5.13

5.13 An evaporative cooling tower (see Fig. P5.13) is used to cool water from 110 to 80°F. Water enters the tower at a rate of 250,000 lbm/hr. Dry air (no water vapor) flows into the tower at a rate of 151,000 lbm/hr. If the rate of wet air flow out of the tower is 156,900 lbm/hr, determine the rate of water evaporation in lbm/hr and the rate of cooled water flow in lbm/hr.

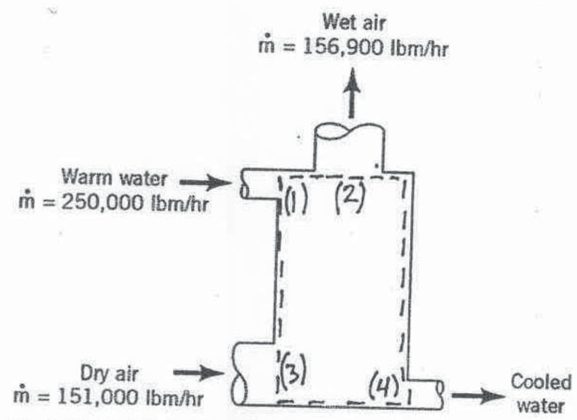

FIGURE P5.13

For steady flow of dry air

$$\dot{m}_3 = \dot{m}_{2,\,dry\ air} \qquad (1)$$

For steady flow of water

$$\dot{m}_1 = \dot{m}_{2,\,water} + \dot{m}_4 \qquad (2)$$

Also

$$\dot{m}_2 = \dot{m}_{2,\,dry\ air} + \dot{m}_{2,\,water} \qquad (3)$$

Combining Eqs. 1 and 3 we get

$$\dot{m}_{2,\,water} = \dot{m}_2 - \dot{m}_3 = \text{rate of water evaporation}$$

So

$$\dot{m}_{2,\,water} = 156,900\ \frac{lbm}{hr} - 151,000\ \frac{lbm}{hr} = \underline{\underline{5900\ \frac{lbm}{hr}}}$$

From Eq. 2 we get

$$\dot{m}_4 = \dot{m}_1 - \dot{m}_{2,\,water} = \text{rate of cooled water flow}$$

or

$$\dot{m}_4 = 250,000\ \frac{lbm}{hr} - 5900\ \frac{lbm}{hr} = \underline{\underline{244,000\ \frac{lbm}{hr}}}$$