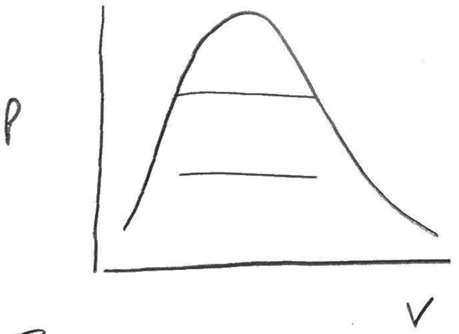
11-41

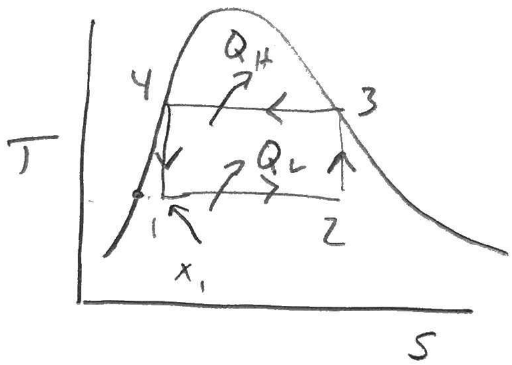
Given: R-134a Carnot refrigerator

Saturated vapor = 90 psia (Warm)

$x = 0.05$

pressure cold = 30 psia





From Table A-11E

$T_{sat@90psia} = 72.78\ F + 459.67 = 532.45\ R$

$T_{sat@30psia} = 15.37\ F + 459.67 = 475.04\ R$

a) $COP_{Carnot} = \dfrac{1}{\frac{T_H}{T_L} - 1} = \dfrac{1}{\frac{532.45}{475.04} - 1} = \boxed{8.28}$

b) quality @ point 1 is beginning of heat absorbtion

$S_1 = S_4 = s_f + x_4 s_{fg} = .07481 + (.05)(.14529)$

$S_1 = 0.08208$ Btu/lbm-R

From Table A-12E

$x_1 = \left(\dfrac{s_1 - s_f}{s_{fg}}\right)_{30psia} = \dfrac{.08208 - 0.03792}{0.18595} = \boxed{0.237}$

11-4 cont

c) find Net work input

$S_3 = S_{g\,90\#} = 0.22011$

$S_4 = S_{f\,90\#} = .08208$

Find Area of cycle

$$W_{net} = (T_H - T_L)(S_3 - S_4)$$

$$= (532.8 - 475.4)(.22011 - .08208)$$

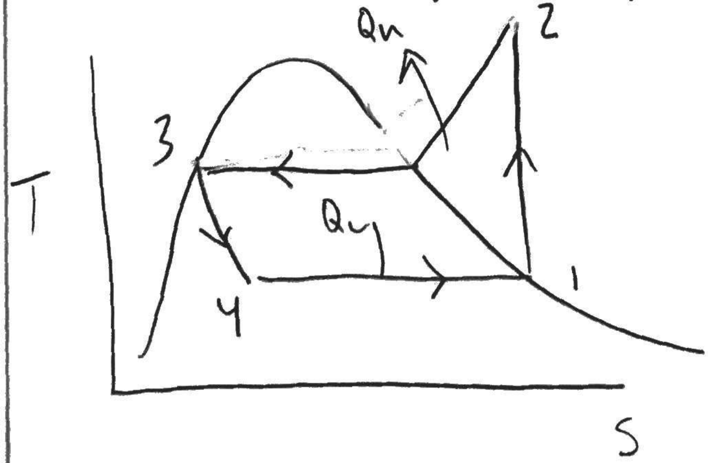
$$\boxed{W_{net} = 7.92\ \text{Btu/lbm}}$$

11-5

Not need to have turbine in real cycle ⇒ throttling valve used to make it closer to actual cycle

11-11

Given: Ideal vapor-compression cycle w/ R-134a



$P_1 = 20\ psia$,

$P_2 = 80\ psia$

$P_3 = 80\ psia$

$P_4 = 20\ psia$

11-11 Cont

Water enters @ 55 F

From Table A-12E

$h_1 = 102.74$ Btu/lbm

$s_1 = .22570$ Btu/lbm R

$s_1 = s_2 \Rightarrow$ find h_2 @ 80psia on Table A-13E

That matches s_1

$\Rightarrow h_2 = 115.01$ Btu/lbm

Q1

h_3 (80psia) $= h_{f@80psia} = 33.39$ Btu/lbm

$h_3 = h_4 \Rightarrow h_4 = 33.39$ Btu/lbm

$\dot{Q}_L = \dot{m}_{ice}(\Delta h\ ice)$

Δh given @ 169 Btu/lbm

$\dot{m}_{ice} = \frac{15\ lbm}{hr} \Big| \frac{1\ hr}{3600\ se}$

$\dot{m}_{ice} = .004167$ lbm/s

$= \left(\frac{.004167\ \cancel{lbm}}{s}\right) \Big| \frac{169\ Btu}{\cancel{lbm}}$

$\dot{Q}_L = 0.7042$ Btu/s

$m_g = \frac{Q_L}{h_1 - h_4} = \frac{.7042}{102.74 - 33.39} = .01015$ lbm/s

$W_{in} = m_g(h_2 - h_1) = \left[.0105\left(11.501 - 102.74\right)\right] \frac{1\ hp}{.707068\ Btu/s} = \boxed{.0176\ hp}$

11-13 **Given:** Ideal vapor-compression R-134a

Condensor @ 800 kPa

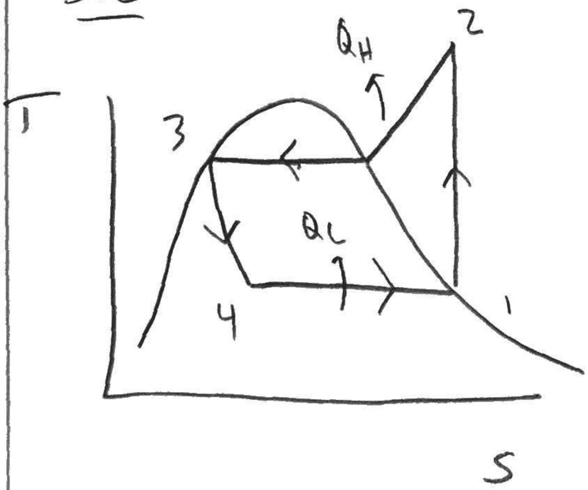
Evaporator @ −12°C

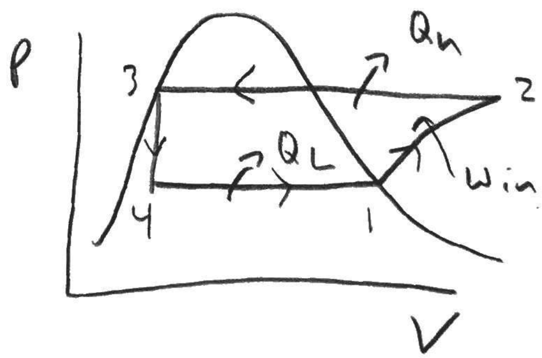
FIND:

a) System COP

b) Power required for 150 kW cooling load

SOL





1 - 2	2 - 3	3 - 4	4 - 1
Compressor	Condensor	Expansion	Evap

1 - 2 Compressor

$h_1 = h_{g\,-12°C} = 243.34$ kJ/kg

$S_1 = S_{g\,-12°C} = 0.93925$ kJ/kgK

2 - 3 Condensor

$P = 800$ kPa

Find h_2 using S_2 and 800 kPa

$h_2 = 273.73$ kJ/kg

11-13 cont'd

Find h_3 @ 0.8 mPa at saturated liquid @ pt 3

$$h_3 = 95.48 \text{ KJ/kg}$$

$$h_3 = h_4$$

$$\Rightarrow \dot{Q}_L = \dot{m}(h_1 - h_4)$$

$$\dot{m} = \frac{\dot{Q}_L}{h_1 - h_4} = \frac{150 \text{ KJ/s}}{(243.34 - 95.48)} \frac{\text{kg}}{\text{kJ}}$$

$$\dot{m} = 1.014 \text{ kg/s}$$

$$\Rightarrow \dot{W}_{in} = \dot{m}(h_2 - h_1)$$

$$= (1.014 \text{ kg/s})(273.73 - 243.34)$$

$$\boxed{\dot{W}_{in} = 30.8 \text{ KW}}$$

$$COP_R = \frac{\dot{Q}_L}{\dot{W}_{in}} = \frac{150 \text{ KW}}{30.8 \text{ KW}} = \boxed{4.87}$$