Thermo

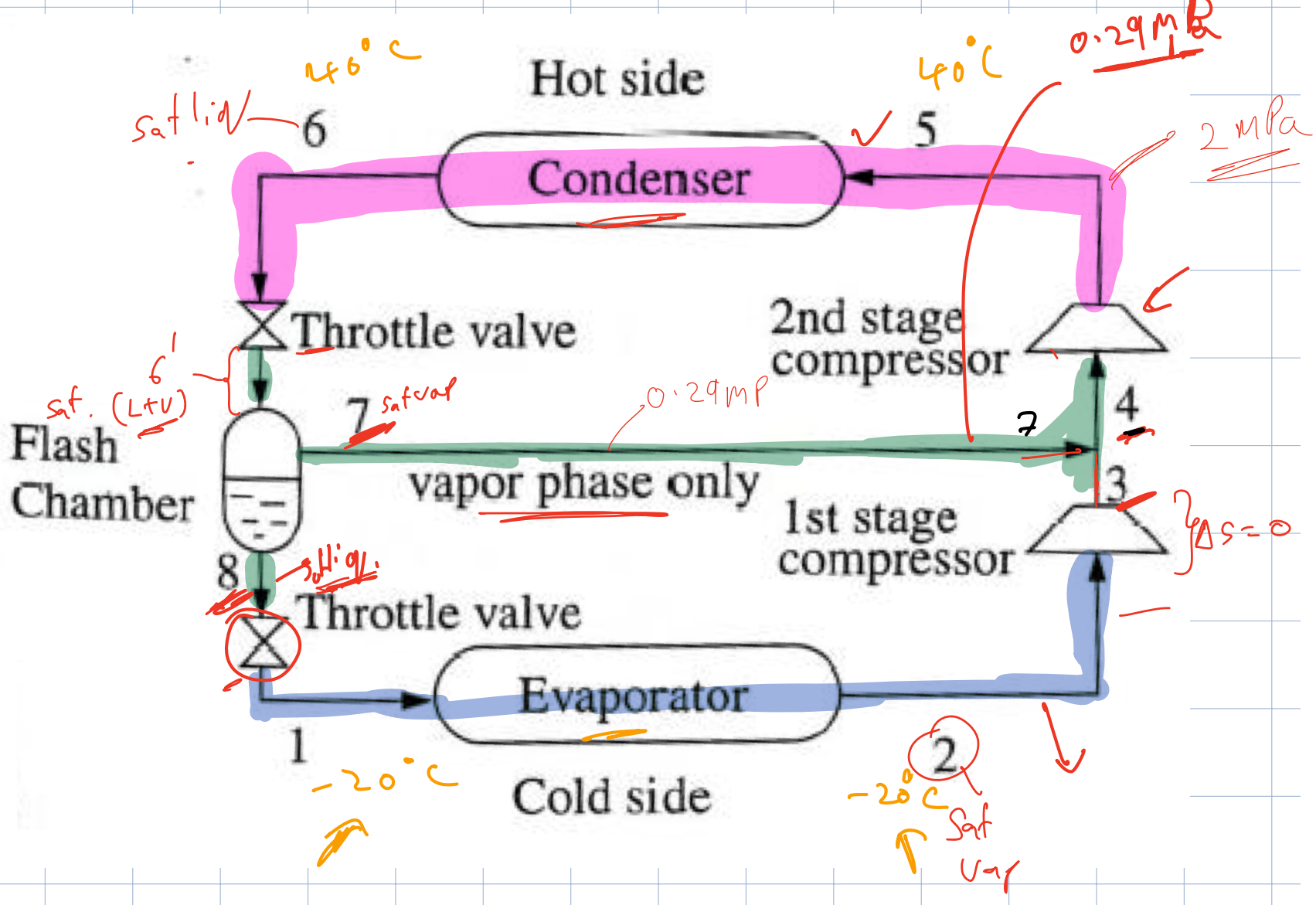
Recitation #9

(04/18/23)

→ 5.14 (Recition # 8 2nd prob)

→ Exam 3

5.14


Hot side
Condenser
Throttle valve
Flash
Chamber
vapor phase only
2nd stage
compressor
1st stage
compressor
Throttle valve
Evaporator
Cold side
6
5
7
4
3
8
1
2
40°C
40°C
0.29MPa
2 MPa
-20°C
-20°C
Sat
Vap
ΔS=0

Stream no.

① Saturated fluid (L + V), $T_1 = -20°C$

② Sat. vapour, $T_2 = -20°C$

③ compressed fluid, P_3

④ = ③ + ⑦, $P_4 = P_3 = P_7 = P_8 = 0.29$ MPa

⑤ Compressed fluid, $T_5 = 40°C$

⑥ Sat. liq, $= T_5 = 40°C$

⑦ Sat Vapour, $P_7 = P_3$ $P_4 = P_8 = 0.29$ MPa

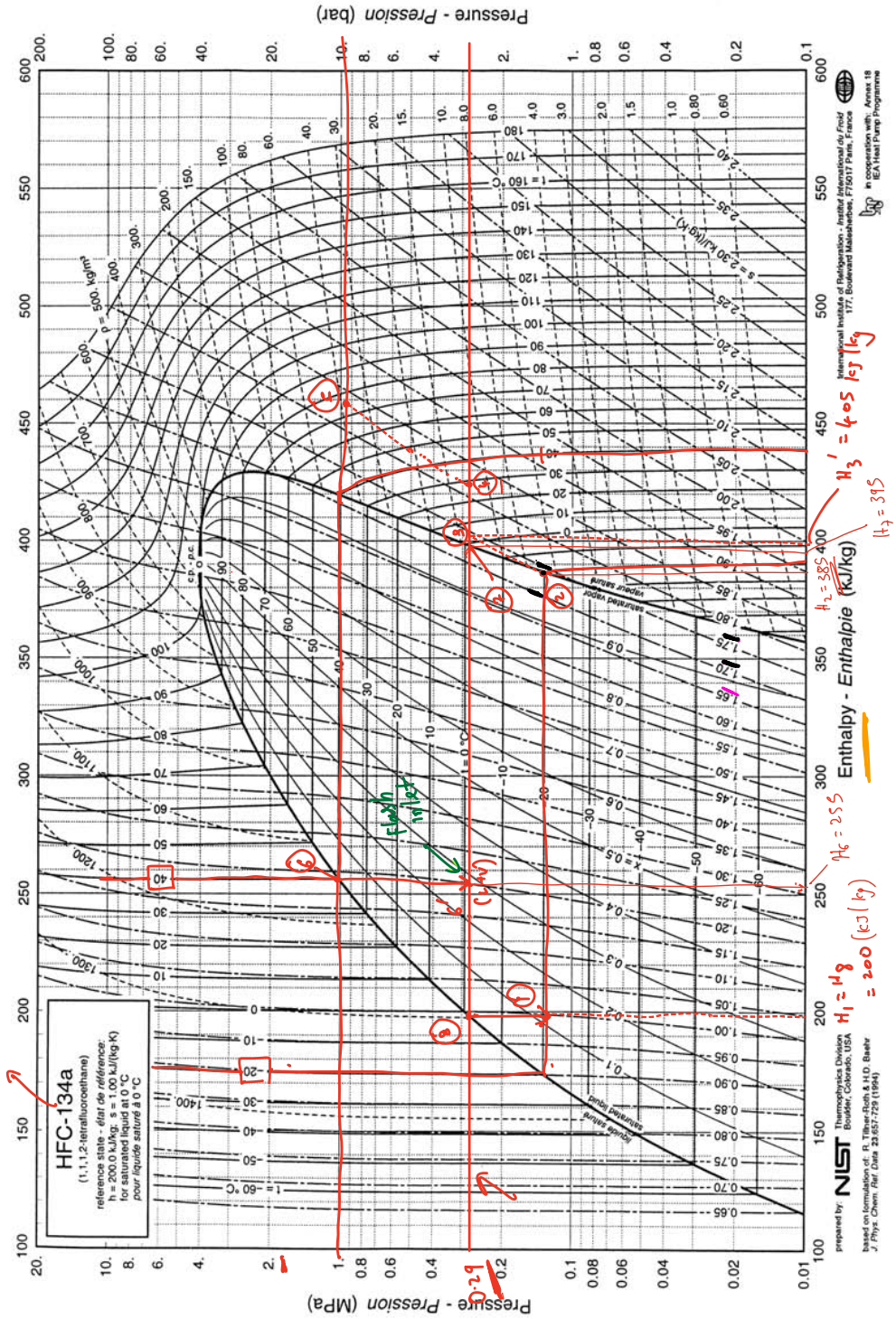
⑧ sat liquid, $P_8 = 0.29$ MPa

$H_8 = H_1$, $\dot{m}_1 = 23$ kg/hr

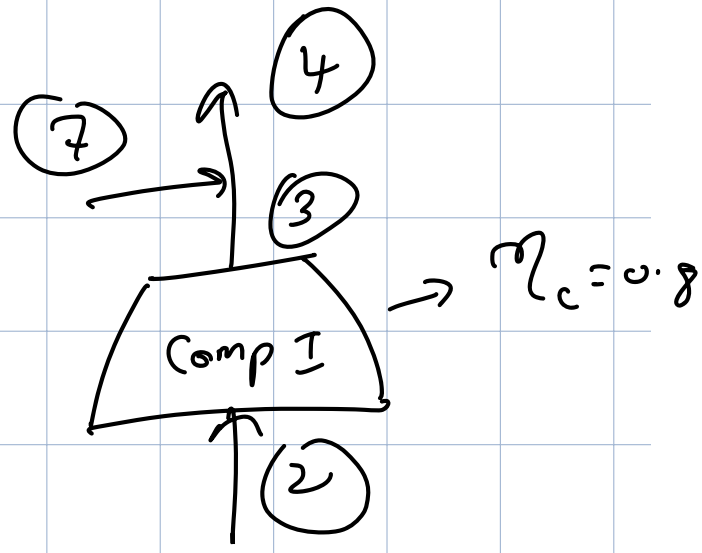
Assumption isenthalpic throttling

E.12 PRESSURE-ENTHALPY DIAGRAM FOR R134A (1,1,1,2-TETRAFLOUROETHANE)

(Source: NIST, Thermophysics Division, Boulder, CO, USA, used with permission.)



(a) $\dot{W}_S$, compressor I = ? (kJ/hr)



Assume ideal operation

$S_3' = S_2 = 1.725$ kJ/kg/K

$H_2 = 385$ kJ/kg

using isentropic line $\rightarrow P_3 : 0.29$ mPa

$H_3' = 405$ kJ/kg

$W_S' = \Delta H' = H_3' - H_2 = 405 - 385$

$w_s' = 20$ kJ/kg

$$w_s = \frac{w_s'}{\eta_c} = \frac{\Delta H'}{\eta_c} = \frac{20}{0.8} = 25 \text{ kJ/kg}$$

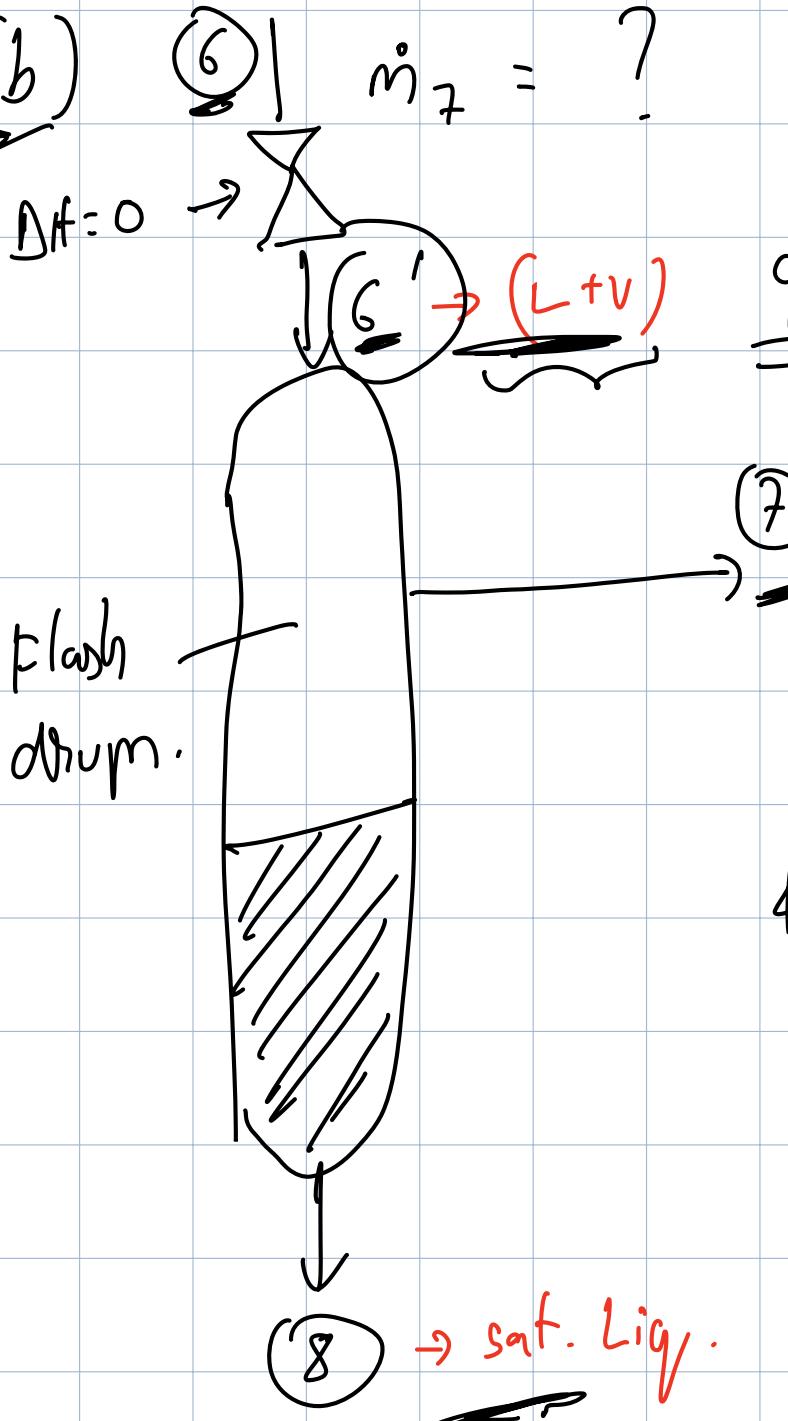
$$= \Delta H$$

$$\dot{W}_s = w_s \cdot \dot{m}_1 = 25 \frac{kJ}{kg} \times 23 \frac{kg}{hr}$$

$$= 575 \frac{kJ}{hr}$$

$$H_3 = \Delta H + H_2 = 25 + 385 = 410 \text{ kJ/kg}$$

(b)



$H_6 = 255$ kJ/kg

$H_7 = 395$ "

$H_8 = 200$ "

$\dot{m}_8 = \dot{m}_1 = 23$ kg/hr.

& mass bal:

$$\dot{m}_6 = \dot{m}_7 + \dot{m}_8$$

q (inlet) $= \dfrac{H_6 - H_8}{H_7 - H_8} = 0.282 \Rightarrow$ 28% vap, 72% liq

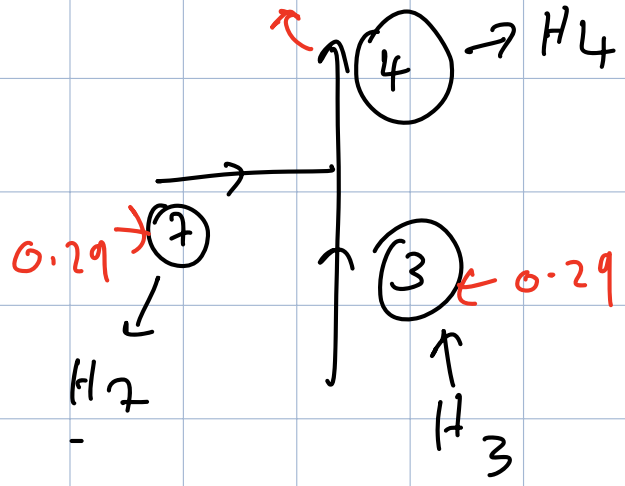
$\therefore \dot{m}_8 = 0.72 \times \dot{m}_6$

& $\dot{m}_7 = 0.28 \times \dot{m}_6$

$\therefore \dot{m}_6 = \dfrac{\dot{m}_8}{0.72} = \dfrac{23}{0.72} = 31.94$ kg/hr

$\therefore \dot{m}_7 = \dot{m}_6 - \dot{m}_8 = 8.94$ kg/hr.

(c)



$H_4 \neq H_7 + H_3$ } intensive Property

$H_4 = H_7 + H_3$

$H_3 = 410$ kJ/kg

$H_7 = 395$ kJ/kg

$\dot{m}_4 = \dot{m}_6 = 31.95$ kg/hr.

$\dot{m}_3 = \dot{m}_1 = 23$ kg/hr

$\dot{m}_7 = 8.94$ kg/hr.

$\dot{m}_4 H_4 = \dot{m}_7 H_7 + \dot{m}_3 H_3$

$\therefore H_4 = \dfrac{\dot{m}_3 H_3 + \dot{m}_7 H_7}{\dot{m}_4}$

$\therefore H_4 = 405.8$ kJ/kg