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

47.72 **A 460-V three phase AC motor rated for $60hp$ operates with an efficiency of 93% and a power factor of 0.85. How much current will the motor draw?**

A. $60A$

B. $66A$

C. $71A$

D. $123A$

Use the first three-phase equation in the table Power for Different Motor Phases, where the power rating is given in horsepower. Voltage, power factor, and efficiency are all given. Calculate the current.

$$I_{[amps]} = \frac{P_{[hp]}\,(746)}{\sqrt{3}V\eta\,(pf)}$$

$$I_{[amps]} = \frac{(60)\,(746)}{\sqrt{3}\,(460)\,(0.93)\,(0.85)} = 71A$$

Answer C

47.73 **Steam enters a turbine at a pressure of $1000psia$ and a temperature of $800°F$ and exits at a pressure of $90psia$ and a temperature of $400°F$. What is the efficiency?**

A. 52%

B. 67%

C. 72%

D. 89%

Consider the entering steam as State 1 and the exit steam as State 2. Both states are fully defined and superheated. Use the properties of Superheated Steam tables to look up the enthalpy and entropy for State 1, and the *actual* enthalpy for State 2.

$$P_1 = 1000psia$$

$$T_1 = 800°F$$

$$h_1 = 1389\frac{Btu}{lb}$$

$$s_1 = 1.567\frac{Btu}{lb \cdot °R}$$