ENCH 445 -- Problem Set #3

Problem 1

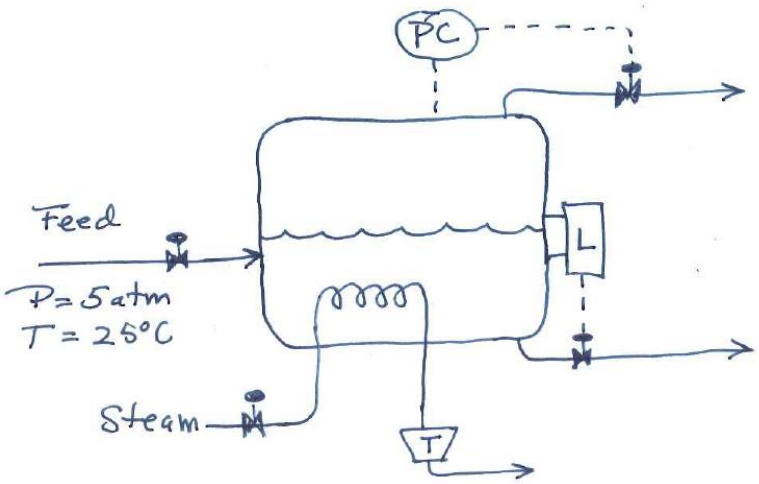
A liquid mixture contains 10% (mole/mole) n-hexane, 20 % n-octane, 30 % toluene, and 40% o-xylene. Determine the boiling point of this mixture at 1 atm total pressure. Also determine the corresponding vapor composition. To accomplish this calculation use the method illustrated on page 6 of the detailed notes for Chapter 4 of the ENCH 445 course WebBook, and solve numerically a set of 5 equations and 5 unknowns. In your calculations account for liquid-phase nonideality using regular solution theory and account for vapor-phase nonideality using the virial equation of state together with the Lewis fugacity rule.

Problem 2

Verify to the extent possible your boiling point calculation performed in Problem 1 by using either ChemSep or Aspen to perform an appropriate single-stage flash calculation. Discuss briefly the reasons for any differences in the results obtained compared to the results obtained in Problem 1. Note that a tutorial on how to perform a single-stage flash calculation using ChemSep is given in Chapter 5 (Part 3) of the ENCH 445 course WebBook.

Problem 3

According to EPA regulations, summer gasoline blends must have a total vapor pressure that is less than 7.8 psi at a temperature of 100 ^{o}F in order to reduce air pollution from gasoline used in automobiles. A waste hydrocarbon stream at a particular refinery contains 8% (mole/mole) n-butane together with 10 % n-octane, 21 % toluene, and 61% o-xylene and is available at 25 ^{o}C and 5 atm. In order for this stream to be used as a blend ingredient for summer gasoline, the n-butane content must be reduced as much as possible. Since hydrocarbons having vapor pressures between n-butane and n-octane are fortuitously absent from this waste stream, it is proposed to remove n-butane in a single-stage process as illustrated below:



The flash chamber in the process shown is equipped with a vacuum pump such that the allowable operating pressure can range from 0.5 to 5 atm. Furthermore, since the vapor product is to be used as a low-grade burner fuel having a value much less than the liquid product, the overall goal of the process is to recover as much liquid-phase product as possible. Using either ChemSep or Aspen, select the optimal operating conditions for the proposed process, and comment on whether the process shown is a viable option for removing the n-butane from the feed stream. In your calculations assume that V/F = 0.10, *i.e.*, 10% of the hydrocarbons are lost in the vapor product. Also determine the heating requirement in the heat exchanger.