ECHE 260: Quiz 1, September 26, 2024

Units 1-2: Material balances on non-reactive processes

Name: _____

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

Directions:

i.   Write your name on all pages.
ii. Number your pages.
iii. You may tear the packet apart, but you must staple you quiz together in the correct order.
iv. Conceptual Questions: You do not need to show your work. Fully circle your answer.
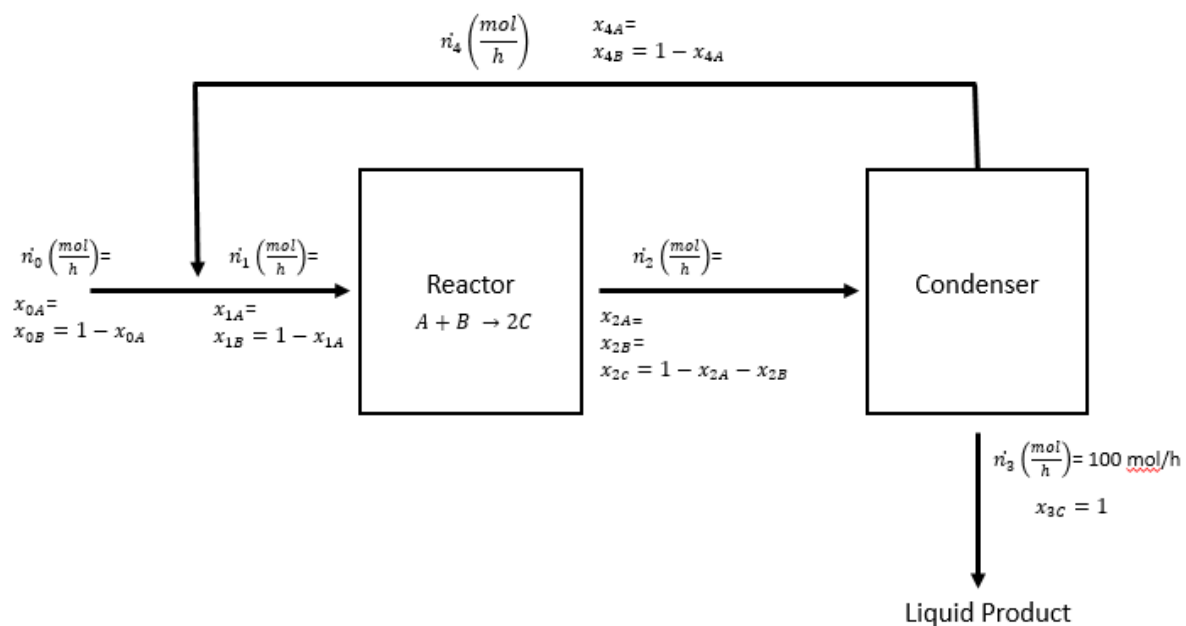v.   Quantitative Question: SHOW ALL WORK. Write neatly.

Conceptual Questions: You do not need to show your work. Circle the answer.

1.   (5 points) For the process shown below, you are asked to calculate the molar flowrate and composition of the reactor effluent (stream 2).

Is the following statement TRUE or FALSE?

It is NOT appropriate to assume a basis of calculation when performing a material balance around the reactor.

Circle one: TRUE   FALSE

$$\dot{n}_4 \left(\frac{mol}{h} \right) \quad\quad \begin{array}{l} x_{4A}= \\ x_{4B} = 1 - x_{4A} \end{array}$$

$$\dot{n}_0 \left(\frac{mol}{h} \right)= \quad\quad \dot{n}_1 \left(\frac{mol}{h} \right)= $$

$$\begin{array}{l} x_{0A}= \\ x_{0B} = 1 - x_{0A} \end{array} \quad\quad \begin{array}{l} x_{1A}= \\ x_{1B} = 1 - x_{1A} \end{array}$$

| Reactor |
| $A + B \rightarrow 2C$ |

$$\dot{n}_2 \left(\frac{mol}{h} \right)= $$

$$\begin{array}{l} x_{2A}= \\ x_{2B}= \\ x_{2C} = 1 - x_{2A} - x_{2B} \end{array}$$

Condenser

$$\dot{n}_3 \left(\frac{mol}{h} \right)= 100 \text{ mol/h}$$

$$x_{3C} = 1$$

Liquid Product

Quantitative Question: SHOW ALL WORK. WRITE NEATLY.

Erythromycin (EM) is a common pharmaceutical drug used to treat bacterial infections. In the production of antibiotic pills, the active ingredient (EM) is crystalized with an inert binder, polyethylene glycol (PEG) in isopropyl alcohol (IPA), the solid crystals are separated by filtration and excess IPA is evaporator in the dryer.

The liquid fresh feed to the process contains EM dissolved in isopropyl alcohol (IPA). The fresh feed is 10% EM by weight. Pure solid PEG is fed to the crystallizer which operates at a temperature of 0°C. During crystallization, all of the EM and PEG precipitate from solution which forms a slurry (mixture of solids and liquids). This slurry is fed to a filtration unit. The filtration unit separates all of the solids from most of the liquid. Pure liquid IPA from the filter is recycled and combined with the fresh feed before entering the crystallizer. The recycle ratio [(mass of the recycle stream)/(mass of the fresh feed) is 0.5]. The stream containing the wet solids (filter cake) from the filtration unit is 25wt% IPA. Finally, the wet solids are fed to a dryer where excess IPA evaporates and leaves the process. The final product (pills) exit the evaporator and contain EM, PEG and 5wt% IPA. The entire system operates at atmospheric pressure.

How many pounds (lbs.) of pills are produced in the process? What is the composition of the pills (by weight)?

You DO NOT need to solve the full problem. Only answer parts a-d, below.

a. (35 points) Draw and fully label a process flow diagram. Assign variables to all knowns and unknowns. Write all additional information from the problem statement as mathematical expressions using variables from your PFD.

b. (25 points) Perform a degree of freedom analysis on the OVERALL process and the MIXING POINT. Clearly identify the process variables associated with the analysis.

c. (25 points) Write all possible material balances for the OVERALL process using variables from your PFD.

d. (10 points) Imagine you are part way through solving the problem and now you know the mass flowrate of the pure IPA stream leaving the evaporator. WITHOUT SOLVING any equations, describe *how* you would solve the equations in part c to get the final composition of the pills.