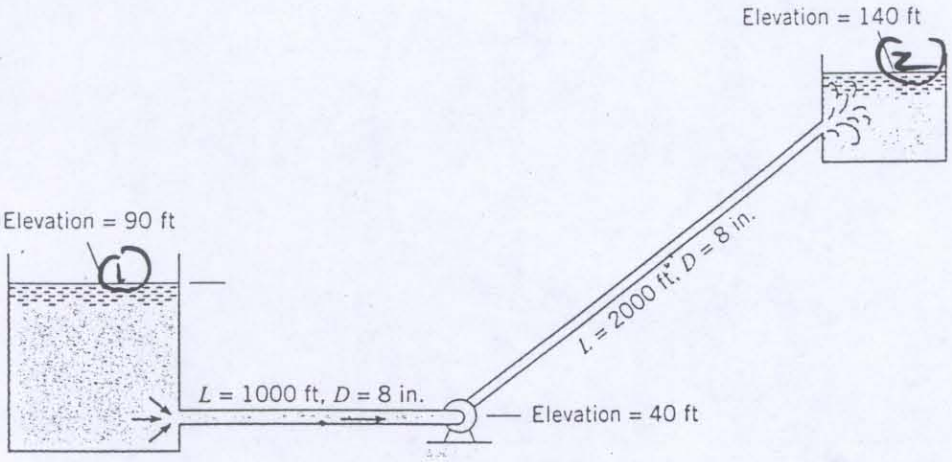
7.62 What horsepower must be supplied to the water to pump 2.5 cfs at 68°F from the lower to the upper reservoir? Assume that the head loss in the pipes is given by $h_L = 0.015(L/D)(V^2/2g)$, where L is the length of pipe in feet and D is the pipe diameter in feet. Sketch the HGL and the EGL.



PROBLEM 7.62

$V = Q/A = 2.5 / \frac{\pi}{4}\cdot(\frac{8}{12})^2 = 7.16$ ft/s

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

$90 + h_p = 140 + .015\left(\frac{L}{D}\right)\frac{V^2}{2g} + \frac{V^2}{2g}$

$h_L = .015\left(\frac{3000}{8/12}\right)\frac{7.16^2}{2\cdot 32.2} + \frac{V^2}{2g} = 54.6$ ft

(53.8 + $\frac{V^2}{2g}$ = h_L)

$\frac{V^2}{2g} = \frac{7.16^2}{2\times 32.2} = .8$

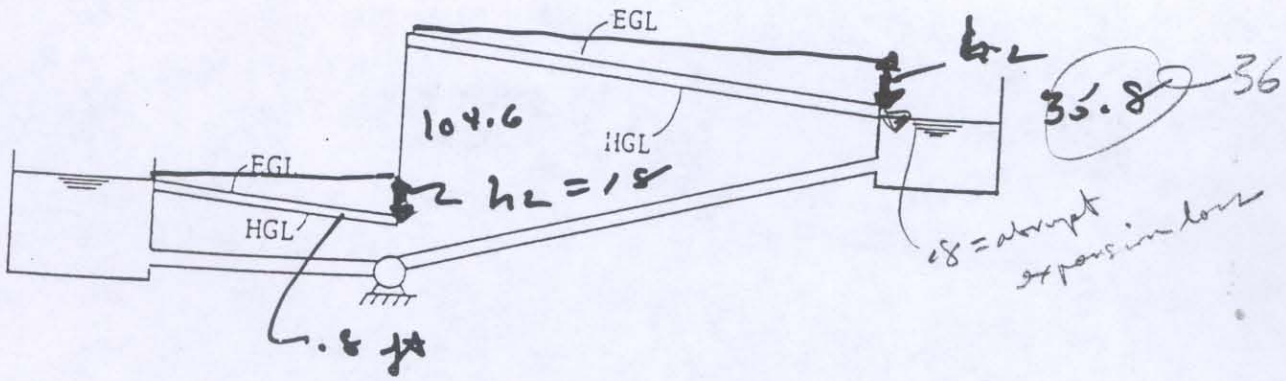
$h_p = 140 + 54.6 - 90 = 104.6$ ft

$\dot{W}_p = \gamma Q h_p = \underbrace{62.4}_{\rho g = 1.94\times 32.2} \cdot 2.5 \cdot 104.6 = 16{,}318 \frac{\text{ft}\cdot\text{lbf}}{\text{s}}$

$= 29.7$ hp

$\frac{1 \text{ ft}\cdot\text{lbf}}{\text{s}} = 550$ hp

$16{,}318 \frac{\text{ft}\cdot\text{lbf}}{\text{s}} \times \frac{1 \text{ hp}}{550 \frac{\text{ft}\cdot\text{lbf}}{\text{s}}} = 29.7$ hp



$$\frac{V^2}{2g} = .8 \text{ ft}$$

$$\text{slope} = \frac{f V^2}{D 2g} = \frac{.015}{8/12} \cdot .8$$

$$= .02 \quad .018$$

$L \cdot \text{slope} = h_L$ in each pipe

$$h_L = f \frac{L}{D} \frac{V^2}{2g}$$