

Homework Set #4

(due February 16, 2001)

- 1.) Solutions of methanol and ethanol are substantially ideal and their vapor pressure can be estimated using the Antoine equation:

$$\log_{10} P' = A - \frac{B}{C + T}$$

where P' is the vapor pressure in mmHg, T is the temperature in $^{\circ}\text{C}$, A , B , and C are given by (taken from *Lange's Handbook of Chemistry*):

substance	A	B	C
ethanol	8.04494	1554.3	222.65
methanol	7.87863	1473.11	230.0

(for $-20 < T < +140^{\circ}\text{C}$)

- a. Determine and plot the Txy and xy diagrams for this mixture at the following total pressures:
 - i. 1 atm
 - ii. 5 atm
 - b. For each pressure compute relative volatilities at several mole fractions and determine an average value.
- 2.) A saturated liquid solution containing 50 mol% acetone in methanol is feed to a flash distillation unit. Equilibrium data for this system is given in the following table (acetone is the more volatile component):

$T (^{\circ}\text{C})$	x	y	$T (^{\circ}\text{C})$	x	y
64.5	0	0	56.7	0.5	0.586
63.6	0.05	0.102	56.0	0.6	0.656
62.5	0.1	0.186	55.3	0.7	0.725
60.2	0.2	0.322	55.05*	0.8	0.800
58.65	0.3	0.428	56.1	1	1
57.55	0.4	0.513			

- a. Determine the bubble point and dew point of this mixture.

Answer: 56.7 $^{\circ}\text{C}$ and 57.7 $^{\circ}\text{C}$.

* Azeotrope

- b. Find the temperature and compositions of the product streams if the liquid and vapor leaving the flash unit are at equilibrium at 1 atm and 30 mol% of the feed is vaporized.

Answer: 56.92°C

- 3.) The same 50 mol% solution of acetone in methanol is charged to the kettle of a batch still, operating at 1 atm pressure. What fraction of the initial charge must be differentially distilled to reduce the composition of the solution remaining in the kettle to 20 mol%?

Answer: 92.8 mol%

- 4.) Enthalpy-concentration data for solutions of n-hexane and n-octane at 1 atm are given by:

x	y	H_L	H_V
0	0	7000	15,700
0.1	0.36	6300	15,400
0.3	0.70	5000	14,700
0.5	0.875	4100	13,900
0.55	0.90	3902	13,735
0.70	0.95	3400	12,900
0.9	0.989	3100	11,600
1.0	1.0	3000	11,300

where the enthalpies above have units of cal/gmol.

- a. If 4000 cal/gmol of heat is added to a 50 mol% saturated liquid, which then undergoes an equilibrium flash at 1 atm, find the mol% of the feed which is vaporized and the composition of the vapor and liquid leaving the flash unit.

Answer: $f = 0.349$.

- b. How much heat must be added per gmol of feed to completely vaporize the feed?