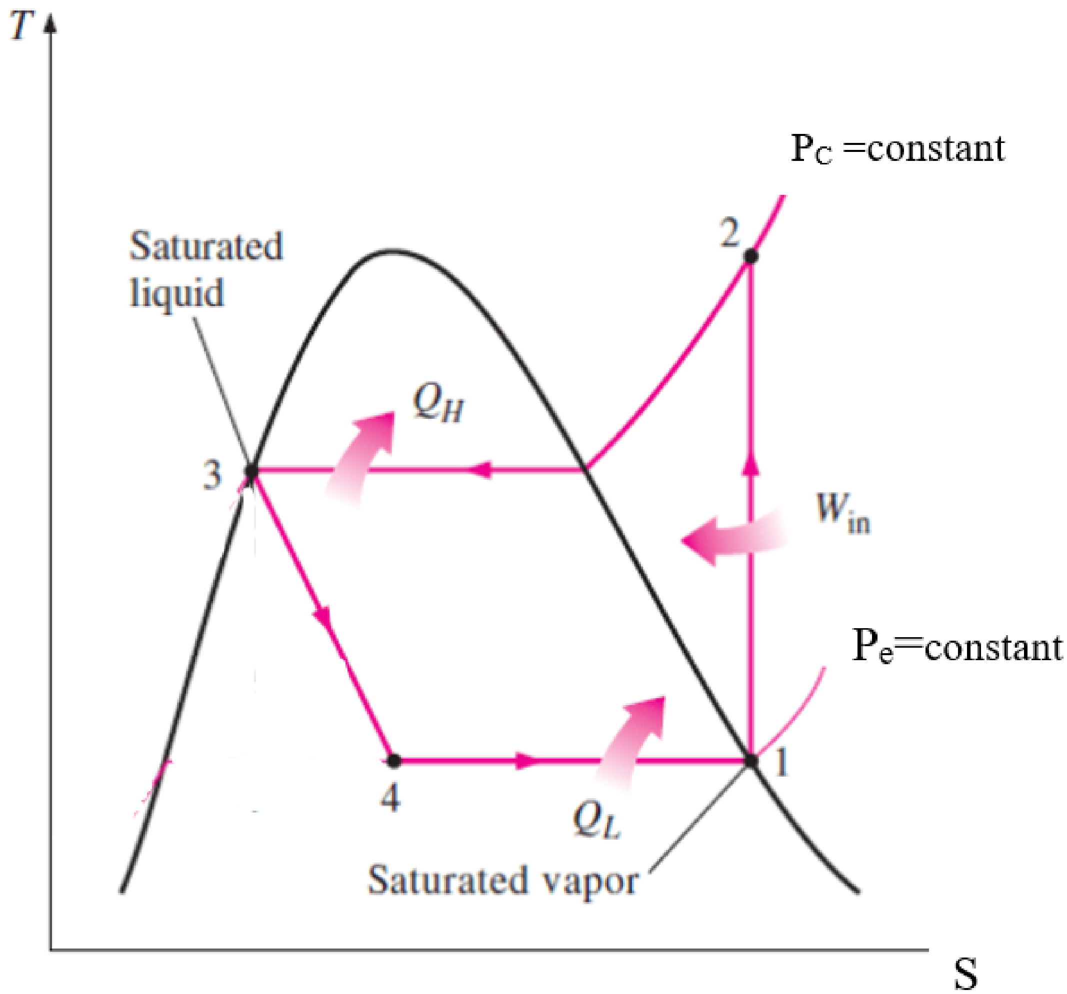
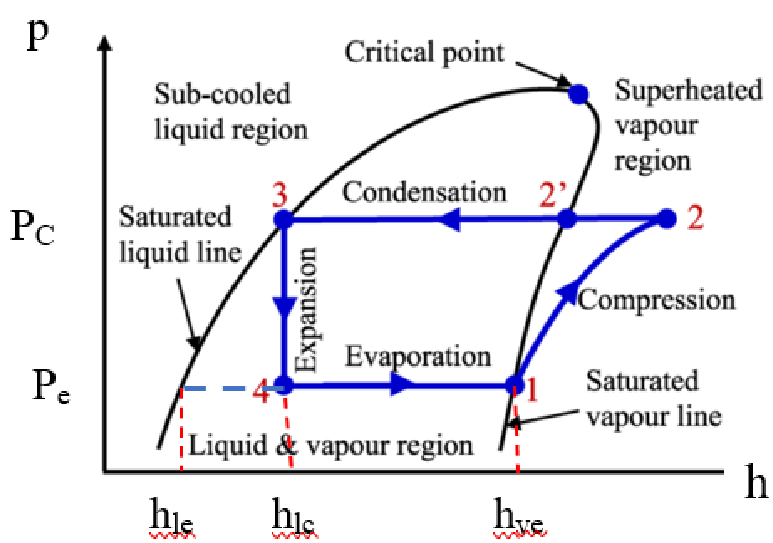
Lecture Fourteen

Heat balance and performance parameters for standard vapour compression cycle:



(T_S) diagram for Standard (Ideal) vapour compression cycle.

Recall P-h diagram for the standard compression cycle.



Standard (ideal) vapour compression cycle.

By applying the steady flow energy equation (S.F.E.E) to each process:

$Q - W = \Delta u + \Delta z + \Delta h$. ($\Delta u = 0$, $\Delta z = 0$)

Process (1-2): $W = h_2 - h_1$ (kJ/kg), ($Q=0$, reversible adiabatic). …….(8).

Process (2-3): $Q_{out} = h_2 - h_3$ (kJ/kg) ………………… (9).

Process (3-4): $Q = W = 0 \rightarrow h_3 = h_4$ ………………… (10).

Process (4-1): $W=0$, $Q_{in} = Q_{ref.} = h_1 - h_4$ (kJ/kg). ………… (11).

$$Cop = \frac{Q_{ref.}}{W.D} = \frac{h_1 - h_4}{h_2 - h_1}$$ ………………………….. (12).

Mass flow rate measured at compressor inlet, (i.e. mass rate needed to produce a certain refrigerating effect (X kw).

$$\dot{m}=\frac{cooling\ demand}{Q_{ref.(refrigerating\ effect)}}=\frac{X}{h1-h4}\frac{kJ/sec}{kJ/kg}\ \text{(kg/sec)}. \quad .... \quad (13).$$

Or for (1kw) of refrigeration, [$\dot{m}=\frac{1}{h1-h4}$ (kg/sec)/kw of refrigeration.] ………………………………………………………………..(13-a).

During throttling, a certain amount of liquid refrigerant is evaporated, which reduce the temperature of the bulk of the liquid from condenser temperature to evaporator temperature. This is known as (flash gas).

$h_{mixture\ (total)} = h_{lc} = h_3 = h_4 = f*h_{ve}+(1-f)\ h_{le}$

$h_{lc} - h_{le} = f\ (h_{ve} - h_{le})$

$$f = \frac{hlc - hle}{(hve - hle)} = \frac{h3 - hle}{(h1 - hle)} \quad ……………(14).$$

Where:

f= flash gas (kg).

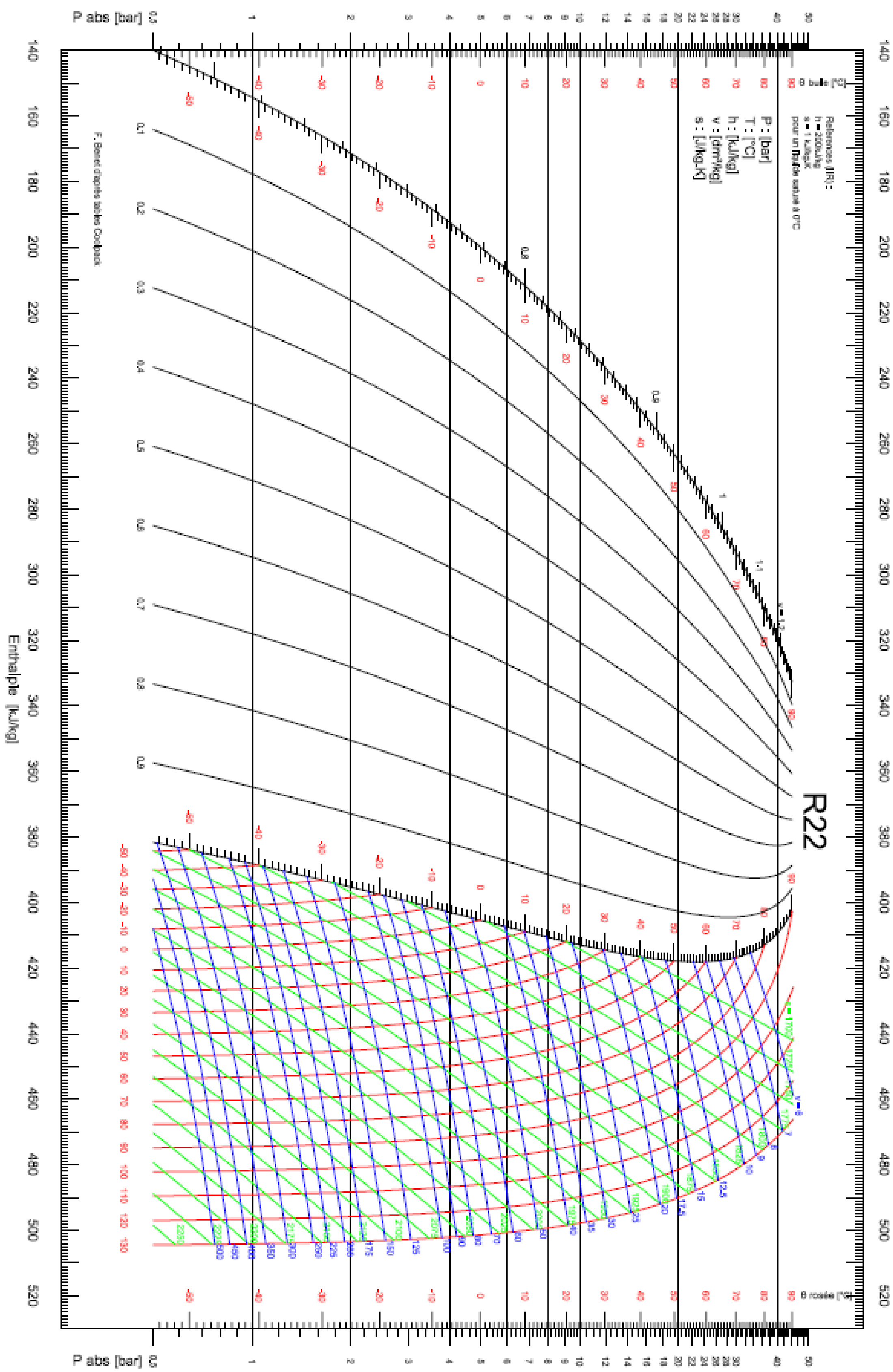
h_{ve}= vapour enthalpy at evaporator temperature (T_e).

h_{le}= liquid enthalpy at evaporator temperature (T_e).

h_{lc} = liquid enthalpy at condenser temperature (T_c).

Volumetric flowrate always measured al compressor inlet.

$\dot{\upsilon} = \dot{m}$ (specific Volume)$_1$.



R22
P abs [bar]
Enthalpie [kJ/kg]
θ bulle [°C]
θ rosée [°C]
P : [bar]
T : [°C]
h : [kJ/kg]
v : [dm³/kg]
s : [J/kg.K]
F. Besset d'après tables Coolpack