

5.15

5.15 Water at $0.1 \text{ m}^3/\text{s}$ and alcohol ($SG=0.8$) at $0.3 \text{ m}^3/\text{s}$ are mixed in a y-duct as shown in Fig. 5.15. What is the average density of the mixture of alcohol and water?

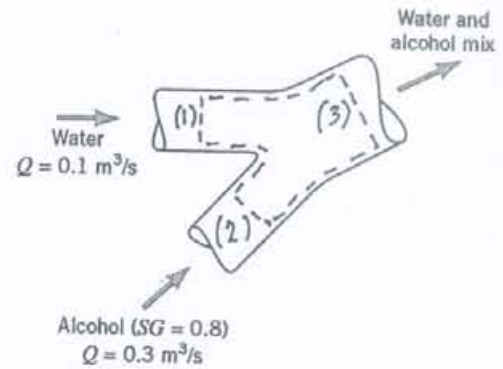


FIGURE P5.15

For steady flow

$$\dot{m}_1 + \dot{m}_2 = \dot{m}_3$$

or

$$\rho_1 Q_1 + \rho_2 Q_2 = \rho_3 Q_3 \quad (1)$$

Also, since the water and alcohol may be considered incompressible

$$Q_1 + Q_2 = Q_3 \quad (2)$$

Combining Eqs. 1 and 2 we get

$$\rho_1 Q_1 + \rho_2 Q_2 = \rho_3 (Q_1 + Q_2)$$

or

$$\rho_3 = \frac{\rho_1 Q_1 + \rho_2 Q_2}{Q_1 + Q_2}$$

and

$$\rho_3 = \rho_1 \frac{(Q_1 + SG_2 Q_2)}{Q_1 + Q_2}$$

$$\text{Thus } \rho_3 = \frac{(999 \frac{\text{kg}}{\text{m}^3}) [0.1 \frac{\text{m}^3}{\text{s}} + (0.8)(0.3 \frac{\text{m}^3}{\text{s}})]}{0.1 \frac{\text{m}^3}{\text{s}} + 0.3 \frac{\text{m}^3}{\text{s}}} = \underline{\underline{849 \frac{\text{kg}}{\text{m}^3}}}$$