Integrating Euler's equation

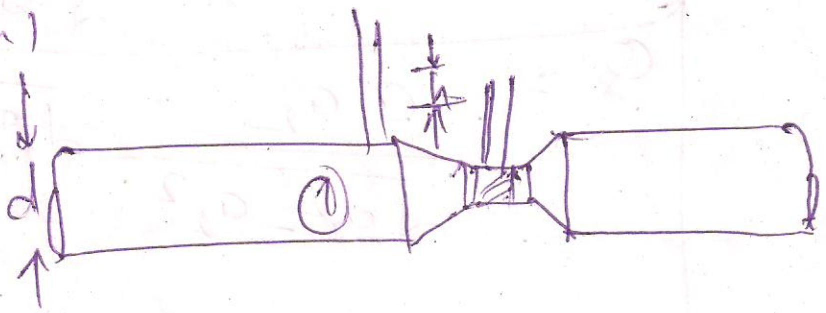
$$\int \frac{dp}{\rho} + g\int dz + \int v\,dv = 0$$

$$\frac{p}{\rho} + gz + \frac{v^2}{2} = 0$$

$$\boxed{\frac{p}{\rho g} + z + \frac{v^2}{2g} = 0}$$

Bernoulli's eqn.

* Venturimeter :–



let d_1 = diameter at section 1

P_1 = Intensity of press.

V_1 = velocity at 1

a_1 = Area at ①

$= \frac{\pi}{4} d_1^2$

Similarly P_2, V_2, a_2 & d_2 for section ②

Applying Bernoulli's equation

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2$$

As pipe is horizontally fitted so $z_1 = z_2$

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

$$\frac{P_1 - P_2}{\rho g} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

But $\frac{P_1 - P_2}{\rho g}$ = Difference of press. head = h

$$\Rightarrow h = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

Using continuity equation,

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

$$h = \frac{V_2^2}{2g} - \frac{\left(\frac{a_2 V_2}{a_1}\right)^2}{2g}$$

$$= \frac{V_2^2}{2g}\left[1 - \frac{a_2^2}{a_1^2}\right]$$

$$h = \frac{v_2^2}{2g}\left[\frac{a_1^2 - a_2^2}{a_1^2}\right]$$

But $Q = a_2 v_2$

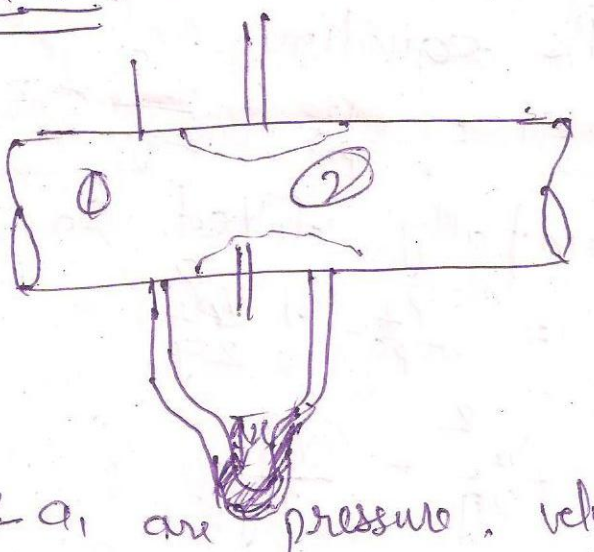
$$v_2^2 = 2gh \frac{a_1^2}{(a_1^2 - a_2^2)}$$

$$v_2 = \sqrt{2gh}\,\frac{a_1}{\sqrt{a_1^2 - a_2^2}}$$

$$\boxed{Q = \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}}\sqrt{2gh}}$$

discharge formula for venturimeter,

* Orificemeter :-



Let P_1, v_1 & a_1 are pressure, velocity & area at section 1 resp.
P_2, v_2 & a_2 are the same at section (2)
Applying Bernaulli's equation

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2$$

$$\left(\frac{P_1}{\rho g} + Z_1\right) - \left(\frac{P_2}{\rho g} + Z_2\right) = \frac{v_2^2}{2g} - \frac{v_1^2}{2g}$$

$$h = \frac{v_2^2}{2g} - \frac{v_1^2}{2g}$$

$$2gh = v_2^2 - v_1^2$$

$$v_2^2 = 2gh + v_1^2$$