

$$\chi_3 = 0$$

$$h_3 = 45 \frac{Btu}{lb}$$

For State 4:

$$P_4 = 50psia$$

$$h_4 = h_3 = 45 \frac{Btu}{lb}$$

On the next page after the Pressure Enthalpy curves, refer to the table for **Refrigerant 1234yf** listing **Properties of Saturated Liquid and Saturated Vapor**. Since the pressure at State 4 is between two rows, it is necessary to interpolate to find h_f and h_g for R-1234yf at $P_4 = 50psia$. Make a table to organize the data collected and help set up for the interpolation:

Pressure[psia]	h_f (liquid) $\frac{Btu}{lb}$	h_g (vapor) $\frac{Btu}{lb}$
48.45	21.98	91.77
50	$h_f \approx 22.5$	$h_g \approx 92$
53.12	23.54	92.54

Calculate the quality at State 4:

$$\chi_4 = \frac{h_4 - h_f}{h_g - h_f} = \frac{45 \frac{Btu}{lb} - 22.5 \frac{Btu}{lb}}{92 \frac{Btu}{lb} - 22.5 \frac{Btu}{lb}} = .32$$

Answer D

44.20 An outside air handler tempers outside air of $90^\circ F$ dry bulb and $80^\circ F$ wet bulb using return air at $74^\circ F$ and 50% relative humidity using an air-to-air heat exchanger. The heat exchanger effectiveness is 72%. What is the enthalpy of the air leaving the heat exchanger?

- A. $31 \frac{Btu}{lb}$
- B. $33 \frac{Btu}{lb}$
- C. $41 \frac{Btu}{lb}$
- D. $43 \frac{Btu}{lb}$

An air to air heat exchanger in a tempering application will drive only sensible cooling of the outside air stream being treated. A 100% efficient heat exchanger would cool the outside air all the way to the temperature of the return air, $74^\circ F$ in this case. Apply the given efficiency to determine the dry bulb temperature actually achieved as the result of tempering. Let State 1 be the outside air,

State 2 be the Return Air, and State 3 be the Tempered Air. Ignore the Exhaust Air (after the Return Air has collected heat from the outside air.

$$\eta = \frac{T_1 - T_3}{T_1 - T_2}$$
$$.72 = \frac{90^\circ F - T_3}{90^\circ F - 74^\circ F}$$
$$T_3 = 78.5^\circ F$$

In order to find the enthalpy at State 4, a second parameter must be determined. Use the **Psychrometric Chart** to look up the dew point for State 1:

$$T_{1,db} = 90^\circ F$$

$$T_{1,wb} = 80^\circ F$$

$$T_{1,dp} = 76.7^\circ F$$

Since the outside air was not cooled past the dew point ($T_3 > T_{1,dp}$), it is confirmed that only *sensible* cooling has been performed. No moisture has been removed and the process from 1 \rightarrow 3 is purely horizontal such that dew point is unchanged. (The humidity ratio is also unchanged). This fully defines State 3. Use the Psychrometric Chart once more to obtain the enthalpy at State 3.

$$T_{3,dp} = T_{1,dp} = 76.7^\circ F$$

$$T_{3,db} = 78.5^\circ F$$

$$h_3 = 40.7 \frac{Btu}{lb}$$

Answer C