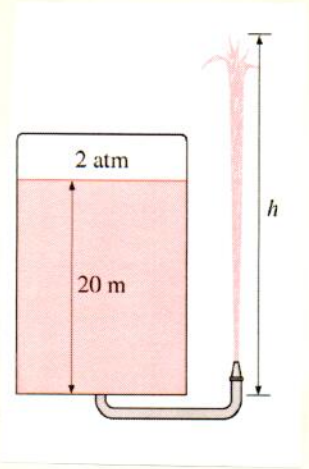
Angel
P5-59

Bernoulli Eqn

The water level in a tank is 20 m above the ground. A hose is connected to the bottom of the tank and a nozzle at the end of the hose points straight up as shown in the sketch. The air in the tank above the water surface is pressurized to 2 atm gage.

Estimate the maximum height to which the water stream could rise.



Assuming negligible losses in the nozzle and negligible air resistance, we can write the Bernoulli eqn between the water surface (pt. 1) and the point of maximum height (pt. 2).

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

$V_1^2/2g \to 0$ large surface area; $P_2/\gamma \to 0$ atm pressure; $V_2^2/2g \to 0$ top of rise

$$\therefore \quad z_2 - z_1 = \frac{P_1}{\gamma}$$

but $z_1 - 20\text{m} + h = z_2$ $\quad \therefore \quad z_2 - z_1 = h - 20\text{m}$

or $h = \frac{P_1}{\gamma} + 20\text{m}$

$\gamma = \rho g = \left(998 \frac{\text{kg}}{\text{m}^3}\right)\left(9.81 \frac{\text{m}}{\text{s}^2}\right)$

$= 9790 \frac{\text{N}}{\text{m}^3}$

$$h = \frac{(2\text{ atm})\left(101\text{ kPa}\frac{}{\text{atm}}\right)}{9790\ \text{N/m}^3} + 20\text{m}$$

$$= \frac{202 \times 10^3\ \text{N/m}^2}{9.790 \times 10^3\ \text{N/m}^3} + 20\text{m}$$

$$= 20.6\text{m} + 20\text{m}$$

$$= \boxed{40.6\text{m}} \quad \text{ans}$$