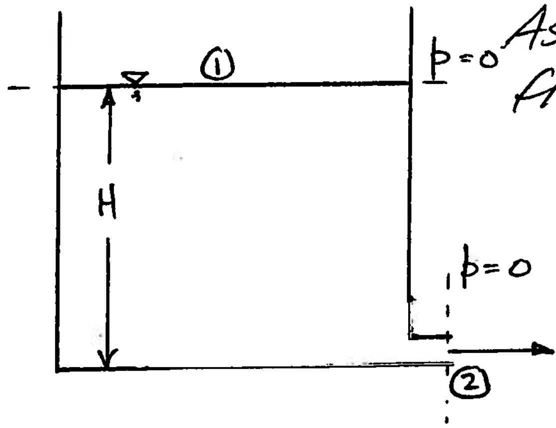
Application of Bernoulli's Equation

A tank with water drains through a small hole to the atmosphere as shown. Determine the speed of the flow in the small hole.



Assume irrotational, frictionless flow.

Solution

$$\frac{p_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{p_2}{\gamma} + z_2 + \frac{V_2^2}{2g} \quad \text{(Bernoulli's Eqn.)}$$

$p_1 = p_2 = 0$

$z_1 = H \; ; \; z_2 = 0$

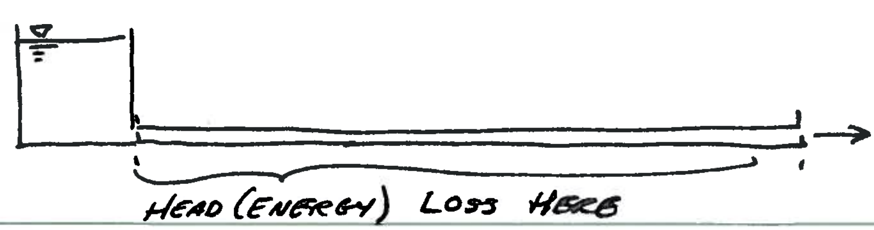
$$H + \cancel{\frac{V_1^2}{2g}} = \frac{V_2^2}{2g}$$

$V_1 \approx 0$ (Fluid is in motion, but relative to the moving free surface the speed is negligible)

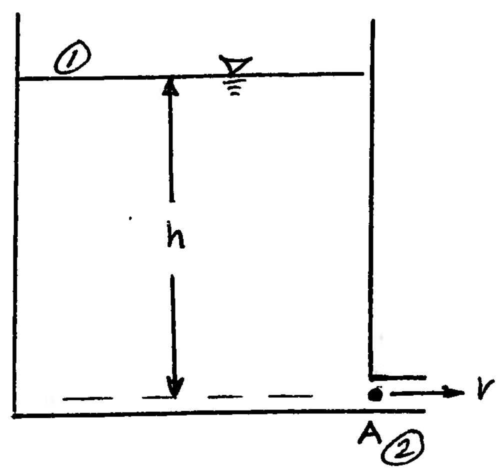
$$\therefore \boxed{V_2 = \sqrt{2gH}}$$

"PRETTY CLASSICAL" EXAMPLE

USED LATER ON IN PIPELINES AS:



Velocity in the outlet pipe from reservoir is 16 ft/sec and h = 15 ft. Assume irrotational, frictionless flow. What is the pressure at A?



Solution

$$\cancel{\frac{p_1}{\gamma}}^{0} + z_1 + \cancel{\frac{V_1^2}{2g}}^{\sim 0} = \frac{p_2}{\gamma} + \cancel{z_2}^{0} + \frac{V_2^2}{2g} \quad \text{(Bernoulli's Eqn.)}$$

$$h = \frac{p_2}{\gamma} + \frac{V_2^2}{2g}$$

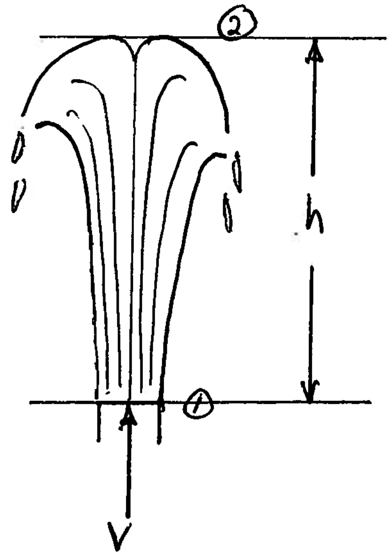
$$\left(h - \frac{V_2^2}{2g}\right)\gamma = p_2$$

$$\left(15\,ft - \frac{(16\,ft/sec)^2}{2(32.2\,ft/sec^2)}\right)\frac{62.4\,lbf}{ft^3} = 687\,lbf/ft^2$$

$$687\frac{lb}{ft^2}\cdot\frac{1\,ft^2}{144\,in^2} = \underline{\underline{4.7\,psig}}$$

BERNOULLI'S EX3

Water issues vertically from a fountain. The water velocity at the exit is 20 ft/sec. Assume irrotational flow. How high will the fountain go?



Solution

$$\frac{p_1}{\gamma} + z_1 + \frac{V_1^2}{2g} = \frac{p_2}{\gamma} + z_2 + \frac{V_2^2}{2g}$$

$p_1 = p_2 = 0$ gage

$z_1 = 0$; $z_2 = h$

$V_2 \approx 0$ at top of jet

$$\therefore \frac{V_1^2}{2g} = h$$

$$h = \frac{(20\,ft/sec)^2}{2(32.2\,ft/sec^2)} = \underline{\underline{6.21\ ft}}$$