

**46.58** An air handler uses  $52^{\circ}F$  chilled water to cool and dehumidify a room which is maintained at  $78^{\circ}F$  and 50% relative humidity. The AHU has a single chilled water coil from which air is discharged at  $60^{\circ}F$  db /  $58^{\circ}F$  wb. The unit also has a bypass damper which is modulated to allow 25% of the required airflow to bypass the coil under normal operating conditions. The unit provides  $10,000cfm$  of supply air to the space. Prior to returning to the unit, 10% of the air is exhausted and outside air at  $95^{\circ}F$  db /  $75^{\circ}F$  wb is mixed into the return stream for ventilation. What is the total cooling load provided by the air handler?

- A. 13tons
- B. 16tons
- C. 18tons
- D. 21tons

Sketch the system and label all given information. Consider the air entering the coil as State 1 and the air being discharged from the coil as State 2. The total cooling load provided by the air handler is a function of airflow over the coil only, as the bypass air is neither cooled nor dehumidified. Since the unit provides a total volume flow rate of  $10,000cfm$ , and the bypass damper allows 25% of the airflow to bypass the coil, the volume flow rate over the coil is the remaining 75%.

$$Q = (0.75)(10,000cfm) = 7500cfm$$

Use the total cooling rule of thumb.

$$\dot{Q}_t = 4.5cfm\Delta h$$

The coil discharge condition is fully defined. Use the **Psychrometric Chart** to obtain the enthalpy of the discharge air coming off the coil.

$$T_{2,db} = 60^{\circ}F$$

$$T_{2,wb} = 58^{\circ}F$$

$$h_2 = 25.1 \frac{Btu}{lb}$$

The entering condition is a mixture of return air and outside air. 10% of the return air is exhausted and replaced by outside air. Use the Psychrometric Chart again to find the enthalpy for the room/return condition, and the enthalpy of the outside air. Then perform a mixing calculation to find the enthalpy of the mixed air. This is the entering coil condition.

$$T_R = 78^{\circ}F$$

$$\phi_R = 50\%$$

$$h_R = 29.96 \frac{Btu}{lb}$$

$$T_{OA,db} = 95^\circ F$$

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

$$h_{OA} = 38.4 \frac{Btu}{lb}$$

$$h_1 = (0.9) \left( 29.96 \frac{Btu}{lb} \right) + (0.1) \left( 38.4 \frac{Btu}{lb} \right) = 30.8 \frac{Btu}{lb}$$

Solve for the total cooling load. Units need not be shown when applying a “rule of thumb” formula provided the input units are as expected, the outcome will be  $\frac{Btu}{hr}$ . Convert the final answer to refrigeration *tons*.

$$\dot{Q}_t = 4.5cfm(h_1 - h_2)$$

$$\dot{Q}_t = 4.5(7500)(30.8 - 25.1) = 192,375 \frac{Btu}{hr}$$

$$\dot{Q}_t = \frac{192,375 \frac{Btu}{hr}}{12,000 \frac{Btu}{hr \cdot ton}} = 16tons$$

**Answer B**