

Ch 11

5.

HW 3.1 & 3.2

$$A_a = \frac{\pi \times D_a^2}{4} = \frac{\pi \times 0.1463^2}{4} = 1.682 \times 10^{-2} \text{ m}^2$$

$$A_b = \frac{\pi \times D_b^2}{4} = \frac{\pi \times 0.493^2}{4} = 1.905 \times 10^{-3} \text{ m}^2$$

$$V_a = \frac{Q_a}{A} = \frac{0.015}{1.682 \times 10^{-2}} = 0.892 \text{ m/s}$$

$$V_b = \frac{Q_b}{A} = \frac{0.015}{1.905 \times 10^{-3}} = 7.87 \text{ m/s}$$

$$N_{Ra} = \frac{V_a \times D_a}{(\mu/\rho)} = \frac{0.892 \times 0.1463}{2.12 \times 10^{-5}} = 6.15 \times 10^3$$

$$\frac{D}{\epsilon} = \frac{0.1463}{4.6 \times 10^{-5}} = 3180$$

$$f_{sa} = 0.035$$

$$f_T = 0.019$$

$$N_{Rb} = \frac{7.87 \times 0.0493}{2.12 \times 10^{-5}} = 1.83 \times 10^4$$

$$\frac{D_b}{\epsilon} = \frac{0.0493}{4.6 \times 10^{-5}} = 1072$$

$$f_{sb} = 0.028$$

$$f_T = 0.019$$

$$h_1 = f_{sa} \left(\frac{L_a}{D_a} \right) \left(\frac{V_a^2}{2g} \right) = 0.035 \left(\frac{180}{0.1463} \right) \left(\frac{0.892^2}{2(9.81)} \right) = 1.746332 \text{ m}$$

$$h_2 = f_{sb} \left(\frac{L_b}{D_b} \right) \left(\frac{V_b^2}{2g} \right) = 0.028 \left(\frac{8}{0.0493} \right) \left(\frac{7.87^2}{2(9.81)} \right) = 14.34338 \text{ m}$$

$$h_3 = 2 \times 20 \times 0.019 \times \left(\frac{7.87^2}{2(9.81)} \right) = 2.399187 \text{ m}$$

$$h_4 = 0.37 \left(\frac{7.87^2}{2(9.81)} \right) = 1.168025 \text{ m}$$

$$h_L = h_1 + h_2 + h_3 + h_4 = 19.65693 \text{ m}$$

$$P_A = 8.80 \left[19.65693 + \frac{12.5 \times 10^6}{8.80} + 4.5 + \left(\frac{0.897^2}{2(9.81)} - \frac{7.87^2}{2(9.81)} \right) \right]$$

$$P_A = 12.74 \text{ MPa}$$

$$13. Q = A \times V \quad A = \frac{\pi \times D^2}{4} = \frac{\pi \left(\frac{0.5}{12}\right)^2}{4} = 0.0013635 \text{ ft}^2$$

$$\frac{D}{\epsilon} = \frac{0.5}{1.5 \times 12 \times 10^{-4}} = 277.777$$

$$h_L = \left(\frac{P_A - P_B}{\gamma} \right) + \left(\frac{V_A^2}{2g} - \frac{V_B^2}{2g} \right) + z_A - z_B = 28.15 \text{ ft}$$

$$Q = -2.22 \times D^2 \sqrt{\frac{g \cdot D \cdot h_L}{L}} \log \left(\frac{1}{3.7D/\epsilon} + \frac{1.784(V)}{D \sqrt{\frac{g \cdot D \cdot h_L}{L}}} \right) = 0.0425 \text{ ft}^3/\text{s}$$

$$V = \frac{Q}{A} = \frac{0.04250}{0.0013635} = \boxed{31.17 \text{ ft/s}}$$

$$6. h_L = \left(\frac{11520}{62.4} \right) + (0 - 18) = 166.615 \text{ ft}$$

$$Q = -2.22 (0.041667^2) \sqrt{\frac{32.2 (0.41667) (166.61)}{20}} \log \left(\frac{1}{3.7(277.778)} + \frac{1.784(7.37 \times 10^4)}{0.041667 \sqrt{\frac{32.2 (0.41667) (166.61)}{20}}} \right)$$

$$Q = 0.088 \text{ ft}^3/\text{s}$$

$$V = \frac{Q}{A} = \frac{0.088}{0.0013635} = \boxed{64.53 \text{ ft/s}}$$