

$$\varepsilon = \frac{\text{range}}{\text{range} + \text{approach}}$$

$$\text{range} = EWT - LWT$$

$$\text{approach} = LWT - T_{wb}$$

$$\varepsilon = \frac{EWT - LWT}{(EWT - LWT) + (LWT - T_{wb})} = \frac{EWT - LWT}{EWT - T_{wb}} = \frac{95^\circ F - 85^\circ F}{95^\circ F - 73.1^\circ F} = 45.7\%$$

**Answer B**

**45.26** A cooling tower has a range of  $15^\circ F$  and a volume flow rate of  $50\text{gpm}$ . Air enters at  $88^\circ F$  dry bulb and  $75^\circ F$  wet bulb and exits at  $92^\circ F$  and  $75\%$  relative humidity. Assuming no losses, what is the required volume flow rate of air?

- A.  $3,300\text{cfm}$
- B.  $7,700\text{cfm}$
- C.  $8,200\text{cfm}$
- D.  $10,900\text{cfm}$

The heat rejected by the condenser water is absorbed into the air. Use the sensible heat rule of thumb for water to determine the quantity of heat removed from the condenser water.

$$\dot{Q}_{cw} = \dot{Q}_{air}$$

$$\dot{Q}_{cw} = 500\text{GPM}\Delta T = (500)(50)(15) = 375,000 \frac{\text{Btu}}{\text{hr}}$$

$$\dot{Q}_{air} = \dot{m}\Delta h = 375,000 \frac{\text{Btu}}{\text{hr}}$$

Use the **Psychrometric Chart** to determine the enthalpy for the entering and leaving air as well as the specific volume for the entering air. Let State 1 represent the entering condition and State 2 represent the leaving condition.

$$T_{1,db} = 88^\circ F$$

$$T_{1,wb} = 75^\circ F$$

$$h_1 = 38.47 \frac{\text{Btu}}{\text{lb}}$$

$$v_1 = 14.2 \frac{ft^3}{lb_{da}}$$

$$T_2 = 92^\circ F$$

$$\phi_2 = 75\%$$

$$h_2 = 49.23 \frac{Btu}{lb}$$

Solve for the mass flow rate of air using the enthalpy values.

$$\dot{m} = \frac{\dot{Q}}{\Delta h} = \frac{\dot{Q}}{h_2 - h_1} = \frac{375,000 \frac{Btu}{hr}}{49.23 \frac{Btu}{lb} - 38.47 \frac{Btu}{lb}} = 34,851 \frac{lb}{hr}$$

Use the specific volume for State 1 to determine the volume flow rate in *cfm*.

$$\dot{V} = \dot{m}v_1 = \left(34,851 \frac{lb}{hr}\right) \left(\frac{1hr}{60min}\right) \left(14.2 \frac{ft^3}{lb}\right) = 8,248 cfm$$

**Answer C**

**45.27** What is the relative humidity of moist air at 6000 *ft* above sea level with a dry bulb temperature of 70° *F* and a partial pressure of dry air of 11.5 *psia*?

- A. 48%
- B. 58%
- C. 68%
- D. 78%

Use the table **Altitude Correction for Air** to find the **Density Factor** at 6,000 *ft* of elevation, and use it to determine the total pressure of moist air at that altitude.

$$DF = 0.801$$

$$p_t = (14.7 psia)(0.801) = 11.78 psia$$

The pressure of moist air is the sum of the pressure of partial pressure of water vapor in the air and the partial pressure of dry air. Since the partial pressure of dry air is given, subtract to find the partial pressure of water vapor.

$$p_w = p_t - p_{da} = 11.78 psia - 11.5 psia = 0.28 psia$$