Flow Rate Calculation

$r = 0.25\,[in] \rightarrow 0.64\,[cm] \rightarrow 0.0064\,[m]$

$Q = \frac{V}{t}$ Volumetric flow rate equation

$A = \pi r^2 = \pi(0.0064)^2$

Pump claims to pump 410 GPH

Let x be my Volumetric flow rate (in GPH)

$$\frac{x\,[G]}{1\,[H]} \cdot \frac{1\,[m^3/s]}{951022\,[g/h]} = \frac{x}{951022}\left[\frac{m^3}{s}\right]$$

$$\hookrightarrow \frac{x}{951022}\left[\frac{m^3}{s}\right] = \frac{V}{t} = \frac{A \cdot d}{t}, \quad \frac{d}{t} = v$$

$$\frac{x}{951022}\left[\frac{m^3}{s}\right] = A \cdot v$$

$$v_0 = \frac{x}{951022 \cdot A}\,[m/s]$$

Bernoulli's equation

$$\cancel{P_1} + \frac{1}{2}\rho v_1^2 + \rho g h_1 = \cancel{P_2} + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Pressures are same atmos, no ext

$$\frac{1}{2}\cancel{\rho_{H_2O}} v_1^2 + \cancel{\rho_{H_2O}} g \underset{0}{\cancel{h_1}} = \frac{1}{2}\cancel{\rho_{H_2O}} v_2^2 + \rho_{air} g h_2$$

$$\frac{1}{2} v_0^2 = \frac{1}{2} v_f^2 + \frac{\rho_{air}}{\rho_{H_2O}} gh$$

$$v_f = \sqrt{v_0^2 - 2\frac{\rho_{air}}{\rho_{H_2O}} gh}$$

$$\boxed{v_f = \sqrt{\left[\frac{x}{951022 \cdot A}\right]^2 - 2\frac{\rho_{air}}{\rho_{H_2O}} gh}}$$

$$\frac{gal}{hours} = \frac{1\ gal}{3600\ seconds}$$

*note $1\ gal = 0.00378541\ m^3$

$$\frac{1\ gal}{3600\ s} \cdot \frac{0.00378541\ m^3}{1\ gal} = \frac{0.00378541\ m^3}{3600\ s}$$

Take inverse of constants to find $1\ m^3/s$

$$\frac{1\ g}{1\ h} = \frac{0.0037854\ m^3}{3600\ s}$$

$$\hookrightarrow \frac{3600\ g}{0.0037854\ h} = \frac{m^3}{s}$$

$$1\ \frac{m^3}{s} = 951022\ g/h$$