

$$h_4 = h_3 = h_{f@125psia} \approx 64.3 \frac{Btu}{lb}$$

Use the table to obtain h_f and h_g at the low pressure condition of 30psia.

$$h_{f@30psia} \approx 38.14 \frac{Btu}{lb}$$

$$h_{g@30psia} \approx 107.4 \frac{Btu}{lb}$$

Calculate the enthalpy at State 4.

$$\chi_4 = \frac{h_4 - h_f}{h_g - h_f} = \frac{64.3 \frac{Btu}{lb} - 38.14 \frac{Btu}{lb}}{107.4 \frac{Btu}{lb} - 38.14 \frac{Btu}{lb}} = 0.378$$

Answer D

47.18 A kitchen contains lighting and cooking equipment which draws 30KW. There is also a moisture load of $2 \frac{lb}{min}$. What is the sensible heat ratio?

- A. 0.02
- B. 0.45
- C. 0.55
- D. 0.98

Change the units of the sensible heat load from KW to $\frac{Btu}{hr}$.

$$Q_S = (30KW) \left(\frac{3412 \frac{Btu}{hr}}{KW} \right) = 102,360 \frac{Btu}{hr}$$

Calculate the latent load. Use the steam table by looking up **Properties of Saturated Water** by temperature. Assume the kitchen is around 80°F. Note the latent heat of vaporization for steam, $h_{fg} \approx 1050 \frac{Btu}{lb}$ at this approximate temperature.

$$Q_L = \dot{m} \Delta h = \dot{m} h_{fg} = \left(2 \frac{lb}{min} \right) \left(1050 \frac{Btu}{lb} \right) \left(\frac{60min}{1hr} \right) = 126,000 \frac{Btu}{hr}$$

Find the **Sensible Heat Ratio**.

$$SHR = \frac{Q_S}{Q_T} = \frac{Q_S}{Q_S + Q_L} = \frac{102,360 \frac{Btu}{hr}}{102,360 \frac{Btu}{hr} + 126,000 \frac{Btu}{hr}} = 0.448$$

Answer B

47.19 How much power is required to isentropically compress $100 \frac{lb}{min}$ of air at atmospheric pressure and $80^\circ F$ to $150 psia$? Assume air is an ideal gas with constant specific heat capacity.

- A. $50hp$
- B. $200hp$
- C. $290hp$
- D. $1920hp$

Look up **Constant Entropy Processes** and find the formula relating temperature and pressure. Determine the temperature after the compression process, T_2 . The ratio of specific heats may be taken as $k = 1.4$ since air is to be considered an ideal gas. Be sure to use the absolute temperature scale ie. Rankine rather than Fahrenheit.

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1} \right)^{\frac{k-1}{k}}$$

$$T_2 = T_1 \left(\frac{P_2}{P_1} \right)^{\frac{k-1}{k}} = (540^\circ R) \left(\frac{150 psia}{14.7 psia} \right)^{\frac{1.4-1}{1.4}} = 1048.6^\circ R = 588.6^\circ F$$

The power for a compressor can be expressed most generally as the product of the mass flow rate and the change in enthalpy. If the gas being compressed has constant specific heats, it is valid to express the enthalpy change in terms of the change in temperature. Calculate the power required and convert the final units to horsepower to be consistent with the answer choices. Look up **Measurement Relationships** for unit conversions that may be useful.

$$\dot{W} = \dot{m}\Delta h = \dot{m}c_p\Delta T = \left(100 \frac{lb}{min} \right) \left(0.24 \frac{Btu}{lb^\circ F} \right) (588.6^\circ F - 80^\circ F) = 12,207 \frac{Btu}{min}$$

$$\dot{W} = 12,207 \frac{Btu}{min} \left(\frac{1hp}{42.4 \frac{Btu}{min}} \right) = 288hp$$

Answer C