ChE 250
Spring 2000

Problem Set #8

Due Thursday, March 30

Review any needed parts of F&R Chapter 6 (especially intro, 6.1, 6.4-6.6a).

1. Identify your choices for the top three key concepts or useful ideas from the first half-semester of ChE 250.

2. Write a homework-level problem that exercises one or more of your listed items, and show what the suggested solution is. Other resources for composing this problem include the top-50 chemicals list, Shreve's CPI, the Kirk-Othmer Encyclopedia of Chemical Technology, and other references on the class list. Bonus points may be given for realism or relevance to current news events.

3. Vapor–liquid equilibrium data for methanol–water mixtures at a pressure of 1 atm are given here.

T(°C)	x_M	y_M	T(°C)	x_M	y_M
100.0	0.000	0.000	75.3	0.400	0.729
96.4	0.020	0.134	73.1	0.500	0.779
93.5	0.040	0.230	71.2	0.600	0.825
91.2	0.060	0.304	69.3	0.700	0.870
89.3	0.080	0.365	67.6	0.800	0.915
87.7	0.100	0.418	66.0	0.900	0.958
84.4	0.150	0.517	65.0	0.950	0.979
81.7	0.200	0.579	64.5	1.000	1.000
78.0	0.300	0.665			

(a) Construct a Txy diagram for this system.
(b) A thermocouple inserted into a two-phase methanol–water mixture at equilibrium reads 70°C. The system pressure is 1 atm. What are the liquid and vapor compositions?
(c) An equimolar mixture of methanol and water is fed to an evacuated vaporizer and allowed to come to equilibrium at 80°C and 1 atm. What are the molar compositions of each phase of the system? What percentage of the final mixture is vapor?
(d) A liquid mixture containing 65 mole% methanol and 35% water is fed to an equilibrium flash tank operating at 1 atm. The system conditions are such that 20% of the entering feed is vaporized. Determine the compositions of the liquid and vapor streams leaving the tank, and the temperature at which the tank operates.

(over for last problem)

4. A) Repeat the problem above (#3) using ideal-solution predictions (instead of the x-y-T data) for the phase diagram. Use the Antoine equation for pure-component vapor pressures, Raoult's Law to approximate this system as an ideal mixture, and your favorite computer tools to determine for specific values of liquid-phase mole fraction (x) to find the temperature at which the two component vapor pressures add to 1 atm, to construct a T-x-y diagram for the water-methanol system at 1 atm (760 mm Hg). Repeat the calculations from parts a, c, and d using your new phase diagram or the corresponding x-y equilibrium plot. Compare the phase diagram and numerical results obtained here with the answers using the measured data.

   [Note: this problem is much like F&R 6.69, so read that if you want guidance on the detailed steps you might use.]

   B) Comment on the differences between your answers for problems 3 and 4(A), and discuss the validity of the assumptions used. Do you find these VLE calculations easier from the data table or T-x-y plot, or from the relative volatility approximation? Is relative volatility actually constant for either the real data, or the ideal-solution predictions? Calculate α at x_M=0.2 and 0.8 for each to check.