$$\omega = 0.0084 \frac{lb_w}{lb_{da}}$$

$$v = 13.6 \frac{ft^3}{lb_{da}}$$

Recall the definition of the humidity ratio as described under Psychrometric Properties. Rearrange to solve for the mass of water.

$$\omega = \frac{m_w}{m_{da}}$$

$$m_w = (m_{da})(\omega)$$

The mass of air can be expressed as density times volume, or volume over specific volume.

$$m_{da} = \rho V = \frac{V}{v} = \frac{35,000 ft^3}{13.6 \frac{ft^3}{lb_{da}}} = 2574 lb_{da}$$

Determine the mass of water.

$$m_w = (m_{da})(\omega) = (2574 lb_{da}) \left(0.0084 \frac{lb_w}{lb_{da}}\right) = 21.6 lb_w$$

Answer B

45.25 Condenser water returns to a cooling tower at $95°F$ and leaves at $85°F$. The outside conditions are $84°F$ and 60% relative humidity. What is the cooling tower effectiveness?

A. 9%

B. 46%

C. 54%

D. 91%

To find the Cooling Tower effectiveness, start by using the Psychrometric Chart to determine the wet bulb temperature of the outdoor conditions.

$$T_{db} = 84°F$$

$$\phi = 60\%$$

$$T_{wb} = 73.1°F$$

Cooling tower effectiveness is defined by the equation below where range and approach are defined in terms of the entering and leaving water temperatures and the wet bulb temperature as shown.

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

$$range = EWT - LWT$$

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

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

Answer B

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

A. $3,300cfm$

B. $7,700cfm$

C. $8,200cfm$

D. $10,900cfm$

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.

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

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

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

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.

$$T_{1,db} = 88°F$$

$$T_{1,wb} = 75°F$$

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