Day-9

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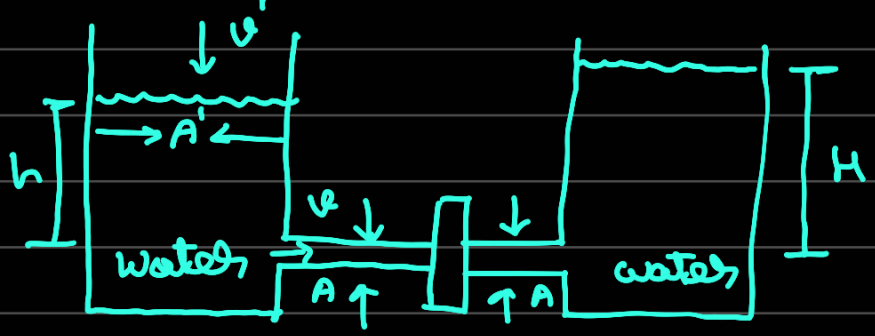

$$\rho A v^2 = \rho g H A$$

$$\Rightarrow 2gh = gH \qquad (v = \sqrt{2gh} \text{ velocity of efflux})$$

$$\Rightarrow h = H/2$$

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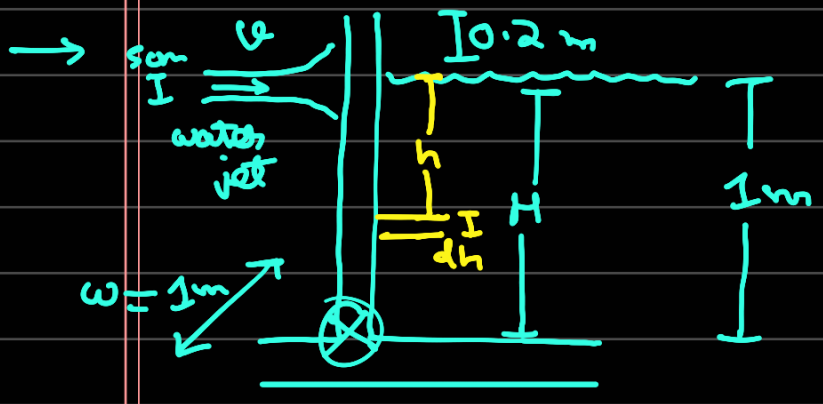

$$\tau_{jet} = \rho A v^2 H$$

$$\tau_{water} = \int d\tau$$

$$= \int (H-h)\, dF$$

$$= \int_0^H (H-h)(P_{atm} + \rho g h)\, \omega\, dh$$

$$= w \int_0^H (H P_{atm} + H\rho g h - P_{atm} h - \rho g h^2)\, dh$$

$$= W\left(H^2 P_{atm} + \frac{H^3 \rho g}{2} - \frac{P_{atm} H^2}{2} - \frac{\rho g H^3}{3}\right)$$

$$\tau_{jet} = \tau_{water}$$

$$\Rightarrow v = \sqrt{\frac{W}{\rho A}\left(H P_{atm} + \frac{H^2 \rho g}{2} - \frac{P_{atm} H}{2} - \frac{\rho g H^3}{3}\right)}$$

$$= \sqrt{\frac{4HW}{\rho \pi d^2}\left(\frac{P_{atm}}{2} + \frac{\rho g H}{6}\right)}$$

mistake: P_{atm} acts on both sides. So we should remove P_{atm} from this expression

$$\text{So } v = \sqrt{\frac{4HW}{\rho \pi d^2} \times \frac{\rho g H}{6}}$$

$$= \frac{H}{d}\sqrt{\frac{2gW}{3\pi}}$$

Put $d = 0.05\ m$, $g = 10\ ms^{-2}$
$W = 1\ m$

$$\text{So } v = 20H\sqrt{\frac{2 \times 10 \times 1}{3\pi}}$$

$$= 29.1346H \quad m$$

$v(H=1) = 29.1346\ m$
$v(H=0.5) = 14.5673\ m$
$v(H=0.25) = 7.28365\ m$

$\rightarrow$ $P_{atm} + 13600 \times 10 \times 0.75 = 1000 \times v^2$

$= 101325$ Pa $\qquad + 1000 \times 10 \times 0.75$

$$v = \sqrt{\frac{203325 - 7500}{1000}} \ ms^{-1}$$

$\approx 14 \ ms^{-1}$

$A_1 v_{exit} = A_2 v \qquad$ (But $A_1 = A_2$)

$\Rightarrow v_{exit} = v = 14 ms^{-1}$

$$F_x = v \frac{dm}{dt}_1 + v_{exit} \frac{dm}{dt}_2 \cos 30^\circ$$

$$= \left(1 + \frac{\sqrt{3}}{2}\right) \times \rho A v^2$$

$$= \left(1 + \frac{\sqrt{3}}{2}\right) \times 195825 \times \pi \times \frac{0.0025}{4}$$

$\approx 717.49 \ N$

$\frac{dm}{dt} \approx 27.46 \ kg \ s^{-1}$