44.3 The compressor for a water cooled chiller draws $40KW$. The chiller delivers $100gpm$ with a $10°F$ delta T. A cooling tower serving the chiller provides $80gpm$ of $80°F$ condenser water. What is the temperature of the condenser water leaving the chiller?

A. $74°F$

B. $78°F$

C. $93°F$

D. $96°F$

Use the sensible heating/cooling rule of thumb for water to determine the total load on the evaporator, which corresponds to the water *delivered* by the chiller:

$$\dot{Q}_{in} = 500gpm\Delta T = 500\,(100)\,(10) = 500,000\frac{Btu}{hr}$$

Determine the total heat to be rejected by the condenser, which is the sum of the evaporator load and the compressor power. Be sure to align units.

$$\dot{Q}_{out} = \dot{Q}_{in} + \dot{W}_{in}$$

$$\dot{Q}_{out} = 500,000\frac{Btu}{hr} + 40KW\left(3412\frac{Btu}{hr \cdot KW}\right) = 636,480\frac{Btu}{hr}$$

Apply the sensible heating/cooling rule of thumb for water again, this time for the condenser, to determine the condenser water return temperature. Note the naming may be counter-intuitive since the water *leaving* the chiller's condenser is *returning* to the cooling tower. The nomenclature for condenser water is typically considered from the perspective of the cooling tower.

$$\dot{Q}_{out} = 500gpm\Delta T = 500gpm\,(CWR - CWS)$$

$$\dot{Q}_{out} = 500\,(80)\,(CWR - 80°F) = 636,480\frac{Btu}{hr}$$

$$CWR - 80°F = 15.9°F$$

$$CWR = 95.9°F$$

Answer D

44.4 An unoccupied $3000ft^2$ technology room with $12ft$ ceilings is located at the perimeter of a building and experiences excessive infiltration from the outdoors amounting to $2ACH$. On a summer design day the outside conditions are $95°F$ dry bulb and 80% RH. The equipment load is $50KW$ sensible and the space is to be maintained at $72°F$ and 50% RH. What is the total cooling demand?

A. $2tons$

B. $13tons$

C. $14tons$

D. $27tons$

To determine the infiltration load, use the Psychrometric Chart to obtain the enthalpy for the outside air and the enthalpy for the internal space, both of which are fully defined.

For the outside air, State 1:

$$T_1 = 95°F$$

$$\phi_1 = 80\%$$

$$h_1 = 54.83\frac{Btu}{lb}$$

For the internal space, State 2:

$$T_2 = 72°F$$

$$\phi_2 = 50°F$$

$$h_2 = 26.43\frac{Btu}{lb}$$

Calculate the change in enthalpy required to condition the outside air:

$$\Delta h = h_1 - h_2 = 54.83\frac{Btu}{lb} - 26.43\frac{Btu}{lb}$$

Based on the ACH and dimensions of the space, find the volume flow rate for the infiltration:

$$\dot{V} = \left(3000ft^2\right)(12ft)\left(\frac{2\,air\,changes}{hr}\right)\left(\frac{1hr}{60min}\right) = 1200cfm$$

Use the total heating/cooling rule of thumb for air to determine the cooling load due to infiltration:

$$\dot{Q}_{infiltration} = 4.5cfm\Delta h$$