Coefficient of Discharge of V-notch

Ex.No : 7
Date: 11/03/2022
Aim :
To determine the coefficient of discharge of V-notch.

Apparatus required :

- A channel with V-notch
- Hook gauge
- Collecting tank
- piezometer

Theory and Definition :

A notch is an opening in the side of a measuring tank or reservoir extending above the free surface. These notches are used to measure discharge of open channel flows, by passing or placing or constructing them across the stream. Notches are generally used for measuring discharge in small open channels or laboratory flumes.

Notches can be of different shapes such as triangular, rectangular, trapezoidal, stepped notch, etc. the bottom of the notch over which the water flows is known as crest or sill and the thin sheet of water flowing through the notch is known as nappe or vein. The edges of the notch are beveled on the downstream side so as to have sharp-edged sides and crest resulting in minimum contact with the flowing fluid.

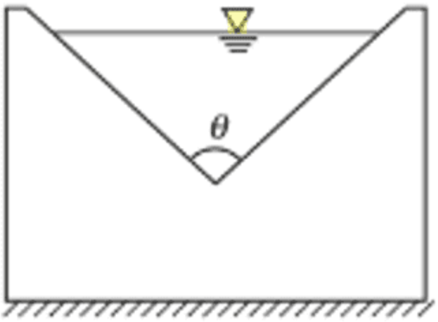
Coefficient of discharge

It is defined as the ratio of actual flow to theoretical flow through a pipe or

orifice. ∴ $c_d = Q_{act}/Q_{th}$

V-notch or Triangular notch

The V-notch or triangular notch is sharp crested notch, which is mainly used to determine the low rate of flow.



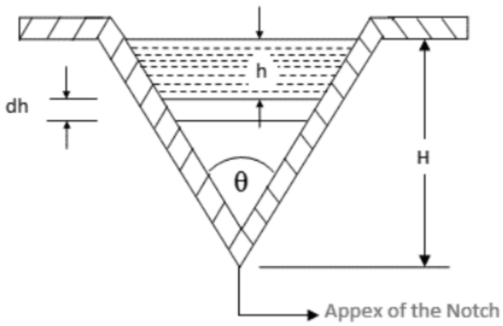


Fig : Triangular Notch

Let,

H = Height of the liquid above the apex of the notch,

θ = Angle of the notch,

Cd = Coefficient of discharge,

From the geometry of the figure, we find that,

$$\text{width of the notch at the water surface} = 2H \tan\frac{\theta}{2}$$

$$\therefore \text{ Area of the strip} = 2(H - h) \tan\frac{\theta}{2}.dh$$

We know that the theoretical velocity of water through the strip $= \sqrt{2gh}$

and discharge over the notch,

$$dq = C_d \times \text{Area of strip} \times \text{Theoretical velocity}$$

$$\Rightarrow dq = C_d \times 2(H - h) \tan\frac{\theta}{2}.dh\, \sqrt{2gh}$$

The total discharge over the whole notch may be found out only by integrating the above equation within the limits 0 and H.

$$Q = \int_0^H C_d \times 2(H - h) \tan\frac{\theta}{2}.\; dh\sqrt{2gh}$$

$$\Rightarrow Q = 2C_d\, \sqrt{2g} \times \tan\frac{\theta}{2} \int_0^H (H - h)\, \sqrt{h}\, dh$$

$$\Rightarrow Q = 2C_d\sqrt{2g}\times\tan\frac{\theta}{2}\int_0^H \left(Hh^{1/2} - h^{3/2}\right)dh$$

$$\Rightarrow Q = 2C_d\sqrt{2g}\times\tan\frac{\theta}{2}\left[\frac{2}{3}H\cdot H^{3/2} - \frac{2}{5}H^{5/2}\right]$$

$$\Rightarrow Q = 2C_d\sqrt{2g}\times\tan\frac{\theta}{2}\left[\frac{2}{3}H^{5/2} - \frac{2}{5}H^{5/2}\right]$$

$$\Rightarrow Q = 2C_d\sqrt{2g}\times\tan\frac{\theta}{2}\left[\frac{4}{15}H^{5/2}\right]$$

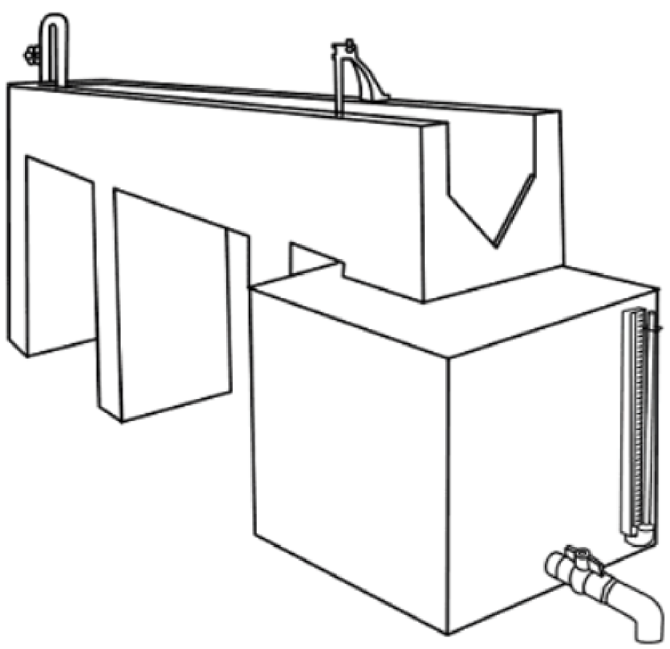
$$\therefore Q = \frac{8}{15}C_d\sqrt{2g}\times\tan\frac{\theta}{2}\times H^{5/2}$$

Qact = KH^n

where K = constant depending upon notch

H = Head over crest

n = constant



Apparatus

Observation and tabulation

Initial height(water level till crest) =3.15cm

Sr.No	**Height of rise (cm)**	**Time for 10 cm rise (sec)**
1	8.85	31.4
2	7.12	72
3	7.12	72

Formulae used :

Area of measuring tank (A)= 3500sq.mm

height= 10cm

t=Time required for 10 cm rise in water(sec)

C_d = Coefficient of Discharge

Q_{The}= Theoretical Flow rate of water

Q_{Act}= Actual Flow rate of water

θ=Angle of inclination = 90 degree

$g=981 cm/s^2$

$Q_{The}= (8/15) \sqrt{(2g)} . \tan(\theta/2) . H^{5/2}$

$Q_{Act}=(A*h)/t$

$C_d= Q_{Act}/Q_{The}$

Procedure :

1. Open the Calibration of V-notch experiment and click on the next button shown at the bottom right corner.
2. Start the pump by clicking on green button and then click on the next button
3. Click on the inlet valve to rotate it.
4. Click on hand to rotate the inlet valve and click on the next button.
5. Note the initial reading of the hook gauge and click on the knob
6. Calculate head of water and theoretical discharge. Then click the next button.
7. Click on the ball valve to close it and allow the water to rise in the collecting tank.
8. Calculate actual discharge of V-notch and click on the next button
9. Repeat the same procedure, after certain trials, click on the red button to stop the pump and click on the next button.
10. Click on the label button to see the graph

Calculations and Observations:

Case 1:

Initial reading (water level till crest) = 3.15cm
Final reading = 8.85 cm
Head of Water, H = Final − Initial

$= 8.85 - 3.15$

$= 5.7$ cm

$$Q_{th} = \frac{8}{15} \times \sqrt{2g} \times \tan\frac{\theta}{2} \times H^{5/2}$$

[$\theta = 90°$

$g = 981\ cm/s^2$]

$$= \frac{8}{15} \times \sqrt{2 \times 981} \times \tan 45° \times (5.7)^{5/2}$$

$$= \frac{8}{15} \times 44.30 \times 1 \times 77.56$$

$$Q_{th} = 1832.69 \approx 1832.7\ cm^3/s$$

$$Q_{act} = \frac{A \times h}{t}$$

$A = 3500\ cm^2$

[where $h = 10$ cm &

$t = 31.4$ sec]

$$Q_{Act} = \frac{3500 \times 10}{31.4}$$

$$= 1114.6\ cm^3/s$$

$$C_d = \frac{Q_{Ac}}{Q_{Th}}$$ = Coffecient of discharge

$$= \frac{1114.6}{1832.7} = 0.608$$

Case 2:

Initial Reading (Water level till crest) = 3.15 cm

Final Reading = 7.12 cm

Head of Water, $H = 7.12 - 3.15$

$= 3.97$ cm

$$Q_{Th} = \frac{8}{15} \times \sqrt{2g} \times \tan\frac{\theta}{2} \times H^{5/2} \quad [\theta = 90^\circ]$$

$$= \frac{8}{15} \times 44.30 \times 1 \times (3.97)^{5/2}$$

$$= \frac{8}{15} \times 44.3 \times 31.40$$

$$= 741.87 \approx 741.9 \text{ cm}^3/\text{s}$$

$$Q_{AC} = \frac{A \times h}{t} = \frac{3500 \times 10}{72} \quad [h = 10 \text{ cm } \& \; t = 72 \text{ s}]$$

$$= 486.1 \text{ cm}^3/\text{s}$$

$$C_d = \frac{Q_{Act}}{Q_{Th}} = \frac{486.1}{741.9}$$

$$= 0.65$$

Case 3:

Initial Reading (Water level till crest) = 3.15 cm

Final Reading = 7.12 cm

Head of Water, $H = 7.12 - 3.15$

$= 3.97$ cm

$$Q_{Th} = \frac{8}{15} \times \sqrt{2g} \times \tan\frac{\theta}{2} \times H^{5/2} \quad [\theta = 90^\circ]$$

$$= \frac{8}{15} \times 44.30 \times 1 \times (3.97)^{5/2}$$

$$= \frac{8}{15} \times 44.3 \times 31.40$$

$$= 741.87 \approx 741.9 \text{ cm}^3/\text{s}$$

$$Q_{AC} = \frac{A \times h}{t} = \frac{3500 \times 10}{72} \quad [h = 10 \text{ cm} \;\&\; t = 72 \text{ s}]$$

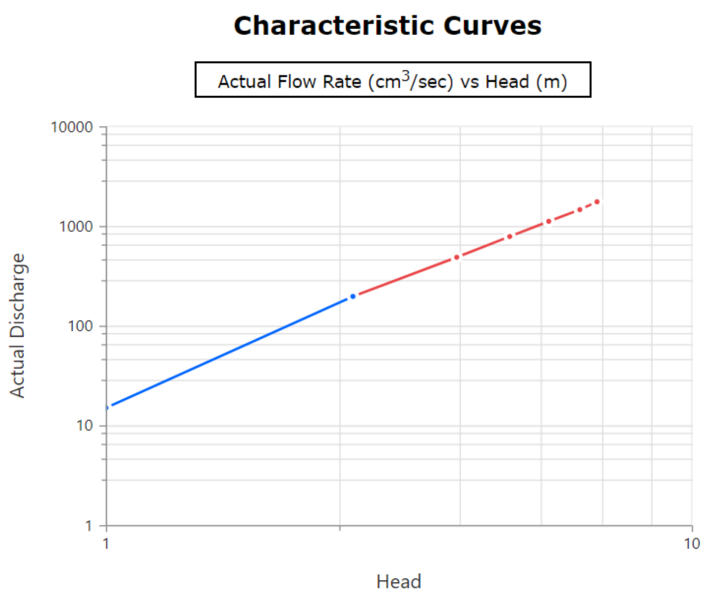
$$= 486.1 \text{ cm}^3/\text{s}$$

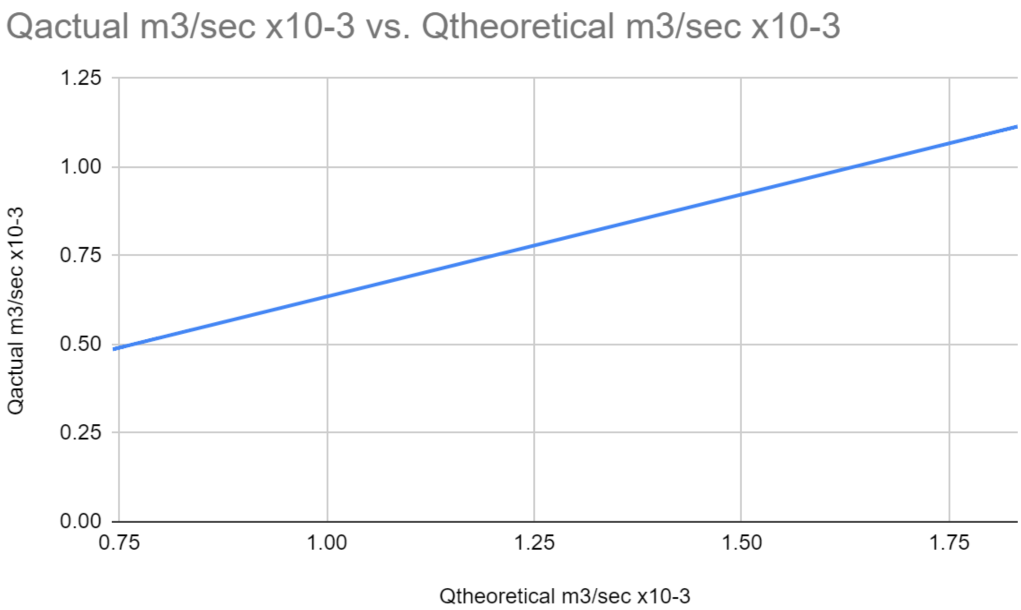
$$C_d = \frac{Q_{Act}}{Q_{Th}} = \frac{486.1}{741.9}$$

$$= 0.65$$

Coefficient of Discharge for V- notch=0.65+0.65+0.608 =0.636

Graph:





Result Table

Sr.No	**Head over notch(H) (m)**	**Q_{actual} m^3/sec $x10^{-3}$**	**$Q_{theoretical}$ m^3/sec $x10^{-3}$**	**C_d**	**ln(H)**	**lnQ_{actual}**
1	0.057	1.1146	1.8327	0.608	-2.864	-6.8
2	0.0397	0.4861	0.7419	0.65	-3.22	-7.62
3	0.0397	0.4861	0.7419	0.65	-3.22	-7.62

Result and conclusion:

Graphical Solution

Slope, n = 2.45

k = 15

Coefficient of discharge, C_d = 0.63

When we increase the time, the value of the Coefficient of discharge also increases.
k=constant depend on the notch =15
n = constant= slope= 2.45