

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.

$$T_{OA} = 92^\circ F$$

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

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

$$T_{RA} = 76^\circ F$$

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

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

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

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.

$$T_{SA,db} = 54^\circ F$$

$$T_{SA,wb} = 53^\circ F$$

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

$$\dot{Q}_t = 4.5cfm\Delta h = 4.5(7000)(33.1 - 22) = 349,650 \frac{Btu}{hr}$$

Since the heat removed from the air is added to the chilled water flowing in the coil, set the total cooling of the air equal to the heating of the water, using the sensible heating rule of thumb for water. Solve for the unknown leaving water temperature.

$$\dot{Q}_t = \dot{Q}_w = 500gpm\Delta T$$

$$\Delta T = \frac{349,650}{(500)(60)} = 11.7^\circ F$$

$$\Delta T = LWT - EWT = LWT - 46^\circ F = 11.7^\circ F$$

$$LWT = 57.7^\circ F$$

Answer B

44.17 During a chiller plant upgrade, an oversized fixed speed pump, producing $200gpm$ and $80ft$ of total dynamic head with a 70% pump efficiency and 80% motor efficiency, is replaced with a duplex parallel pump set with variable frequency drives. The two replacement pumps provide $60gpm$ each at $45ft$ TDH which is sufficient to meet operational demands. The new pump efficiency is 75% and the new motor efficiency is 93%. The system operates continuously 24 hours per day 365 days per year. The average cost of electricity is $\$0.12/kWh$. What are the annual savings?

- A. \$3100
- B. \$4100
- C. \$4900
- D. \$5500

Make a table to organize the given information for the two scenarios:

	Existing	New
Qty of Pumps	1	2
Flow Rate	$200gpm$	$2 \times 60gpm$
TDH	$80ft$	$45ft$
Pump Efficiency	70%	75%
Motor Efficiency	80%	93%
Run Hours	7/24/365	7/24/365
Electricity Rate	$\$0.12/kW \cdot hr$	$\$0.12/kW \cdot hr$