44.15 Air at $85°F$ and 40% relative humidity enters a direct evaporative cooler with a saturation efficiency of 60%. What is the leaving air temperature?

A. $62°F$

B. $68°F$

C. $74°F$

D. $78°F$

The efficiency (Saturation Efficiency) of an Evaporative Cooler is the ratio of the actual temperature reduction achieved compared with the temperature differential if the air was cooled to the wet bulb temperature, i.e. fully *saturated*.

The entering conditions, State 1, are fully defined. Use the Psychrometric Chart to obtain the wet bulb temperature:

$$T_{1,db} = 85°F$$

$$\phi_1 = 40\%$$

$$T_{1,wb} = 67.3°F$$

Write the equation for the Saturation Efficiency and solve for the leaving air temperature, T_2:

$$\varepsilon_e = \frac{T_1 - T_2}{T_1 - T_{wb}}$$

$$.6 = \left(\frac{85°F - T_2}{85°F - 67.3°F}\right) \rightarrow T_2 = 74.4°F$$

Answer C

44.16 $1000cfm$ **of outside air at** $92°F$ **and 85% RH and** $6000cfm$ **of return air at** $76°F$ **and 55% RH are cooled by an air handling unit supplying** $54°F$ **dry bulb and** $53°F$ **wet bulb air.** $60gpm$ **of chilled water enters the cooling coil at** $46°F$**. What is the leaving water temperature?**

A. $54°F$

B. $58°F$

C. $62°F$

D. $66°F$

The outside air and return air conditions are both fully defined and volume flow rates are known. Use the Psychrometric Chart to look up the enthalpy values and perform a mixing calculation to determine the enthalpy of the mixed air entering the cooling coil.

$$T_{OA} = 92°F$$

$$\phi_{OA} = 85\%$$

$$h_{OA} = 53\frac{Btu}{lb}$$

$$T_{RA} = 76°F$$

$$\phi_{RA} = 55\%$$

$$h_{RA} = 29.8\frac{Btu}{lb}$$

$$h_{MA} = \frac{(1000cfm)\left(53\frac{Btu}{lb}\right) + (6000cfm)\left(29.8\frac{Btu}{lb}\right)}{1000cfm + 6000cfm} = 33.1\frac{Btu}{lb}$$

The air leaving the coil, the supply air, is also fully defined. Use the Psychrometric Chart to look up the enthalpy value for the supply air. Then use the total cooling rule of thumb to determine the rate of heat removal from the air stream.

$$T_{SA,db} = 54°F$$

$$T_{SA,wb} = 53°F$$

$$h_{SA} = 22\frac{Btu}{lb}$$