State 3, leaving the condenser and entering the expansion valve, must be selected to the left of the saturation curve in the subcooled region to account for 20°F of subcooling. Since the expansion process $3 \rightarrow 4$ is isenthalpic, assume $h_4 = h_3$.

Solve for mass flow rate, substitute enthalpy values, and convert units where necessary:

$$\dot{Q}_{in} = \dot{m}\left(h_1 - h_4\right) = \dot{m}\left(h_1 - h_3\right)$$

$$\dot{m} = \frac{\dot{Q}_{in}}{\left(h_1 - h_3\right)} = \frac{\left(200 tons\right)\left(12,000 \frac{Btu}{hr \cdot ton}\right)}{\left(122 \frac{Btu}{lb} - 28 \frac{Btu}{lb}\right)} = 25,532 \frac{lb}{hr}$$

$$\dot{m} = 25,532 \frac{lb}{hr}\left(\frac{1 hr}{60 min}\right) = 425 \frac{lb}{min}$$

Answer A

44.13 R-134a is used in a chiller with an evaporator pressure of $30 psia$ and a condenser pressure of $150 psia$. There is $20°F$ of superheat. What is the coefficient of performance?

A. 3

B. 4

C. 5

D. 6

Look Up Pressure Versus Enthalpy Curves for Refrigerant 134a in the Reference Handbook and draw the refrigeration cycle directly on the screen. If drawing on the screen is unworkable, sketch on scrap paper and mark key values obtained from the chart on the axes. Assume State 3, leaving the condenser and entering the expansion valve, is a saturated liquid since there is no mention of subcooling. Locate State 1 to the right of the saturation curve in the superheated region to account for 20°F of superheat. The enthalpy at State 4 is equal to the enthalpy at State 3 assuming isenthalpic expansion. Note the vertical axis is nonlinear so take special care to identify the low and high pressure conditions for the evaporator and condenser.

Calculate the Coefficient of Performance (COP) for the refrigeration cycle:

$$COP_R = \frac{\dot{Q}_{in}}{\dot{W}_{in}} = \frac{\dot{m}\left(h_1 - h_4\right)}{\dot{m}\left(h_2 - h_1\right)} = \frac{\left(h_1 - h_3\right)}{\left(h_2 - h_1\right)} = \frac{\left(109 \frac{Btu}{lb} - 47 \frac{Btu}{lb}\right)}{\left(122 \frac{Btu}{lb} - 109 \frac{Btu}{lb}\right)} = 4.8$$

Answer C

44.14 A $2ton$ AC unit with remote compressor using R-134a operates with a condenser pressure of $150psia$ and an evaporator pressure of $50psia$. The suction line is a $5/8in$ diameter type L copper tube with a length of $30ft$. What is the pressure drop for the suction line?

A. $0.5psi$

B. $1.3psi$

C. $1.9psi$

D. $5.8psi$

Look up Suction Line Capacities in Tons for Refrigerant 134a in the Reference Handbook. Using the Pressure Versus Enthalpy Curves for Refrigerant 134a, determine the evaporator temperature that corresponds to an evaporator pressure of $50psia$. Use the evaporator temperature and the diameter of the suction line to obtain the capacity from the table. Also note the corresponding pressure drop from the table.

$$P_{evap} = 50psia$$

$$T_{evap} = 40°F$$

$$Capacity = 0.66tons$$

$$\Delta P = 1.93psi/100ft$$

Use the equation from Note 3 below the table to adjust for the actual length and capacity given:

$$\Delta t = Table\,\Delta t\left(\frac{Actual\,L_e}{Table\,L_e}\right)\times\left(\frac{Actual\,Capacity}{Table\,Capacity}\right)^{1.8}$$

$$\Delta t = (2°F)\left(\frac{30ft}{100ft}\right)\times\left(\frac{2tons}{0.66tons}\right)^{1.8} = 4.41°F$$

The actual pressure drop is linearly related to the actual temperature drop. Set up a proportion and solve, using the actual length:

$$\frac{\Delta P_{actual}}{\Delta P_{table}} = \frac{\Delta T_{actual}}{\Delta T_{table}}$$

$$\Delta P_{actual} = \Delta P_{table}\left(\frac{\Delta T_{actual}}{\Delta T_{table}}\right) = \left(1.93\frac{psi}{100ft}\right)\left(\frac{4.41°F}{2°F}\right) = 4.25\frac{psi}{100ft}$$

$$\Delta P = \left(4.25\frac{psi}{100ft}\right)(30ft) = 1.3psi$$

Answer B