

Problem 7.42

$$\frac{p_1}{\gamma} + z_1 + \frac{v_1^2}{2g} + h_A - h_R - h_L = \frac{p_2}{\gamma} + z_2 + \frac{v_2^2}{2g}$$

$$P_1 = 30 \text{ psig} \times 144 \text{ in}^2/\text{ft}^2 = 4320 \text{ lb}/\text{ft}^2$$

$$Z_1 = 220 \text{ ft}$$

$V_1 = \text{zero}$  (assume tank level doesn't move quickly)

$h_A = \text{head being added to fluid}$  (solve for this)

$h_R = \text{no energy being removed from the fluid}$

$h_L = \text{Given head loss through piping of } 15.5 \text{ ft}$

$P_2 = \text{zero psig}$  (atmospheric)

$Z_2 = \text{zero reservoir level}$

$V_2 = \text{zero}$  (assume level doesn't change enough to matter)

Solve for  $h_A$

$$h_A = z_1 - h_L - \frac{p_1}{\gamma} = 220 \text{ ft} - 15.5 \text{ ft} - \frac{4320 \text{ lb}/\text{ft}^2}{62.4 \text{ lb}/\text{ft}^3}$$

$$h_A = 135.27 \text{ ft}$$

$$P_A = h_A \gamma Q = 135.27 \frac{\text{ft} \cdot \text{lb}}{\text{lb}} * 62.4 \frac{\text{lb}}{\text{ft}^3} * 40 \text{ gpm} * \frac{\text{ft}^3/\text{s}}{449 \text{ gpm}}$$

$$P_A = 752 \frac{\text{lb} \cdot \text{ft}}{\text{s}} * \frac{1 \text{ HP}}{550 \frac{\text{lb} \cdot \text{ft}}{\text{s}}} = 1.37 \text{ hp}$$