FDE 447
Cold preservation Technology

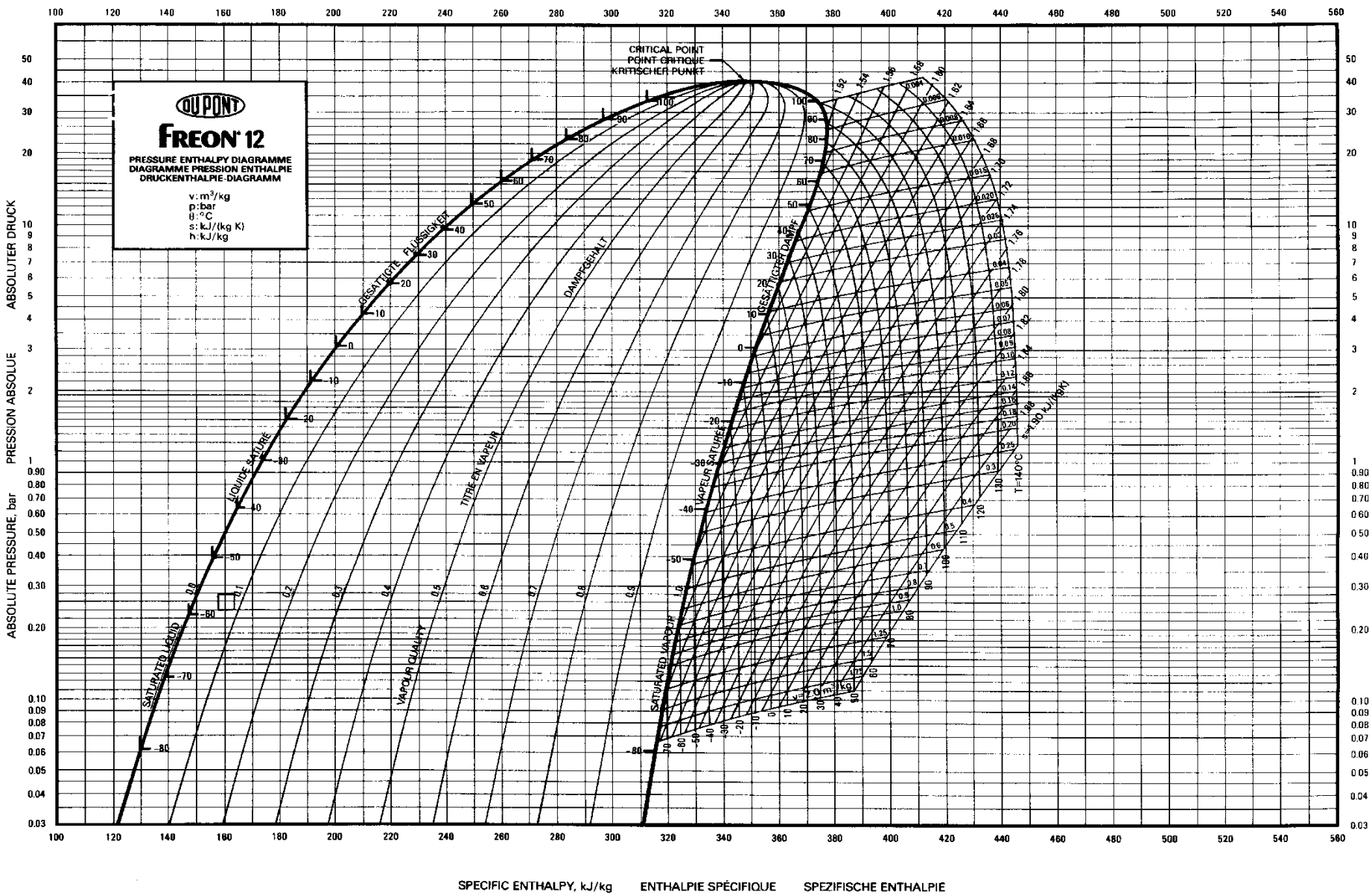
Content

*Refrigerants pressure-enthalpy (P-H)diagrams

*Analysis of the cooling cycle

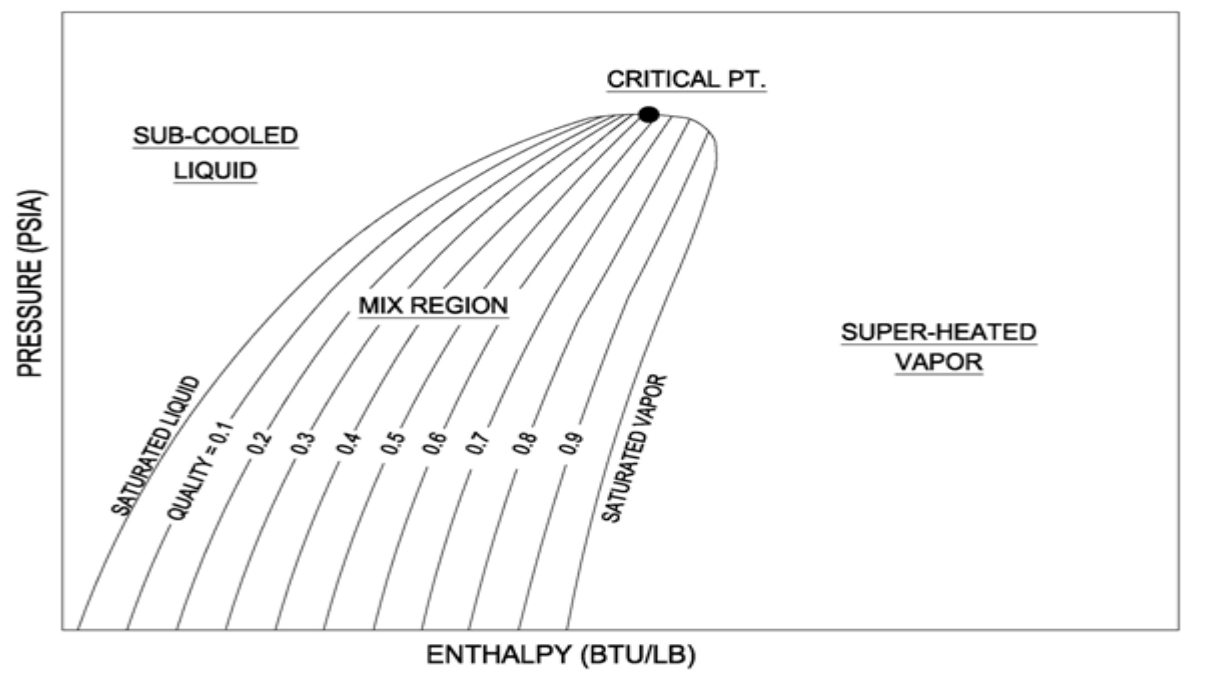
Refrigerants pressure-enthalpy diagrams

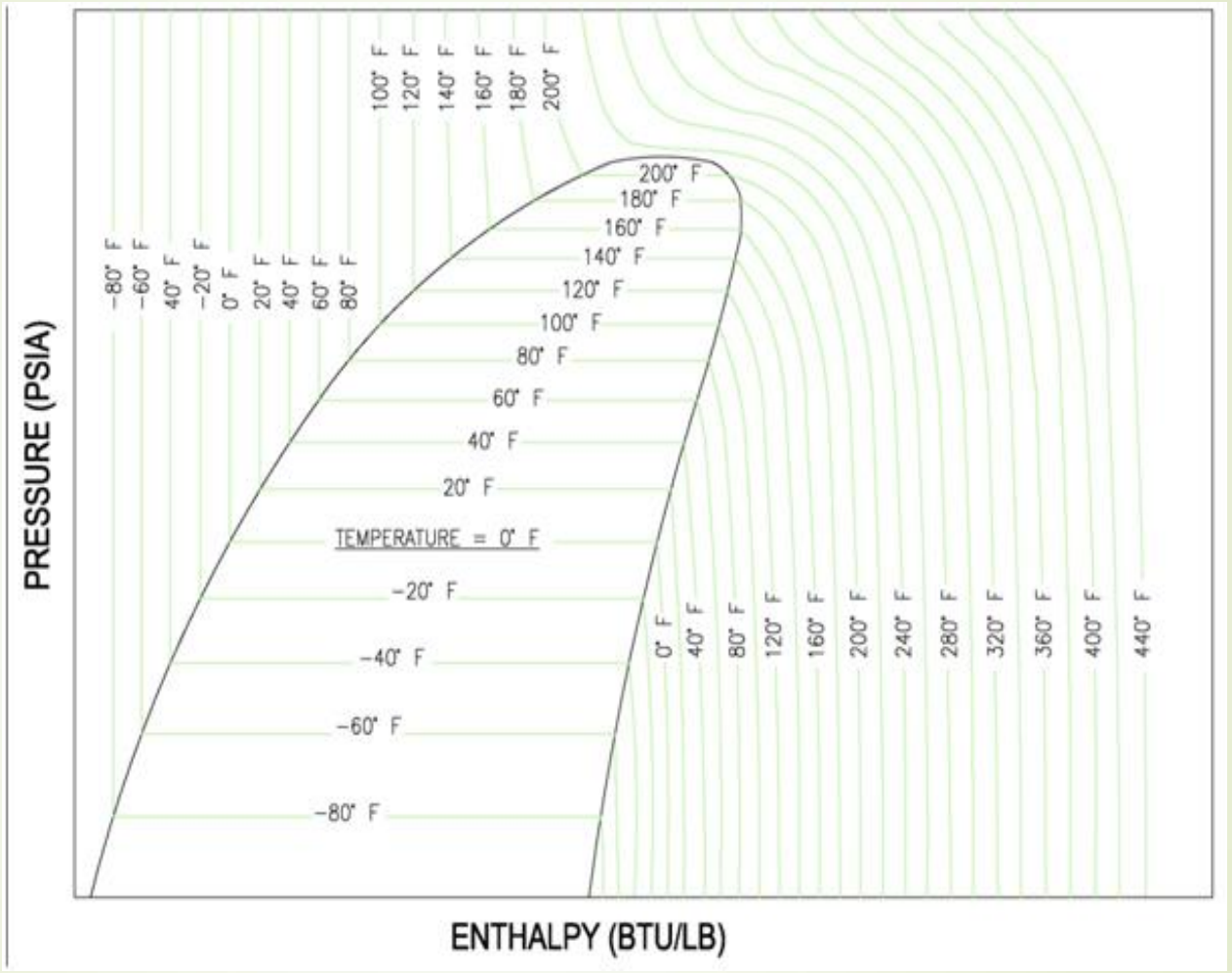
- It is an important diagram used frequently for a performance calculation of a refrigerating machine.
- A P-H diagram is made respectively for a specified refrigerant.
- It can, of course, not be used for another refrigerant.

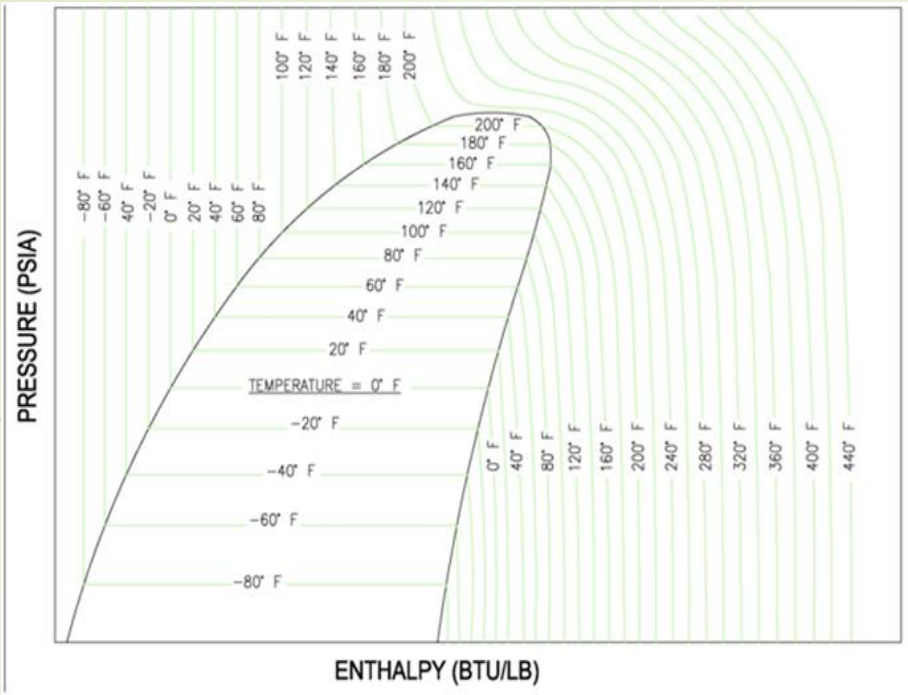


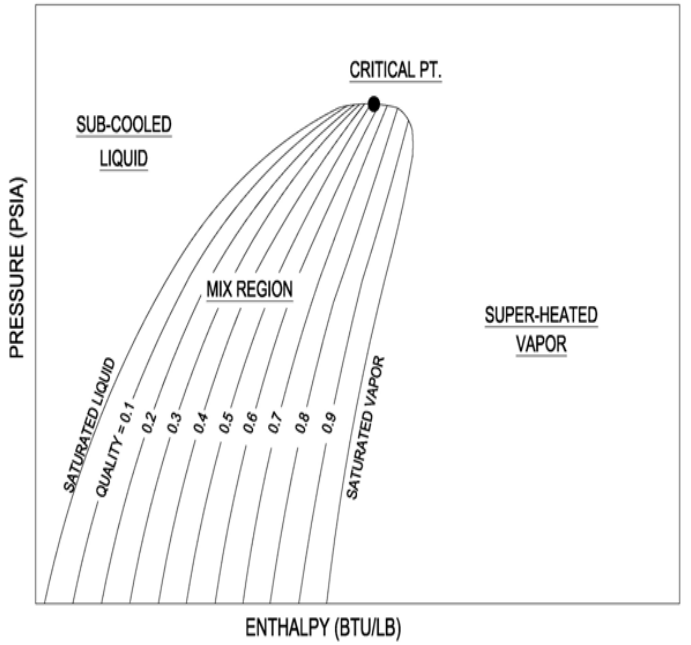
E-52455(A4) *FREON is Du Pont's registered trademark for its fluorocarbon refrigerants

Examination of pressure-enthalpy diagram




PRESSURE (PSIA)
ENTHALPY (BTU/LB)
TEMPERATURE = 0° F
-80° F
-60° F
-40° F
-20° F
0° F
20° F
40° F
60° F
80° F
100° F
120° F
140° F
160° F
180° F
200° F
240° F
280° F
320° F
360° F
400° F
440° F





3) Liquid-Vapor Mix Region:

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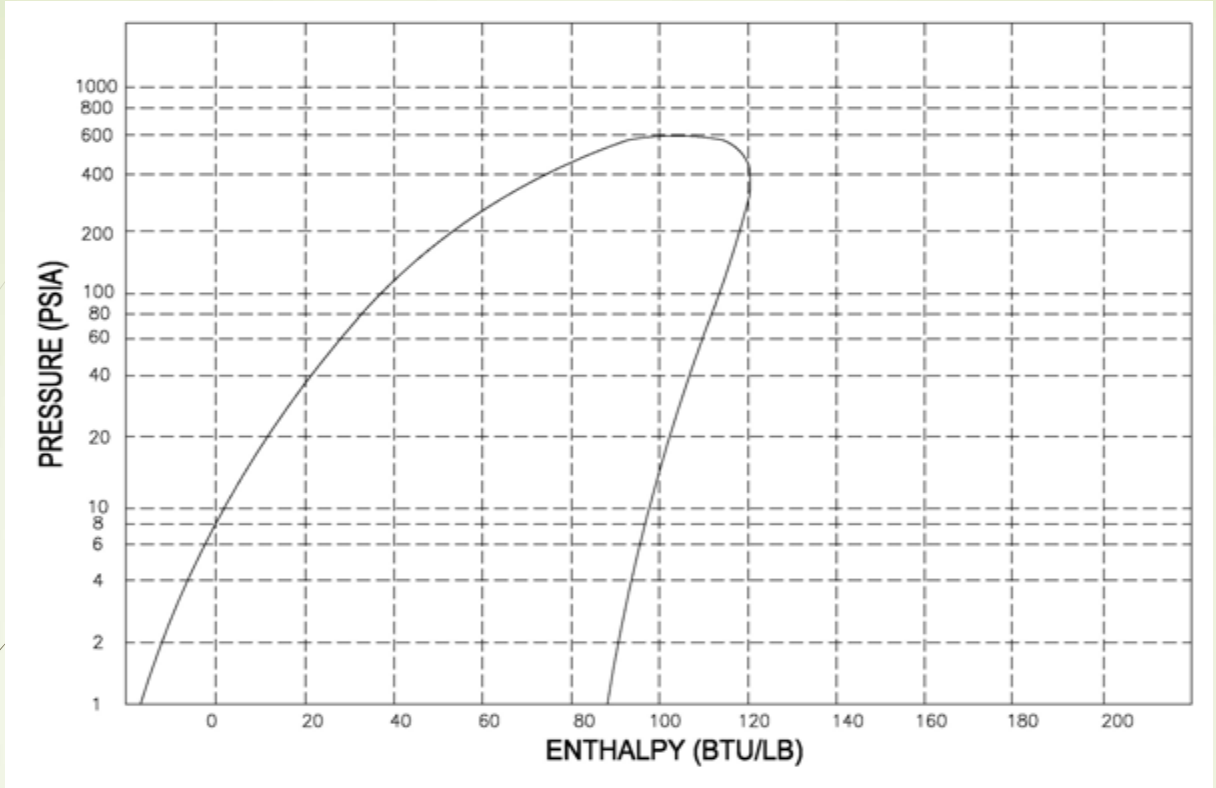
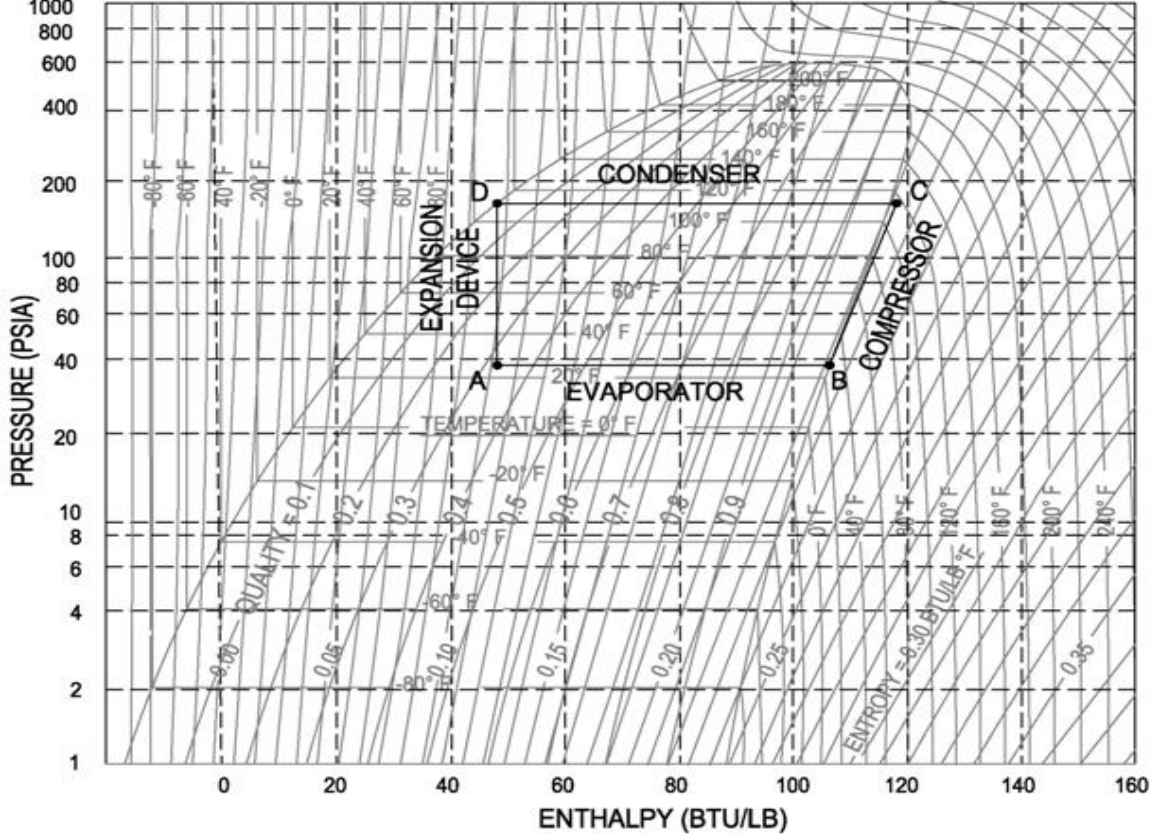
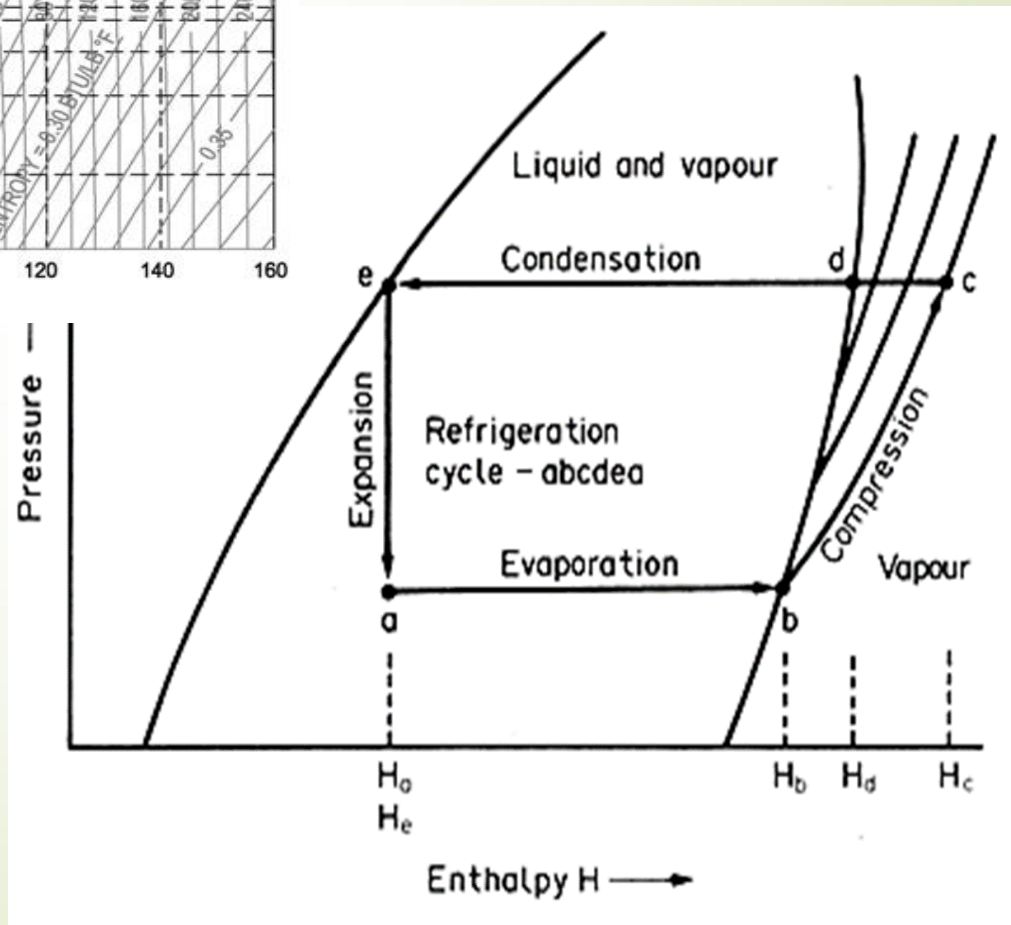


- The x-y axes of the P-H diagram are the enthalpy lines running from left to right. The pressure lines are the vertical lines.


PRESSURE (PSIA)
ENTHALPY (BTU/LB)
CONDENSER
EXPANSION DEVICE
COMPRESSOR
EVAPORATOR
A
B
C
D
TEMPERATURE = 0° F
QUALITY = 0.1
ENTROPY = 0.30 BTU/LB °F


Liquid and vapour
Condensation
Expansion
Refrigeration cycle – abcdea
Evaporation
Compression
Vapour
Pressure
Enthalpy H
e
d
c
a
b
H_a
H_e
H_b
H_d
H_c

The following equation are used to analyze refrigeration system

- Refrigerant flow rate:

$$m = \frac{refrigeration\ load}{(H_2 - H_1)}$$

- Work done on refrigerant during isentropic compression in a compressor:

$$q_w = m(H_3 - H_2)$$

- Heat rejected toenvironment during condensation:

$$q_c = m(H_3 - H_1)$$

- Heat absorbed by refrigerant during evaporation:

$$q_e = m(H_2 - H_1)$$

Where

H_1: is the enthalpy at saturated liquid conditions before the refrigerant enters the evaporator,

H_2 : the saturated state vapor enthalpy before the refrigerant enters the compressor,

H_3: the superheated vapor enthalpy before the refrigerant enters the condenser,

m: the mass flow rate of refrigerant (kg/s)

The following equation are used to analyze refrigeration system

- Performance of a refrigeration system is described by calculating the coefficient of performance (C.O.P.), defined as a ratio of heat absorbed by the refrigerant in the evaporator to energy supplied to the refrigerant in the compressor.

$$C.O.P. = \frac{H_2 - H_1}{H_3 - H_2}$$

- C.O.P. is always bigger than 1.

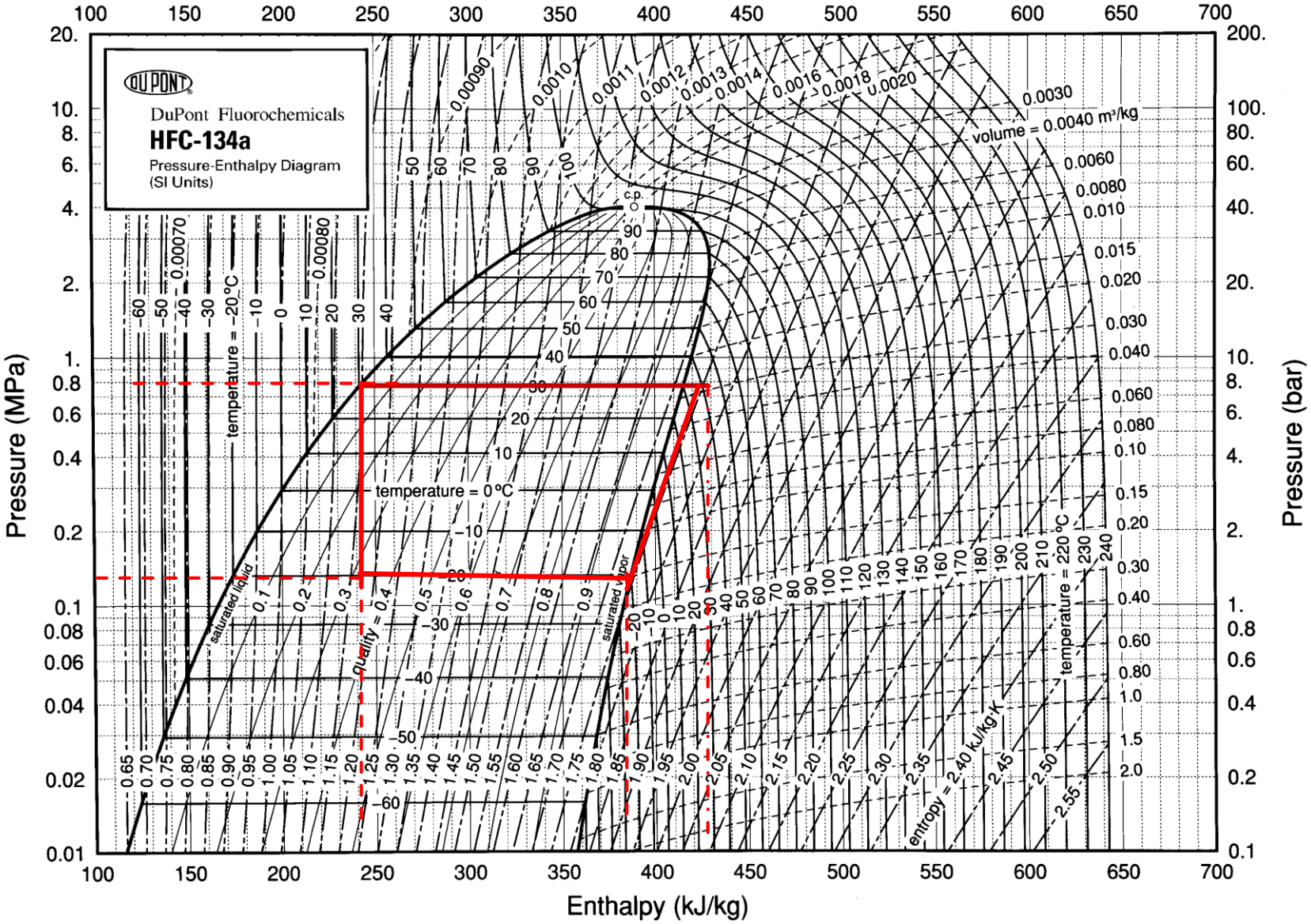
Example-1

- A refrigerator uses refrigerant-134a as the working fluid in a vapor-compression refrigeration cycle. The evaporator temperature is -20 (without any superhating)and the condenser temperature is 30 (without any subcooling). The mass flow rate of the refrigerant is 0.32 kg/s.

  (a) the rate of heat removal from the refrigerated space and the power input to the compressor,

  (b) the rate of heat rejection to the environment, and

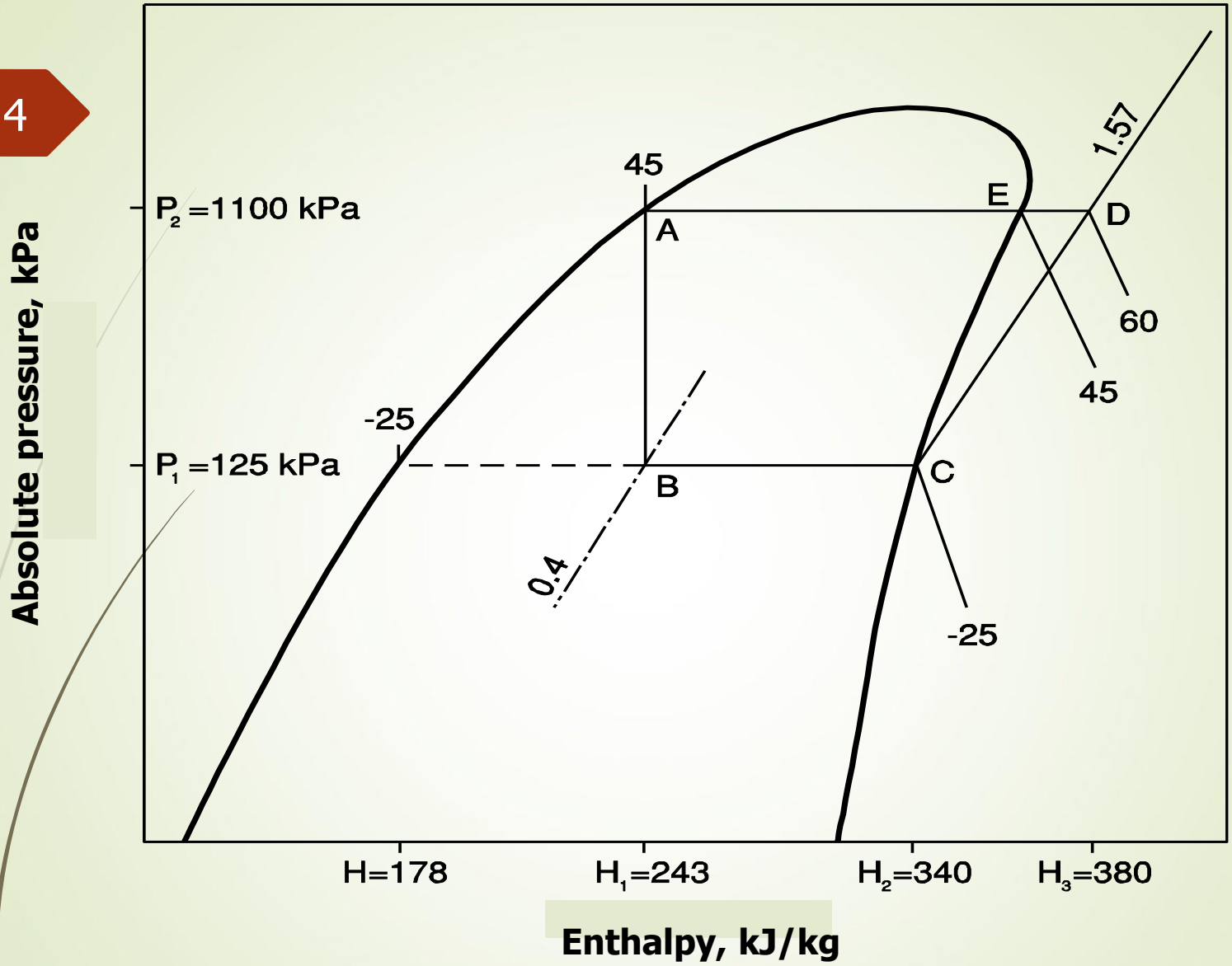
  (c) the COP of the refrigerator.



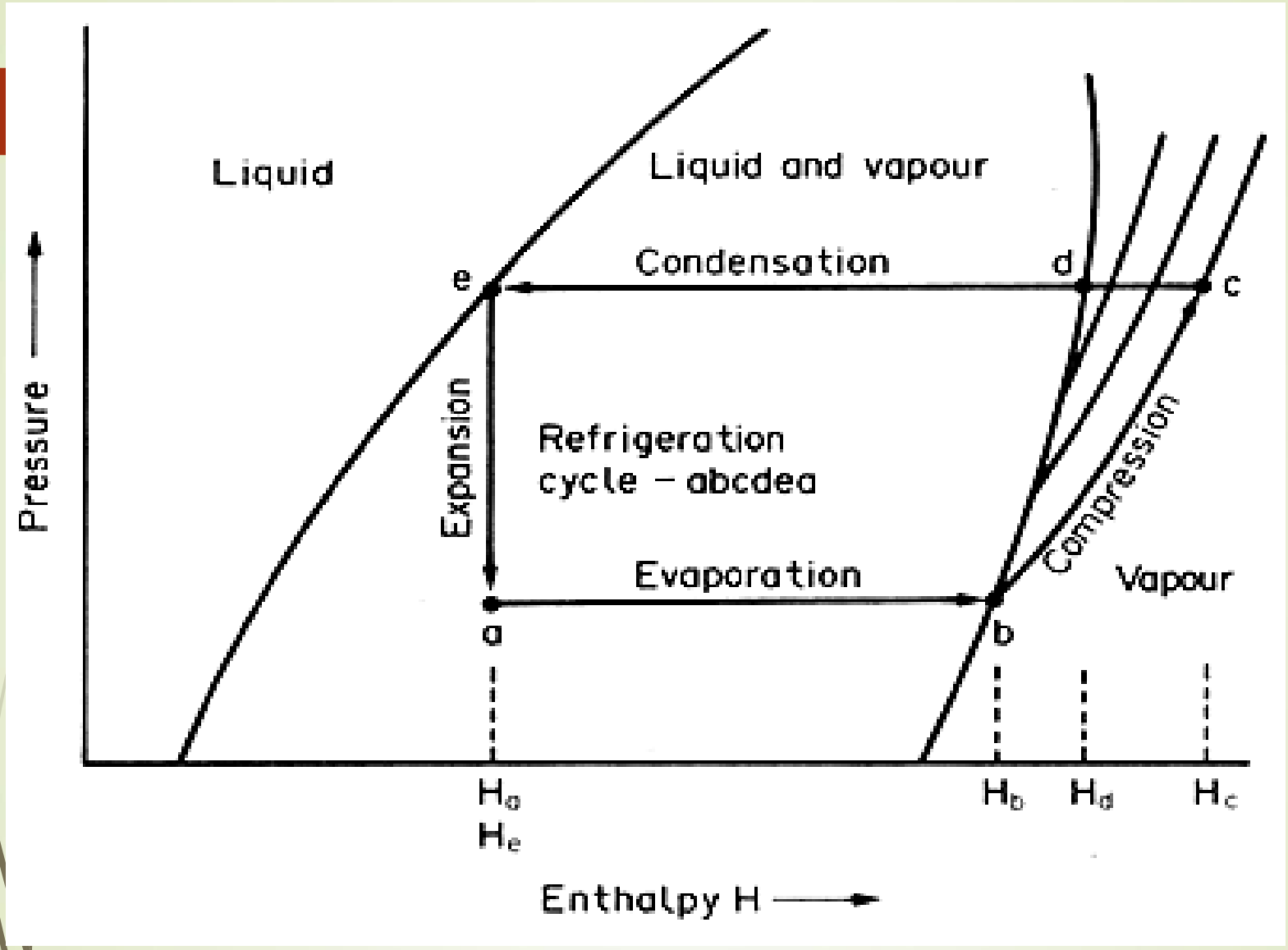
Soyer, A, Cold preservation Technology, Refrigerants P-H Diagrams

Example- 2

- R-12 refrigerant is used in a cooling system with a cooling load of 60 kW. The temperature of which is kept constant at -18°C; evaporator temperature is -25°C and condensation temperature is 45°C. The refrigerant reaches the expansion valve as saturated liquid and leaves the evaporator as saturated vapor. The efficiency of the compressor is 85%. Analyze this cooling circuit according to these data.



Pressure-Enthalpy diagram for R-12


Liquid
Liquid and vapour
Condensation
e
d
c
Expansion
Refrigeration
cycle – abcdea
Compression
Evaporation
Vapour
a
b
Pressure
H_a
H_e
H_b
H_d
H_c
Enthalpy H