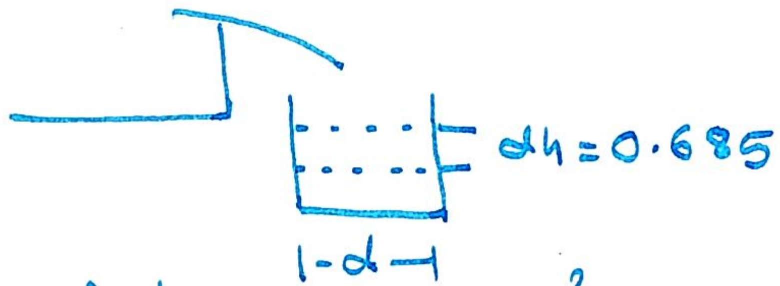
Q.1 In an experiment on 90° V notch, the flow is collected in a 0.90 m diameter vertical cylindrical tank . It is found that the depth of water increases by 0.685 m in 16.8 seconds when the head over the notch is 0.2 m. Determine the coefficient of discharge. If the error in observation of head over the notch is 1mm ,what will be the error in discharge?

$C_d = ?$



given

$\theta = 90^\circ \quad \theta/2 = 45^\circ$

$d_m = 0.90 m$

$dh = 0.685 m$

$T = 16.8 sec$

$H = 0.2 m$

$dH = 1 mm = 1 \times 10^{-3} m$

$$Q_{actual} = \frac{A \times h}{Time} = \frac{\pi/4 \times d^2 \times h}{Time} = \frac{\pi/4 \times (0.9)^2 \times 0.685}{16.8}$$

$$Q_{actual} = 0.02594 \ m^3/sec$$

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

$$= \frac{8}{15} \tan 45^\circ \sqrt{2 \times 9.81} \times (0.2)^{5/2}$$

$$Q_{th} = 0.0423 \ m^3/sec$$

$$C_d = \frac{Q_{actual}}{Q_{th}} = \frac{0.02594}{0.0423} = 0.614$$

→ Error

$$dQ = \frac{8}{15} C_d \tan\theta/2 \sqrt{2g}\ 5/2\ H^{3/2} dH$$

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

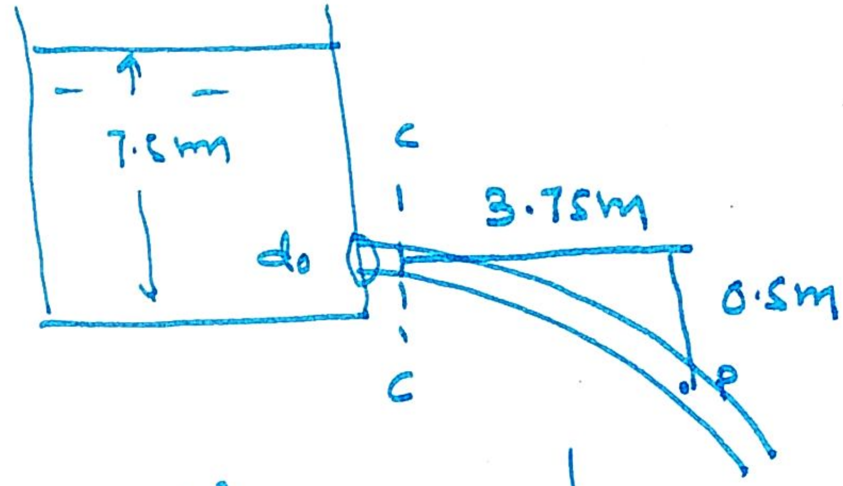
$$\frac{dQ}{Q} = \frac{8/15\ C_d \tan\theta/2 \sqrt{2g}\ 5/2\ H^{3/2} dH}{8/15\ C_d \tan\theta/2 \sqrt{2g}\ H^{5/2}}$$

$$\frac{dQ}{Q} = 5/2 \frac{dH}{H}$$

$$\frac{dQ}{0.02594} = 5/2 \frac{0.001}{0.2} \Rightarrow dQ = 0.324 \times 10^{-3}\ m^3/sec$$

Q.2 The head of water over an orifice of diameter 7.5 cm is 7.5 m. The jet of water coming out from the orifice is collected in a tank having cross-sectional area of 1 m x 1 m. The rise of water level in this tank is 0.87 m in 25 seconds. The coordinates of a point on the jet measured from venacontracta are 3.75 m horizontal and 0.5 m vertical. Find the co-efficient of discharge, co-efficient of velocity and coefficient of contraction.

Given Data



$D_o = 7.5cm = 7.5 \times 10^{-2} m$

$H = 7.5m$

$A_o = \pi/4 \, D_o^2 = \pi/4 \, (7.5 \times 10^{-2})^2$

$= 0.004178 m^2$

$A_m = 1 m^2$

$Q_{th} = (\pi/4 \, d_o^2) \sqrt{2gH}$

$h = 0.87 m$

$T = 25 sec$

$= 0.004178 \times \sqrt{2 \times 9.81 \times 7.5}$

$X = 3.75m$

$= 0.050 \, m^3/sec$

$y = 0.5m$

$$Q_{actual} = \frac{A \times h}{Time} = \frac{1 \times 0.87}{25} = 0.0348 \, m^3/sec$$

$$C_d = \frac{Q_{actual}}{Q_{th}} = \frac{0.0348}{0.050} = 0.696$$

$$C_v = \frac{x}{\sqrt{yH4}} = \frac{3.75}{\sqrt{4 \times 0.5 \times 7.5}} = 0.96$$

$$C_c = \frac{C_d}{C_v} = \frac{0.696}{0.96} = 0.71$$