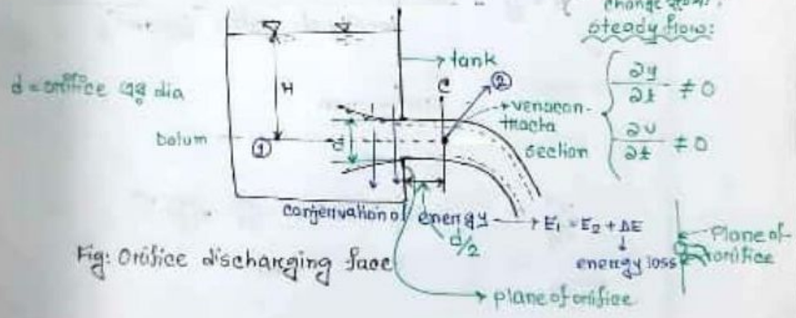


Fig: Orifice discharging face

pressure head → p

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\omega} + \frac{v_2^2}{2g} + z_2$$

γ → ω; $\frac{v^2}{2g}$ ← velocity head

1 → fluid pressure আছে

2 → atmospheric " "

$z_1 = z_2$ → orifice এর dia বরাবর datum.

vena contracta → when the stream lines are parallel to each other.

Consider 2 points 1 and 2 as shown in figure. Point 1 is inside the tank and point 2 is at the venacontracta. Let the flow is steady and at a constant head, H.

Applying Bernoulli's equation at points 1 and 2 →

$$\frac{P_1}{\omega} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\omega} + \frac{V_2^2}{2g} + z_2$$

here,

$$H = \frac{P_1}{\omega} = \frac{\text{fluid pressure at a point } (kg/cm^2)}{\text{density of water } (g/cm^3)}$$

its a height

$= cm \longrightarrow m$

$\frac{V_1^2}{2g} \longrightarrow$ velocity head $= \frac{m^2}{s^2} \times \left(\frac{m}{s^2}\right)^{-1}$

$= m$

But $z_1 = z_2$

$$\therefore \frac{P_1}{\omega} + \frac{V_1^2}{2g} = \frac{P_2}{\omega} + \frac{V_2^2}{2g}$$

V_1 is very small in comparison to V_2. as the area of the tank is very large as compared to the area of the jet of liquid.

therefore,

$\frac{P_1}{\omega} = H$, $\frac{P_2}{\omega} = 0$ (atmospheric pressure)

↳ fluid pressure

and. $V_2 \gg V_1$

$\therefore H + 0 = 0 + \frac{V_2^2}{2g}$

$\Rightarrow H = \frac{V_2^2}{2g}$

$\Rightarrow V_2^2 = 2gH$

$\Rightarrow V_2 = \sqrt{2gH}$

$\Rightarrow \boxed{V_t = \sqrt{2gH}}$

Therefore,

$Q_t = A \times V_t$

$= A\sqrt{2gH}$ —— ①

$A = \frac{\pi}{4} d^2$

theoritical discharge /velocity.

Therefore, this is the theoritical velocity. also known as Torricelli's theorem.

Hydraulic co-efficient:

(i) Co-efficient of discharge. (C_d) $= \frac{Q_a}{Q_t}$

(ii) Co-efficient of velocity (C_v) $= \frac{V_a}{V_t}$

(iii) Co-efficient of contraction. (C_c) $= \frac{a_c}{a}$

a_c → area of jet at c

a → area of orifice

[Prove that $C_d = C_v \times C_c$]

(ii) Objectives:

(i) To find the value of C_d for the orifice.

(ii) To plot a graph to show the variation of Q_a with respect to Q_t in plain graph paper.

(iii) To plot a graph to show the variation of Q_a with respect to actual head (H).

(iv) To plot a graph to show the variation of Q_a with respect to H in log-log graph paper. and find the exponent of H.

(H^n)

$n = 0.5$

* plane and log-log graph এর diff.
↓
linearly vary করে ... 10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} ...
non-linear variation

(v) find the ad+co-efficient of discharge from the log-log graph paper mension in number. 4. plain and the

③ Apparatus:

(i) Constant head water tank.
(ii) Orifice
(iii) discharge measuring tank.
(iv) Stop watch.
(v) point gauge.

④ Procedure:

(i) dia of orifice measurment.
(ii) Supply water to the cons. head water tank.
(iii) Manometer থেকে [illegible] head.
(iv) Q_t → $\frac{Vol}{t}$
(v) Q_a → A = ... $m^2 \times \frac{h}{t}$ = m^3/sec = Q_a

লেখো page④

Sample
⑤ Calculation: H, Q_t, t

লেখ

and height of H_2O in the measuring tank (h)

$V = Ah$

⑥ Observation sheet: Q_a

আঁকো

$C_d = Q_a/Q_t$

Dia of orifice = 0.90 cm

Cross sectional area of the orifice = $\pi/4 \times 0.9^2$ =

Cross sectional area of measuring tank, A =

Theoritical discharge, Q_t = --- t = --- Q_a = ---

Actual head, H = --- V = --- C_d = ---

Data Table:

Page ⑧ → Calculation from log-log graph paper

Page ④

No. of Obs.	Actual head H	Theoritical discharge Q_t (m^3/sec)	Collection time, t (sec)	Volume of water, V (m^3)	Actual discharge Q_a (m^3/sec)	Co-efficient of discharge $C_d = Q_a/Q_t$
1.						
2.						
3.						
4.						
5.						
6.						

Mean cd =

*Objective number 1.#

প্রথম খোলের graph

- Average C_d value for the orifice =
- The exponent of H, n =
- The C_d value from plain graph paper =
- The C_d value from log-log graph paper =

(cm)

⑥ **Results and ⑦ Discussion:**

The average co-efficient of discharge = . . .

The exponent of H = . . .

The C_d from log-log graph paper = . . .

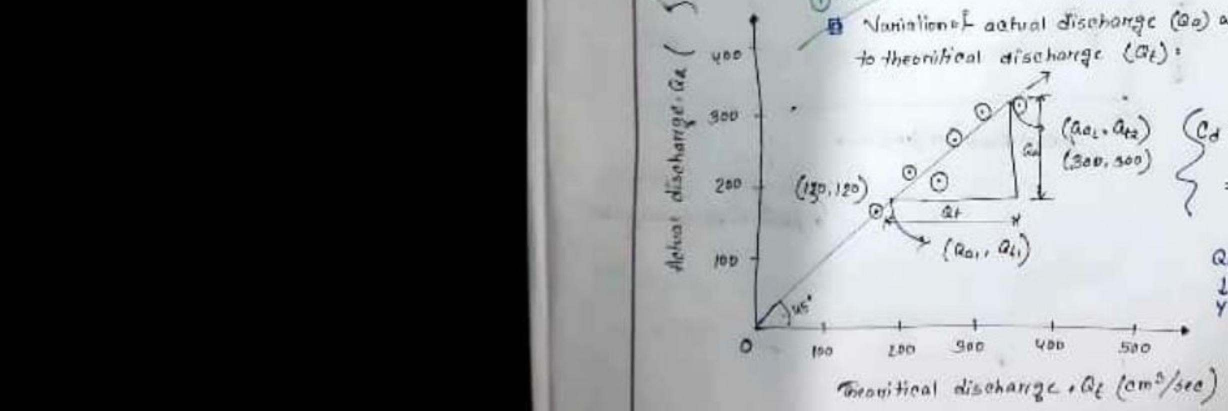
⑦ ⑧ **Assignment:**

— 0 —

#2 (objective)

① The graph

Variation of actual discharge (Q_a) with respect to theoritical discharge (Q_t):



$$C_d = \frac{Q_a}{Q_t} = \frac{300-120}{300-120}$$

$Q_a = C_d \times Q_t$

$y = mx + 0$

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

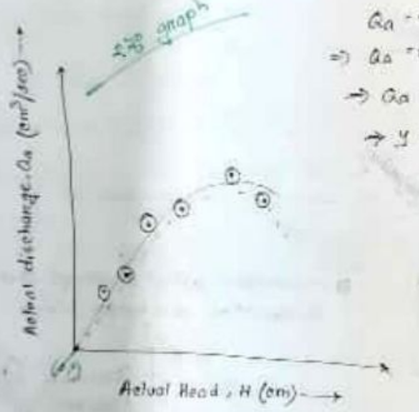
$\Rightarrow Q_a = C_d \times Q_t$

$\Rightarrow y = mx$

08/02/2020

Why the co-eff. of discharge of mouthpiece is greater than oriplece

3



$Q_a = C_d \times Q_t$

$\Rightarrow Q_a = C_d A \sqrt{2gH}$

$\Rightarrow Q_a = K H^{1/2}$

$\Rightarrow y = m x^n \; [n = \frac{1}{2}]$

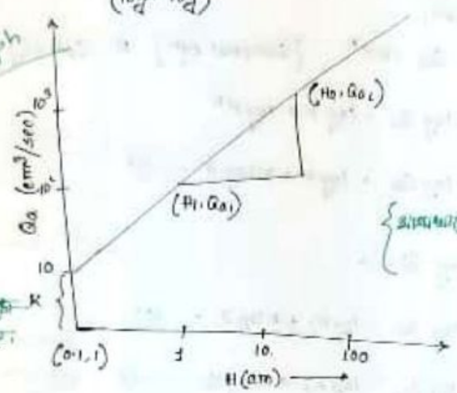
$Q_a = \frac{A \times h}{t}$ (cm³/sec)

Area of measuring tank

1 log cycle

#4

(log ~ log)



$Q_a = C_d Q_t$

$\Rightarrow Q_a = K H^{1/2}$

{ graph Cd →

diff × 30%

#5

① ও ⑪ নং graph থেকে Cd এর মান পাই।

let,

$K = 5$

$C_d = \frac{K}{A\sqrt{2g}}$

Derive a relationship to find the exponent of H expression

We know that,

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

$\Rightarrow Q_a = C_d \times Q_t$

$\Rightarrow Q_a = C_d \times A\sqrt{2gH}$

$= K\sqrt{H}$

calculation from log-log graph paper

Therefore,

$$Q_a = KH^n \quad \text{[General eq}^n\text{]} \quad K = C_d A \sqrt{2g}$$

$$\Rightarrow \log Q_a = \log K + \log H^n$$

$$\Rightarrow \log Q_a = \log K + n \log H \quad \text{——} (1)$$

V-notch

$$Q_a = C_d \frac{8}{15} \tan\frac{\theta}{2} \sqrt{2g}\, H^{5/2}$$

$$= KH^{5/2}$$

$$= KH^n$$

$$\boxed{n = 5/2}$$

$$C_d = \frac{K}{\frac{8}{15} \tan\frac{\theta}{2} \sqrt{2g}}$$

derivation এভাবেই হবে, শুধু K এর মান change হবে।

by using (1) →

$$\log Q_{a_1} = \log K + n \log H_1 \quad \text{——} (2)$$

$$\log Q_{a_2} = \log K + n \log H_2 \quad \text{——} (3)$$

eq^n (3) − (2) ⟶

$$\log Q_{a_2} - \log Q_{a_1} = n (\log H_2 - \log H_1)$$

$$\Rightarrow \log\left(\frac{Q_{a_2}}{Q_{a_1}}\right) = n \log\left(\frac{H_2}{H_1}\right)$$

$$\Rightarrow \boxed{n = \frac{\log\left(\frac{Q_{a_2}}{Q_{a_1}}\right)}{\log\left(\frac{H_2}{H_1}\right)}}$$

Exp. no: 02

Name of exp: Determination of the co-efficient of discharge of an external cylindrical mouthpiece.

① Theory:

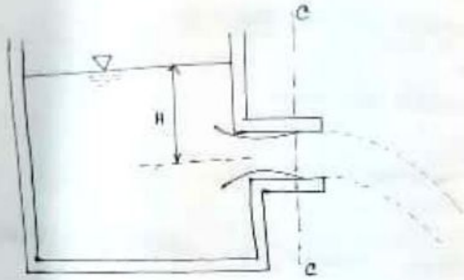


Figure: Flow through a mouthpiece.

$$Q_t = A\sqrt{2gH} \quad \text{(সূত্র)}$$

② Objectives:

① To find the C_d for the mouthpiece.

② … ④ } exp - ①

③ **Apparatus:**

④ **Procedure:**

} exp - ①

⑤ **Observation sheet and sample calculation:**

Diameter of the mouthpiece - exp - ① } related to mouthpiece

⑥ **Data Table:** exp - ①

Calculation from log-log graph paper বানানো লাগবে না।

C_d → graph থেকে তোমাদের বের করতে হবে।

n → " " " " "

সাধারণ graph paper (১টা)

⑦ **Result and discussion:**

COURSE NO. CE 2122
COURSE TITLE: ...

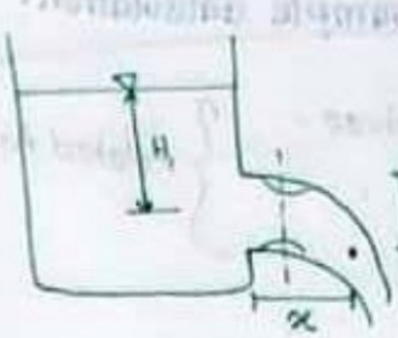
⑧ **Assignment:**

Submitted by:

NAME:
CLASS: 2ND YEAR ODD SEMESTER
ROLL: 18000, SECTION - C
GROUP: 01
SESSION: 2018-19

Exp. no: 03

Exp name: Determination of co-efficient of velocity by co-ordinate method.



$C_v = \frac{V_a}{V_{th}}$

$= \frac{V_a}{\sqrt{2gH}}$ → Cons. water head.

3.1 Theory:

3.1.1 Co-efficient of velocity (C_v): Co-efficient of velocity is defined as the ratio betn the actual vel. of the jet of a liquid at vena-contracta and the theoritical vel. of jet.

Mathematically,

$$C_v = \frac{\text{Actual Vel.}}{\text{Theoritical Vel.}}$$

$$= \frac{V_a}{V_{th}}$$

where,

V_a = actual vel. of water at vena-contracta
V_{th} = theorical " " "

The value of C_v varies from 0·95 – 0·99 for different orifices depending on the shape, size of the orifice and on the head under which flow takes place.

Generally the value of C_v = 0·98 is taken for sharp edged orifice.

Co-ordinate method:

3·1·2. Determination of co-efficient of velocity (C_v)

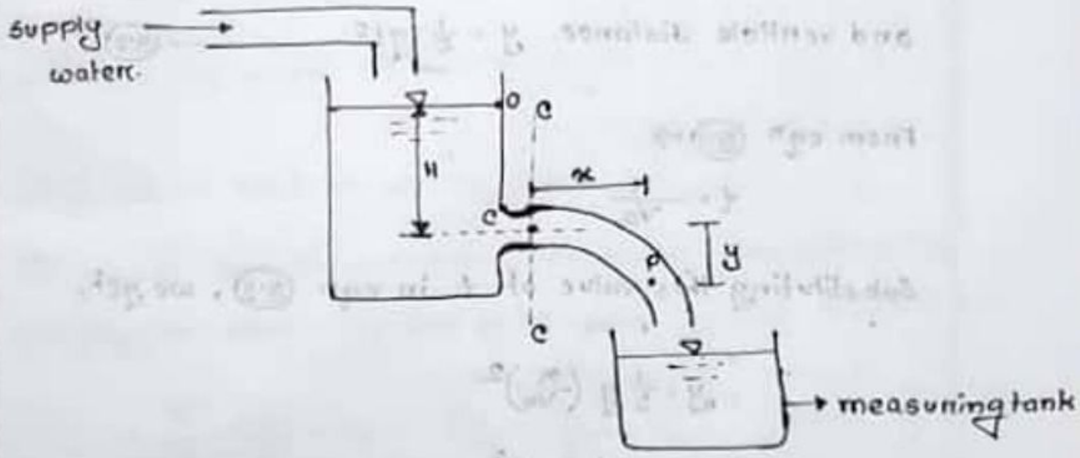


Fig 3·1: Determination of C_v

Let (c-c) represents the vena-contracta of a jet of water coming out from an orifice under constant head, H as shown is Figure 3·1

4

Considerr a liquid particle which is at vena contracta at any time and takes the position at p along the jet in time t.

Let,

x = horizontal distance travelled by the particle in time t.

y = vertical " betn p and (c-c).

V_a = Actual velocity of jet at vena- contracta.

Then,

Horizontal distance, $x = V_a * t$ ——— (3.1)

and verticle distance, $y = \frac{1}{2} g t^2$ ——— (3.2)

From eqn (3.1) ⇒

$$t = \frac{x}{V_a}$$

Substituting this value of t in eqn (3.2), we get,

$$y = \frac{1}{2} g \left(\frac{x}{V_a}\right)^2$$

$$\Rightarrow y = \frac{1}{2} g \frac{x^2}{V_a^2}$$

$$\Rightarrow V_a = \frac{\sqrt{g x^2}}{2y} \quad \text{——— (3.3)}$$

but theoritical velocity.

$$V_{th} = \sqrt{2gH} \quad \text{——— (3.4)}$$

$\therefore$ Co-efficient of velocity. $C_V = \frac{V_a}{V_{th}}$

$$\Rightarrow C_V = \frac{\sqrt{\frac{gx^2}{2y}}}{\sqrt{2gH}}$$

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

This is the required equation of C_V.

* Friction-এর কারণে V_a কম হবে

3.1.3 Loss of head in orifice flow:-

The loss of head through an orifice can be determined by applying the Bernoulli's eqn betn point o and c (Fig 3.1)

$$\frac{P_o}{\omega} + \frac{V_o^2}{2g} + z_o = \frac{P_c}{\omega} + \frac{V_c^2}{2g} + z_c + \text{loss of head} \quad [\text{here, } V_c = V_a]$$

$$\Rightarrow 0 + 0 + H = 0 + \frac{V_a^2}{2g} + 0 + h_f$$

$$\Rightarrow h_f = H - \frac{V_a^2}{2g}$$

$$= H\left(1 - \frac{V_a^2}{2gH}\right) = H\left(1 - C_v^2\right)$$

$$h_f = H(1 - C_v^2)$$

This is the required eqn of loss of head.

3.2 Objectives:

① To find the value of C_v for the orifice.

② " " " " H_f " "

③ To plot a graph to show the variation of V_a with V_{th} in plain graph paper.

④ To plot a graph to show the variation of V_a with H in log-log graph paper and find C_v and exponent of H.

3.3: Apparatus:

(i) Constant head water tank

(ii) Orifice

(iii) Point gauge

(iv) Discharge measuring tank.

3.4 – Procedure:

1. Diameter of orifice
2. Water supply to the tank.
3. When H is cons. the reading taken from the manometer.
4. Determine the coordinate, x and y from vena-contracta.
5. Repeat the procedure for different combination.

3.5 – Observation sheet and sample calculation:

Observation sheet:

Diameter of orifice	0.9 cm
Head constant	60 cm

Group No.	Observed Head	Horizontal co-ordinate. x	Verticle co-ordinate. y
সিয়েফ জুল	600 mm = 60 cm	440 mm = 44 cm	88 mm = 8.8 cm

Calculation sheet:

Area of orifice, $A_o = \frac{\pi}{4} d^2$

Group No.	Actual Head, H (cm)	Theoritical Velocity V_{th} (cm/s)	Horizontal Co-ordinate x (cm)	Verticle co-ordinate y (cm)	Actual Velocity. V_a (cm/s)	Co-eff of Velocity $C_v = V_a/V_{th}$	Head loss, h_f (cm)
1.	60	343.10	44	88	328.49	0.957	5.05
2.	55	328.33	42	8.6	317.03	0.97	3.25
3.	50	313.21	40	8.4	305.66	0.98	1.98
4.	45	296.98	38	8.3	291.04	0.98	1.52
5.	40	280.14	36	8.4	275.09	0.98	1.58
6	35	261.92	34	8.7	255.29	0.975	1.73

$V_{th} = \sqrt{2gH} = 343.1$

$V_a = \sqrt{\frac{gx^2}{2y}} = 308.49$

$h_f = H(1 - C_v^2)$

$= 5.05$

3.6 Results and Discussions:

Results: (Observation sheet-এ দ্রষ্টব্য)

Discussions:

29/02/2020

EXP : 04

Mithun Sir

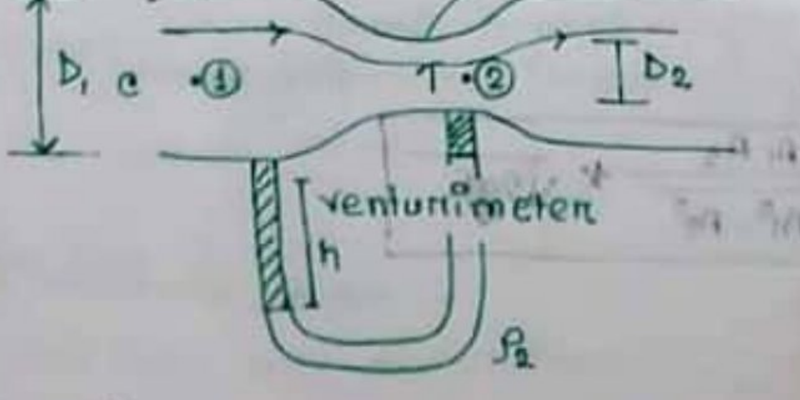
Exp no: 04

Exp. name: Determination of co-efficient of discharge for flow through venturimeter.

4.1 Theory:

Venturimeter: Venturimeter is the most widely used device to measure the discharge through the pipe.

A venturimeter is a converging-diverging nozzle of circular cross sectional area. The principle of venturimeter is that when a fluid flows through the venturimeter, it accelarates in the converging section and deaccelarates in diverging section resulting in a drop in the static pressure followed by a pressure recovery in the flow direction.



3 sections →

(i) Converging section
(ii) Throat section
(iii) Diverging section

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

$$\Rightarrow \frac{P_1}{\gamma} - \frac{P_2}{\gamma} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} \qquad \Rightarrow h = \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right)$$

$$Q = A_1 V_1 = A_2 V_2$$

$$\therefore V_1 = \frac{A_2 V_2}{A_1}$$

Putting the value of V_1,

$$\therefore \quad h = \left(\frac{V_2^2}{2g} - \left(\frac{A_2 V_2}{A_1}\right)^2 \Big/ 2g \right)$$

$$\Rightarrow h = \frac{V_2^2}{2g} - \frac{A_2^2 V_2^2}{A_1 2g}$$

$$\Rightarrow h = V_2^2 \left(\frac{1}{2g} - \frac{A_2^2}{A_1 2g} \right)$$

$$\Rightarrow V_2 = \sqrt{\frac{h}{\left(\frac{1}{2g} - \frac{A_2^2}{A_1 2g}\right)}}$$

$$\Rightarrow \quad V_2 = \frac{A_1}{\sqrt{A_1^2 - A_2^2}} * \sqrt{2gh}$$

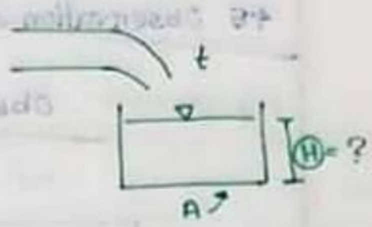
$$\therefore Q_{th} = A_2 V_2$$

→ Area of throat.
→ Area of converging section

$$\boxed{Q_{th} = \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} * \sqrt{2gh}}$$

→ Static pressure difference.

$Q_a = A*H/t$



$C_d = \frac{Q_a}{Q_{th}}$

4.2 Objectives:

(i) To find C_d for the venturimeter.

(ii) To plot a plain graph paper to show the variation of Q_a w.r. to h.

(iii) To plot a plain " " " Q_{th} wr. to h.

(iv) To plot a log-log " " " Q_a wr. to h. and to find exponent of h and value of C_d.

4.3 Apparatus:

(i) Venturimeter
(ii) Measuring gauge
(iii) " tank
(iv) Stop watch.
(v) Manometer.

4.4 Procedure:

(i) Volume of water (A*h)
(ii) Collection time (t)
(iii) Dia of the con. and div. section.
(iv) Head ~~differen~~ measure
(v) Head difference
(vi) Vel. of con. and throat section.

4.5 Observation sheet and sample calculation:

My group → Observation sheet:

Dia of converging section, D_1 (cm)	3.15
Area " " " A_1 (cm^2)	7.79
Dia " throat " D_2 (cm)	1.55
Area " " " A_2 (cm^2)	1.89
Area of tank, A (cm^2)	1372.5

measuring tank.

Group no.	Pressure Head at con. sec. h_1	Pressure Head at throat sec. h_2	Pressure head diff $h = h_1 - h_2$	Collection time t
01.	~~6.55~~ 65.5	~~6.25~~ 62.5	~~0.25~~ 3	53

Calculation sheet:

Grp. no.	Pressure head at conv. h_1 (cm)	Pressure head at th. h_2 (cm)	Pressure diff. $h = h_1 - h_2$ (cm)	Theoritical velocity. Q_{th} (cm^3/s)	Collection time t (s)	Height in H_2O tank. H (cm)	Actual disch. $Q_a = \frac{AH}{t}$ (cm^3/s)	Co-eff disch. $C_d = \frac{Q_a}{Q_{th}}$
01.	~~6.55~~ 65.5	~~6.25~~ 62.5	3	~~47.27~~ 149.47	53	5	129.48	~~0.74~~ 0.87
02.								
03.								
04.								
05.								
06.								

$D_1 = 3.15$ cm
$D_2 = 1.55$ cm
$H_1 = 655$ mm
$H_2 = 625$ mm
$t = 53$ s

4.6 Result:

4.7 Discussion:

4.7 Assignment: