

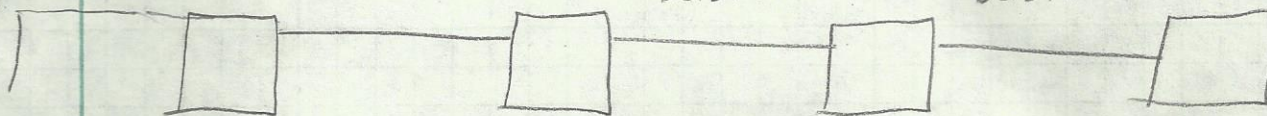
③

68.3 mi

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$$\rho = 78.6 \frac{\text{lbm}}{\text{ft}^3}$$

$$0.58 \frac{\text{kg}}{\text{m}^3} \times \frac{1 \text{ lbm}}{0.454 \text{ kg}} \times \frac{1 \text{ m}}{3.28 \text{ ft}} = 0.389$$

$$\text{S.G.} = 1.26$$

$$L = 273 \text{ miles}$$

$$D = 18''$$

$$Q = 4200 \text{ gal/min}$$

$$K \left(\frac{\text{kg}}{\text{m}^3} \right) = 0.58$$

$$\eta = 0.70$$

$$n = 0.2$$

$$\dot{M} = 660 \frac{\text{tons}}{\text{hr}} \times \frac{2000 \text{ lbm}}{\text{ton}} \times \frac{1 \text{ hr}}{3600 \text{ s}} = 366.7 \text{ lbm/s}$$

$$K = 0.389 \frac{\text{lbm}}{\text{ft}^3}$$

$$\bar{V} = \frac{Q}{A} = \frac{4200 \text{ gal/min} \times \frac{1 \text{ ft}^3}{7.48 \text{ gal}} \times \frac{1 \text{ min}}{60 \text{ s}}}{\frac{\pi (1.5 \text{ ft})^2}{4}} = \frac{9.36 \frac{\text{ft}^3}{\text{s}}}{1.77 \text{ ft}^2} = 5.296 \text{ ft/s}$$

$$\frac{\pi (1.5 \text{ ft})^2}{4}$$

$$Re = 2^{2.8} \left(\frac{0.2}{1.6} \right)^{0.2} \frac{(5.296 \text{ ft/s})^{1.8} (1.5 \text{ ft})^{0.2} (78.6 \frac{\text{lbm}}{\text{ft}^3})}{0.389 \frac{\text{lbm}}{\text{ft}^3}}$$

$$= 20,233 \text{ turbulent}$$

$$68.25 \text{ miles} \times \frac{5280 \text{ ft}}{\text{mi}} = 360360 \text{ ft}$$

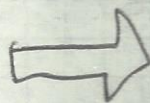
$$f = 0.0018$$

$$W = \frac{\Delta P}{\rho} + g \Delta z + h_f + \frac{\Delta V^2}{2}$$

$$\frac{\Delta P}{\rho} = h_f$$

$$h_f = 4 f \frac{L}{D} \frac{\bar{V}^2}{2} = \frac{4 (0.0018) (360360 \text{ ft}) (5.296 \text{ ft/s})^2}{2 \left(\frac{32.2 \text{ lbm} \cdot \text{ft}}{\text{lb}_f \cdot \text{s}^2} \right) (1.5 \text{ ft})}$$

$$\Delta P = 753.3 \frac{\text{lb}_f \cdot \text{ft}}{\text{lbm}} \left(78.6 \frac{\text{lbm}}{\text{ft}^3} \right) = 753.3 \frac{\text{lb}_f \cdot \text{ft}}{\text{lbm}}$$



$$\Delta P = -411.2 \text{ psi}$$