

44.8 A counterflow heat exchanger is used to remove heat from steam condensate prior to discharge and for pre-heating cold water. Cold water enters at $50^{\circ}F$ and leaves at $70^{\circ}F$. Condensate enters at $160^{\circ}F$ and leaves at $100^{\circ}F$. What is the log mean temperature difference?

- A. $62^{\circ}F$
- B. $68^{\circ}F$
- C. $76^{\circ}F$
- D. $90^{\circ}F$

For a counterflow heat exchanger, the hot stream enters on the opposite side from the cold stream such that the ΔT along the length is close to the average ΔT . (Contrast this with the temperature profile for a parallel flow heat exchanger which varies dramatically along the length.) Arbitrarily call the hot entering end “Side A” and cold entering end “Side B.” Calculate the temperature differences at both ends. It may be useful to draw the temperature profile on a *Temperature vs. Length* diagram.

$$\Delta T_A = 160^{\circ}F - 70^{\circ}F = 90^{\circ}F$$

$$\Delta T_B = 100^{\circ}F - 50^{\circ}F = 50^{\circ}F$$

Look up **Log Mean Temperature Difference** (LMTD) in the Reference Handbook. Consider applying the simplified version of this formula initially introduced during in the Heat Transfer section of this book:

$$LMTD = \frac{\Delta T_A - \Delta T_B}{\ln\left(\frac{\Delta T_A}{\Delta T_B}\right)} = \frac{90^{\circ}F - 50^{\circ}F}{\ln\left(\frac{90^{\circ}F}{50^{\circ}F}\right)} = 68^{\circ}F$$

Answer B

44.9 An outside air handler mixes 2000cfm of 90°F db / 80°F wb fresh air with recirculated return air at 76°F / 50% relative humidity. The unit supplies 10,000cfm of 58°F air to the space. What is the enthalpy of the mixed air entering the cooling coil?

- A. $31 \frac{Btu}{lb}$
- B. $32 \frac{Btu}{lb}$
- C. $33 \frac{Btu}{lb}$
- D. $34 \frac{Btu}{lb}$

It may be helpful to draw and label a typical outside air handling arrangement. The supply air temperature downstream of the cooling coil is extra information.

Since the volume flow rate of outside air is 2000cfm and a total of 10,000cfm is being supplied, the volume flow rate of recirculated air is given by:

$$Q_{recirculation} = 10,000cfm - 2000cfm = 8,000cfm.$$

To find the enthalpy of mixed air (prior to the coil), perform a mixing calculation using the outside air stream and return (recirculated) air stream, both of which are fully defined. Use the **Psychrometric Chart** to obtain the enthalpy values for both states:

$$T_{OA,db} = 90^\circ F$$

$$T_{OA,wb} = 80^\circ F$$

$$h_{OA} = 43.57 \frac{Btu}{lb}$$

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

$$\phi_{RA} = 50\%$$

$$h_{RA} = 28.74 \frac{Btu}{lb}$$

$$h_{MA} = \frac{(2000cfm) \left(43.57 \frac{Btu}{lb}\right) + (8000cfm) \left(28.74 \frac{Btu}{lb}\right)}{2000cfm + 8000cfm} = 31.7 \frac{Btu}{lb}$$

Answer B