Quiz 7 Chemical Engineering Thermodynamics
February 27, 2020

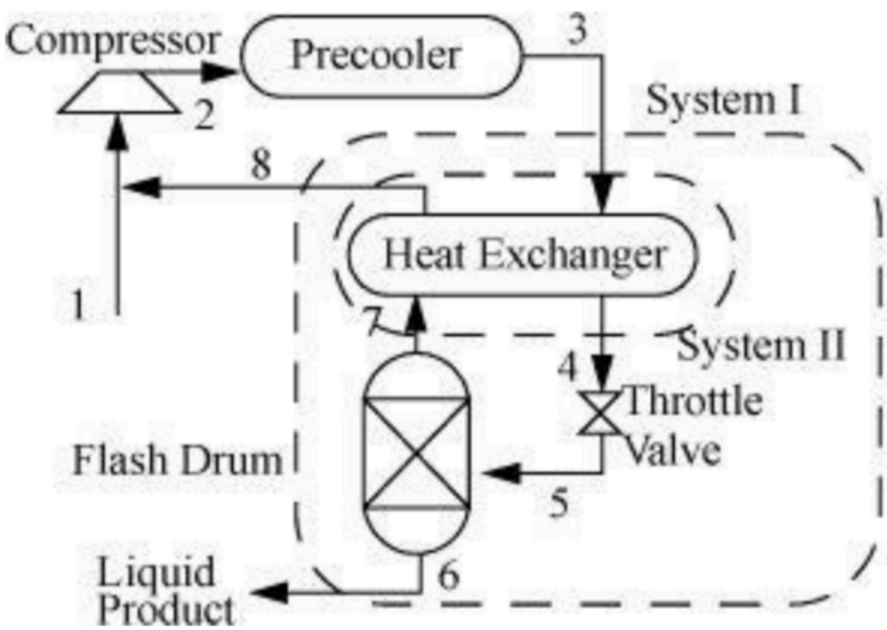
A Linde process is used to produce liquified propane. Stream 3 is at 260K and 6 MPa. Stream 5 is at 0.1 MPa. Streams 8 and 1 are at 295K. Determine all of the missing parameters in the attached table using PREOS.xls. Assume perfect efficiency and no heat loss in the process.

-For the reference state use an ideal gas with H = 0 at 298K and 0.1 MPa.

-Determine all values using PREO.xls .

In addition to filling out the table:

1) Explain the origin of the two equations shown below the diagram.
2) What is Q_{PC} for the precooler?
3) What is W_S for the compressor?
4) How is the amount of product m_6 related to Q_{PC} for the precooler and W_S? (Do a balance around the entire process.)

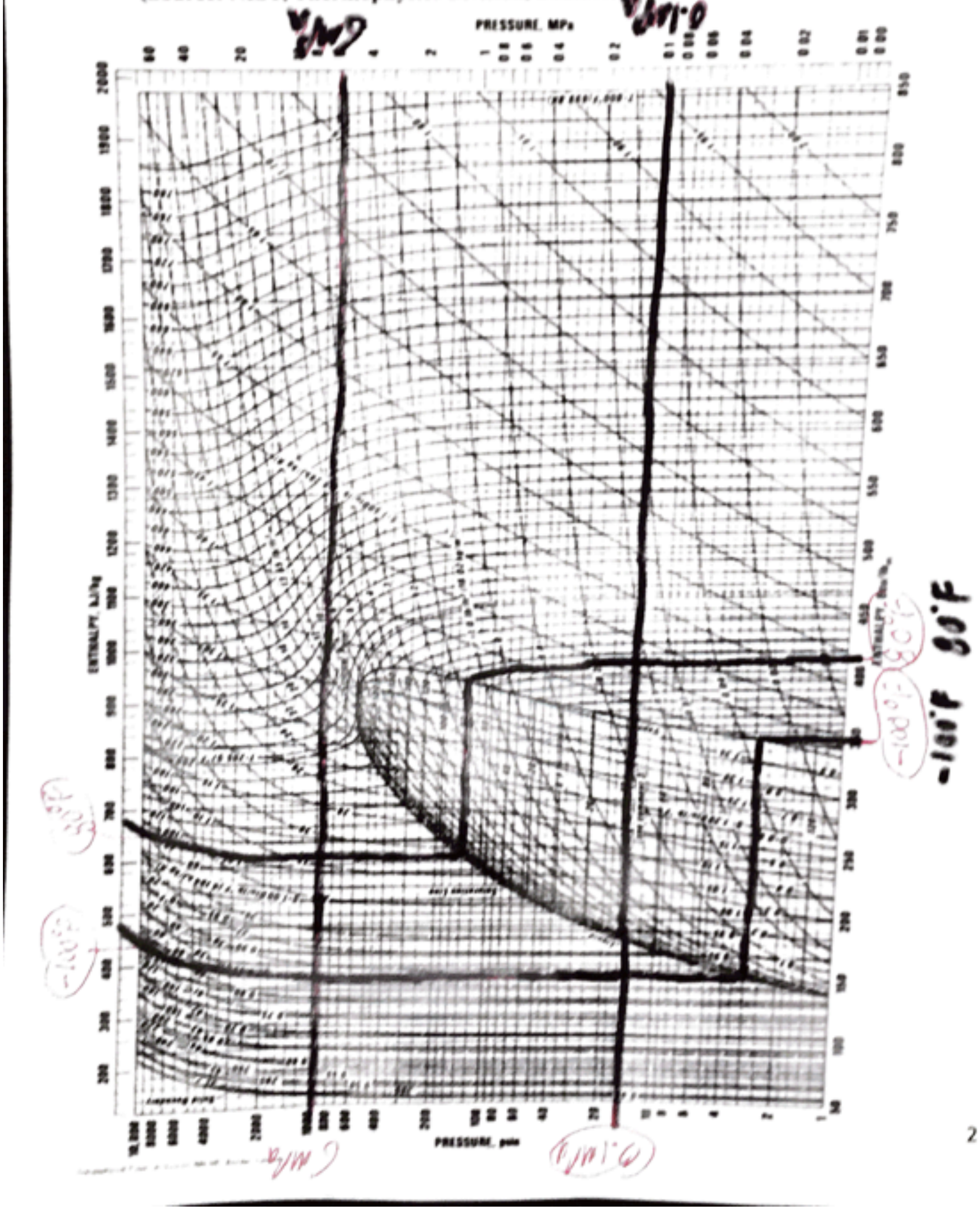


$$q = \frac{H_3 - H_6}{H_8 - H_6} \qquad H_4 - H_3 = -q(H_8 - H_7)$$

300K is about 80°F
200K is about -100°F
For a perfect compressor, turbine, or pump $\Delta S = 0$
For a throttle or valve $\Delta H = 0$

.11 PRESSURE-ENTHALPY DIAGRAM FOR PROPANE

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



300K is about 80°F   200K is about -100°F

Reference state ideal gas with H = 0 at 298K and 0.1 MPa

Stream	State	q	T, K	P, Mpa	V, cm3/mole	H, J/mole	S, J/(mole K)
1							
2							
3							
4							
5							
6							
7							
8							

V = Vapor; L = Liquid; SV = Saturate Vapor ; SL = Saturated Liquid ; V/L = mixed V & L; SCF = Supercritical Fluid

1) Explain the origin of the two equations shown below the diagram.

$q = \frac{H_3 - H_6}{H_8 - H_6}$ $\quad$ $H_4 - H_3 = -q(H_8 - H_7)$ (Use another sheet if you need more space)

2) What is the value for Q_{PC} for the precooler?

3) What is the value for W_S for the compressor?

4) How is the amount of product m_6 related to Q_{PC} for the precooler and W_S? (Do a balance around the entire process.)

Answers Quiz 7 2020

Stream	State	q	T, K	P, Mpa	V, cm3/mole	H, J/mole	S, J/(mole K)
1	V	1	295	0.1	24100	-334	-0.988
2	SCF	1	462	6	474	11000	-0.988
3	SCF	1	260	6	74.2	-20300	-87.8
4	SCF	1	254	6	73.2	-20900	-90.2
5	V/L	0.131	231	0.1	2490	-20900	-87.8
6	SL	0	231	0.1	70.9	-23300	-98.4
7	SV	1	231	0.1	18500	-4620	-17.3
8	V	1	295	0.1	24100	-334	-0.988

1) Explain the origin of the two equations shown below the diagram.

$q = \frac{H_3 - H_6}{H_8 - H_6}$ $\quad H_4 - H_3 = -q(H_8 - H_7)$ (Use another sheet if you need more space)

First from the dotted box that combines streams 3, 8, and 6. Energy balance. $H_3 = (1-q)H_6 + qH_8$

Second from an energy balance on the heat exchanger $H_4 - H_3 = -q(H_8 - H_7)$

2) What is the value for Q_{PC} for the precooler?

$Q_{PC} = H_3 - H_2$ = -20300 J/mole – 11,000 J/mole = -31,300 J/mole

3) What is the value for W_s for the compressor?

$W_s = H_2 - H_1$ or $H_2 - H_8$ = 11,000 J/mole + 334 J/mole = 11,300 J/mole

4) How is the amount of product m_6 related to Q_{PC} for the precooler and W_s? (Do a balance around the entire process.)

$m_6(H_6 - H_1) = (W_S + Q_{PC})$

$m_6 = \frac{(W_S + Q_{PC})}{(H_6 - H_1)} = m_1$

Use

$$q_5 = \frac{H_3 - H_6}{H_8 - H_6}$$

To get

$$H_4 = -q(H_8 - H_7) + H_3$$

For the table.