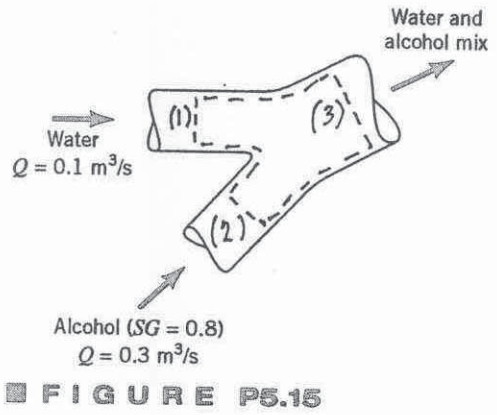
5.15

5.15 Water at 0.1 m^3/s and alcohol (SG=0.8) at 0.3 m^3/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

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

Also, since the water and alcohol may be considered incompressible

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

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

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

Thus

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