ECHE 260: Quiz 3

Units 6 and 7: Energy balances on non-reactive and reactive processes

Name: _____

50 minutes, closed book, closed notes, no calculators, no cell phones

Directions:

i. Write your name on all pages.
ii. You may tear the packet apart, but you must staple your quiz together in the correct order.
iii. Quantitative Question: SHOW ALL WORK. Write neatly.
iv. You must turn in your tables/equations packet.

Quantitative Question (100 points): SHOW ALL WORK. WRITE NEATLY.

At a local chemical company, a gaseous waste stream contains a mixture of two solvents, diethyl ether (DE) and ethyl acetate (EA), at 1.5 atm at 80°C. This equimolar mixture of solvents is fed to a partial condenser where both species are in vapor-liquid equilibrium at 0.9 atm. The mole fraction of DE in the vapor phase leaving the partial condenser is 0.6. The mole fraction of EA in the liquid phase leaving the partial condenser is 0.8. To cool the partial condenser, heat is removed at a rate of 100 kJ/hour. Using an energy balance, determine the temperature of the gas stream leaving the partial condenser.

a. (10 points) Draw and fully label a process flow diagram. Assign variables to all relevant unknowns.

b. (5 points) Derive material balances from the law of conservation of mass for all species. Without solving for a numerical answer, describe how you would solve the equations for all unknown process variables.

c. (15 points) Write the first law of thermodynamics for the PARTIAL CONDENSER, cancel terms & justify why. Your final equation should use flowrates from your PFD and specific enthalpies ($\widehat{H}$).

d. (20 points) For the PARTIAL CONDENSER, draw the hypothetical path for ETHYL ACETATE in the LIQUID stream. Clearly identify the reference state used.

e. (45 points) Based on the hypothetical path in part d, write an equation (or series of equations) for the specific enthalpy of ETHYL ACETATE ($\widehat{H}$) in the LIQUID stream. The equation should be dimensionally homogeneous. Write all necessary values from physical property tables and cite the source of your numbers. Do not integrate.

f. (5 points) Without solving any more of the problem, qualitatively describe how would you calculate the temperature of the stream leaving the partial condenser.