Calculate the NPSHA.

$$NPSH_A = 34ft - 10ft - 1.178ft - 15ft = 7.8ft$$

Answer A

47.69 Refrigerant R-410a is compressed isentropically from a saturated condition at $20psia$ to a pressure of $190psia$. What is the change in temperature during the compression process?

A. $11°F$

B. $63°F$

C. $76°F$

D. $174°F$

Sketch the compression process on a Pressure-Enthalpy diagram. Use the table for Refrigerant 410A to obtain the saturation temperature corresponding to the compressor inlet pressure, P_1. Note the table provides two temperatures, 'Bubble' and 'Dew'. Typically the values are close in magnitude and selection is of little consequence. For simplicity, use the 'Dew' temperature since this value corresponds to when the last drop of refrigerant evaporates, which should be complete prior to entering the compressor.

$$P_1 = 20psia\ (saturated)$$

$$T_1 = -49.2°F$$

Using the chart Pressure Versus Enthalpy Curves for Refrigerant 410A, draw a horizontal line across the chart for the high pressure condition, $P_2 = 190psia$. To locate the line properly, check the table for the corresponding saturation temperature which is approximately $T_3 \approx 61.6°F$. The goal is to find T_2, however, knowing T_3 will help draw the horizontal line contain the condensing process from $2 \rightarrow 3$ in the correct location on the chart. The vertical axis uses log scale so using pressure alone can be challenging. It is also essential to recognize that in the superheated region, the temperature is no longer constant along a horizontal line.

Next, draw a line of constant entropy starting from State 1 and making best effort to remain parallel with local constant entropy lines on the chart, which tend to travel north-northeast to south-southwest, but are not perfectly linear. Find the interesection of this constant entropy line from $1 \rightarrow 2$ and the horizontal line containing States 2 & 3. The interesection represents State 2. Read the temperature by following the constant temperature lines which waterfall down and to the right. Be willing to accept reduced precision when using a graphical approach.

$$T_2 \approx 125°F$$

Calculate the change in temperature between State 2 and State 1.

$$T_2 - T_1 = 125°F - (-49.2°F) = 174.2°F$$

Answer D

47.70 $20\frac{lb_m}{min}$ **of** $50°F$ **air at atmostpheric pressure enters an air compressor and exits at** $350°F$**. What is the power required to drive the compressor?**

A. $34hp$

B. $40hp$

C. $114hp$

D. $142hp$

Consider the air entering the Compressor as State 1 and the air exiting the compressor as State 2. Since there is not enough information about State 2 to fully define it, assume the air behaves as an Ideal Gas with Constant Specific Heats. Solve for the compressor power and convert units to hp.

$$\dot{W}_{comp} = \dot{m} c_p \left(T_e - T_i\right)$$

$$\dot{W}_{comp} = \left(20\frac{lb}{min}\right)\left(0.24\frac{Btu}{lb \cdot °F}\right)(350°F - 50°F) = 1440\frac{Btu}{min}$$

$$\dot{W}_{comp} = 1440\frac{Btu}{min}\left(\frac{60min}{1hr}\right)\left(\frac{1KW}{3412\frac{Btu}{hr}}\right)\left(\frac{1hp}{0.7457KW}\right) = 34hp$$

Answer A

47.71 What is the wet bulb temperature of $150°F$ **sea level air with 50% relative humidity?**

A. $123°F$

B. $126°F$

C. $135°F$

D. $138°F$

Use the high temperature Psychrometric Chart. Identify the state point which is fully defined since the temperature and relative humidity are both given.

$$T = 150°F$$

$$\phi = 50\%$$

Read the wet bulb temperature from the light gray diagnonal lines that run from west-northwest to east-southeast on the chart. Note the wet bulb temperature and enthalpy are not perfectly parallel at high temperature. Special care should be taken to avoid inadverently reporting the enthalpy value rather than the wet bulb temperature, as $120°F\,wb$ and $120\frac{Btu}{lb}$ are close together, and the constant enthalpy lines are heavier and easier to read.

The light gray lines of constant wet bulb temperature are $2°F$ apart. By visual inspection, the state point in consideration is between $125°F\,wb$ and $126°F\,wb$.

Answer B