ChEn 3603 Homework #8

Problem 1 (6 pts)

Assuming that Raoult's law (for ideal mixtures) holds, and starting from the Rachford-Rice equation,

1. (3 pts) Derive the equation for the *bubble point pressure* given a system temperature T. Express your answer in terms of z_i and P_i^s.
2. (3 pts) Derive the equation for the *dew point pressure* given a system temperature T. Express your answer in terms of z_i and P_i^s.

Problem 2 (14 pts)

Calculate the bubble-point temperature and the composition of the first vapor bubble of an equimolar mixture of ethylene, *n*-butane, iso-pentane and *n*-hexane at **4 atm** using

1. (2 pts) The DePriester correlation
2. (4 pts) Raoult's law
3. (6 pts) The Redlich-Kwong equation of state
4. (2 pts) The Soave-Redlich-Kwong equation of state.

Feel free to use the python files I posted on the class web page for this, as it will save you a *lot* of time - particularly for the RK/SRK equation of state.

Provide a table that summarizes the bubble point temperature and the composition of the corresponding vapor phase for each method.Be sure to include a description of the equations you solve and the parameters you use in those equations. For the SRK equation, you can refer to the appropriate sections in the book or lecture notes so that you don't need to re-hash all of those equations. Include an algorithm for how you use the SRK equation to obtain the bubble point.

Problem 3 (12 pts) - (from SHR)

A feed of 13,500 $\mathrm{kg/h}$ is 8 wt% acetic acid (B) in water (A). Removal of acetic acid is to be by liquid–liquid extraction at 25°C, as shown schematically in Figure 1. The raffinate is to contain 1 wt% acetic acid. The following four solvents, with accompanying distribution (partition) coefficients in mass-fraction units, are candidates. Water and each solvent (C) can be considered immiscible. For each solvent, estimate the $\mathrm{kg/h}$ required if one equilibrium stage is used. The partition coefficients,

$$K_{D_B} \equiv \frac{\omega_B^{(E)}}{\omega_B^{(R)}}, \tag{1}$$

are given in Table 1.

Table 1: Partition coefficients, K_D, in mass-fraction units (see equation (1)).

Solvent	K_D
Methyl Acetate	1.273
Isopropyl Ether	0.429
Heptadecanol	0.312
Chloroform	0.178

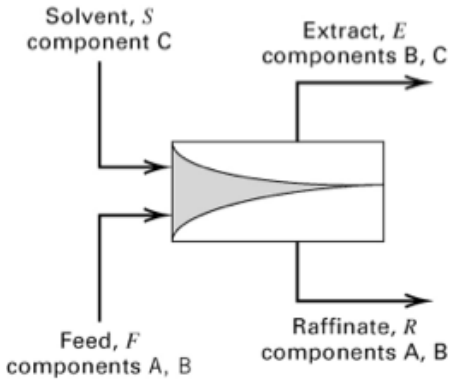

Figure 1: Process schematic

Problem 4 (10 pts)

SHR 4.48 in the fourth edition (4.46 in the third edition).