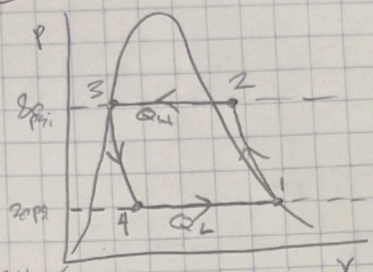
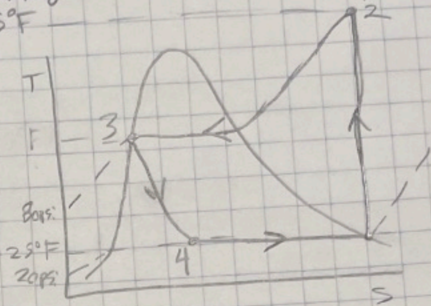
(11-11) Nathon Cherry?, Brad Etheridge





$\dot{Q}_L = 15\ \text{lbm/h}$

(1) $\xrightarrow[\text{compression}]{\text{isentropic}}$ (2) $\xrightarrow[\text{condenser}]{\text{P const}}$ (3) $\xrightarrow[\text{expansion}]{\text{isenthalpic}}$ (4) $\xrightarrow[\text{evaporator}]{\text{P const}}$

$P_1 = 20\text{psi}$ $P_2 = 80\text{psi}$ $P_3 = 80\text{psi}$ $P_4 = 20\text{psi}$

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(1) sat. vapor → refrigerant 134a @ 20psi → $h_1 = 102.74\ \frac{btu}{lbm}$ $s_1 = s_2 \rightarrow s_1 = 0.22557\ \frac{btu}{lbm \cdot R}$

(2) interpolate → Superheated refrigerant → $s_1 = s_2$ and @ $P_2 = 80$psi → $h_2 = 115.015\ \frac{btu}{lbm}$

(3) Sat. liquid → refrigerant @ 80psi → $h_3 = 33.391\ \frac{btu}{lbm}$

(4) $h_3 = h_4$ → isenthalpic → $h_4 = 33.391\ \frac{btu}{lbm}$

Resulting ice produced $Q_L = 169\ \frac{btu}{lbm}$

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

$\dot{Q}_L = \dot{m}_L \cdot Q_L$

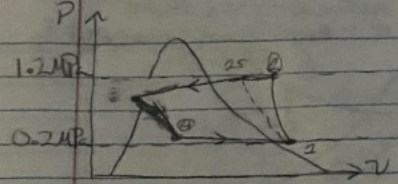
$\dot{Q}_L = 169\ \frac{btu}{lbm} \cdot \left(\frac{15\ \frac{lbm}{h}}{3600}\right) = 0.704\ \frac{btu}{s} = \dot{Q}_L$

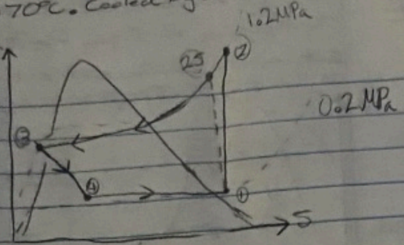
$\dot{m}_R = \frac{\dot{Q}_L}{\Delta h_{4-1}} = \frac{0.704\ \frac{btu}{s}}{102.74\ \frac{btu}{lbm} - 33.391\ \frac{btu}{lbm}} = 0.01015\ \frac{lbm}{s} = \dot{m}_R$

$\dot{W}_{in} = 0.01015\ \frac{lbm}{s}\left(115.015\ \frac{btu}{lbm} - 102.74\ \frac{btu}{lbm}\right)$

$$\boxed{\dot{W}_{in} = 0.1246\ \frac{btu}{s}}$$

11-17 R-134a enters comp. as superheated vapor @ 0.2MPa & -5°C at rate of 0.07 kg/s. Leaves @ 1.2 MPa & 70°C. Cooled by condenser to 44°C & 1.15MPa. Throttled to 0.21MPa.





①	②	③	④
$T_1 = -5°C$	$T_2 = 70°C$	$T_3 = 44°C$	$h_3 = h_4$
$P_1 = .2\ MPa$	$P_2 = 1.2\ MPa$ (A-13)	$P_3 = 1.15\ MPa$	$P_4 = .21\ MPa$
A-13 $h_1 = 248.815\ kJ/kg$	$h_2 = 300.63\ kJ/kg$	A-11 $h_3 = h_f @ T_3$	$h_4 = 114.30\ kJ/kg$
Interp. $s_1 = .9442\ kJ/kg \cdot K$	$s_2 = .9939\ kJ/kg \cdot K$	$h_3 = 114.30\ kJ/kg$	

$$\underline{h_{2s} = 283.986\ kJ/kg}$$

$s_1 = s_{2s} = .9442$ & $P_2 = 1.2$ (A-13) ← Interpolate

a.) The power input to the compressor:

$$\dot{Q}_L = \dot{m}(q_L) = \dot{m}(h_1 - h_4) \Rightarrow \dot{Q}_L = 0.07\ kg/s\ (248.815 - 114.3)\ \frac{kJ}{kg}$$

$$\boxed{\dot{Q}_L = 9.41605\ kJ/s}$$

$$\dot{W}_{in} = \dot{m}(h_2 - h_1) \Rightarrow \underline{\dot{W}_{in} = 3.62705\ kJ/s}$$

b.) Isentropic efficiency of Compressor:

$$\eta_{th} = \frac{h_{2s} - h_1}{h_2 - h_1} \Rightarrow \boxed{\eta_{th} = .679 \text{ or } 67.9\%}$$

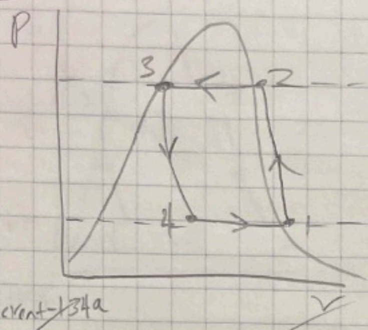
c.) COP of the refrigerator:

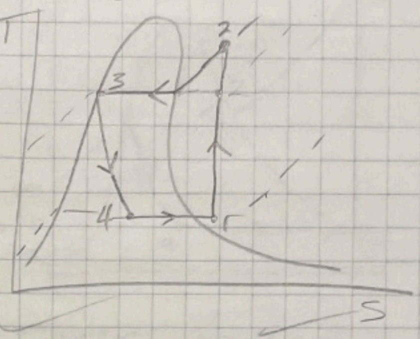
$$COP_R = \frac{\dot{Q}_L}{\dot{W}_{in}} \Rightarrow \frac{9.41605}{3.62705} \Rightarrow \boxed{COP_R = 2.596}$$

Brad
& Nathan

7-21

Nathan Chernys, Brad Etheridge





refrigerant-134a

1 $\xrightarrow[\text{isentropic comp.}]{W_{in}}$ 2 $\xrightarrow[\text{P const}]{\text{condenser}}$ 3 $\xrightarrow[\text{isenthalpic}]{\text{expansion}}$ 4 $\xrightarrow[\text{P const}]{\text{evaporator}}$

1	2	3	4
$P_1 = P_4 = 120\,kPa$	$T_2 = 70°C$	$P_3 = 800\,kPa$	$P_4 = 120\,kPa$
$h_1 = 236.99\frac{kJ}{kg}$	$\boxed{P_2 = 800\,kPa}$	$h_3 = 95.4068\frac{kJ}{kg}$	$x = 0.34$
	$h_2 = 306.9\frac{kJ}{kg}$		$h_4 = 95.4068\frac{kJ}{kg}$

4

$h_4 = h_f + x \cdot h_{fg}$ → table A-12 → $h_f = 22.47\frac{kJ}{kg}$

$= 22.47\frac{kJ}{kg} + 0.34 \cdot 214.52\frac{kJ}{kg}$ $\qquad h_{fg} = 214.52\frac{kJ}{kg}$

$\underline{h_4 = 95.4068\frac{kJ}{kg}}$

1

$P_1 = 120\,kPa$ → superheated gas → table A-12 $\underline{h_1 = 236.99\frac{kJ}{kg}}$

3

isenthalpic process

$h_3 = h_4 = 95.4068\frac{kJ}{kg}$

also on the sat. liquid line → $P_3 = 798.8\,kPa \approx 800\,kPa$ in superheated tables

h_3 → sat. liquid → table A-12 → interpolate for P_3

2

$P_3 = P_2$ → constant pressure process

table A-13 $\left.\begin{matrix} P_2 \\ T_2 \end{matrix}\right\}$ $\underline{h_2 = 306.9\frac{kJ}{kg}}$

$\dot{W}_{in} = .45\,kW$

$\dot{m} = \frac{\dot{W}_{in}}{W_{in}}$

$W_{in} = h_2 - h_1 = 69.91\frac{kJ}{kg}$

$\frac{0.45\,kW}{69.91\frac{kJ}{kg}} = \boxed{0.0064\ kg/s}$

$COP = \frac{Q_L}{W_{in}} = \frac{h_1 - h_4}{h_2 - h_1}$

$COP = \frac{141.5832\frac{kJ}{kg}}{69.91\frac{kJ}{kg}} = \boxed{2.025}$

COP

Etheridge