THERMODYNAMICS 201 2003

5 A vapour compression refrigerator uses refrigerant 12 as the working fluid and operates between temperature limits of -10°C and 60°C.

(a) Sketch the flow diagram, indicating the components of the refrigeration cycle.

(b) If the refrigerant entering the compressor is dry saturated sketch the temperature-entropy (T-s) and the pressure-enthalpy (p-h) diagrams for the two following cases;

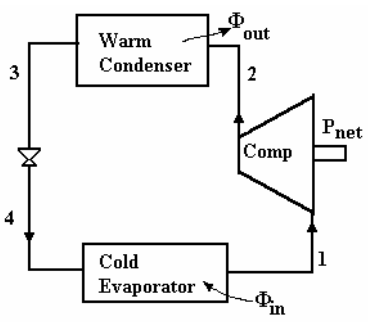
(i) the refrigerant leaves the condenser saturated

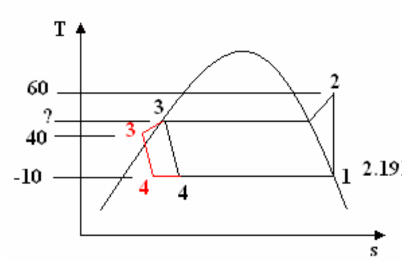
(ii) the refrigerant is sub-cooled to 40°C before entry to the throttle valve.

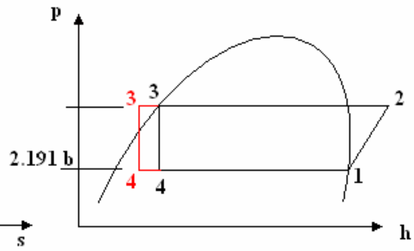
(c) For the case in which the refrigerant leaves the condenser and enters the throttle valve as saturated liquid and assuming isentropic processes for the compressor determine:

(i) the refrigeration effect

(ii) the coefficient of performance.







The red lines show the difference when under cooled.

The major trap to fall into here is the maximum operating temperature is not the same as the condenser temperature. Without a p - h chart this seems very difficult. If anyone knows how to complete this correctly please contact admin@freestudy.co.uk

h_1 = 183.19 kJ/kg s_1 = 0.7020 kJ/kg K

$p_1 = p_s$ at -10°C = 2.191 bar v_1 = 0.0766 m^3/kg T_1 = 263 K T_2 = 333 K

Assuming the compression is reversible and adiabatic $s_1 = s_2$. but this does not help. Clearly the refrigerant is superheated at exit from the compressor.

On the row for 60°C in the tables, s_2 = 0.7020 kJ/kg K occurs between 0 and 15 K of superheat so interpolation is needed. Using the data on 60°C row of the tables we find:

	Sat.	θ	15K
s	0.6765	0.7020	0.7146
h	209.26	h_2	222.23

$$\frac{0.7020-0.6765}{0.7146-0.6765}=0.66929=\frac{\theta-0}{15-0}$$

θ = 10K so the actual saturation temperature is around 50°C

Now find the values using the 50°C row at 10 K superheat

	Sat.	10K	15K
s	0.6797	s_2	0.7166
h	206.45	h_2	218.64

$$\frac{s_2-0.6797}{0.7166-0.6797}=\frac{10}{15}$$

s_2 = 0.7043 kJ/kg K this is close so we will use this temperature.

$$\frac{h_2 - 206.45}{218.64 - 206.45} = \frac{10}{15} \qquad h_2 = 214.6 \text{ kJ/kg}$$

$h_3 = h_f$ at 60^oC= 95.74 kJ/kg $\qquad h_4 = h_3$

$\Phi(in) = h_1 - h_4$ = 87.45 kJ/kg = Refrigeration Effect
$P(in) = h_2 - h_1$ = 31.39 kJ/kg
C of P (refrigerator) = 87.45/31.39 = 2.8
$\Phi(out) = h_2 - h_3$ =118.56 kJ/kg
C of P (Heat Pump) = 118.56/31.39 = 3.8