ECHE 260: Intro to Chemical Systems

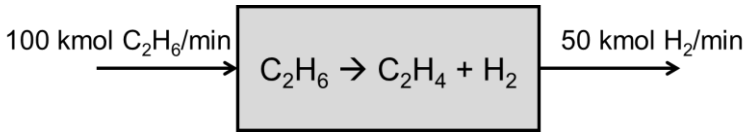
Homework #3

Assignments are due in Canvas by the due date and time. No late assignments are accepted. Homework should follow the general formatting guidelines posted in Canvas.

Conceptual Questions and Short Answers (20 points)

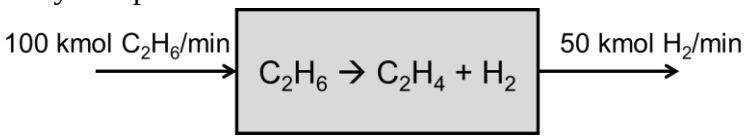
1. (5 points) Consider the reaction 2 C_2H_4 + O_2 → 2 C_2H_4O. 100 kmol C_2H_4 and 100 kmol O_2 are fed into a reactor. The reaction proceeds until 60 kmol of O_2 remain. Which of the following is true about the fractional conversion of oxygen (f_{O2})?
    a. $f_{O2} > f_{C2H4}$
    b. $f_{O2} < f_{C2H4}$
    c. 55 mol/s
    d. $f_{O2} = f_{C2H4}$
    e. There's not enough information to determine this

2. (5 points) Are moles conserved in this process?



    a. Yes
    b. No

3. (5 points) How many independent material balances can be written?



    a. 1
    b. 2
    c. 3
    d. 4

4. (5 points) When given volumetric flowrates and volume fractions, you can use them to write a material balance. Select the appropriate response:

    a. Yes for non-reactive and yes reactive systems
    b. Yes for non-reactive systems and no for reactive systems
    c. No for non-reactive systems and yes for reactive systems
    d. No for non-reactive systems and no reactive systems

Quantitative Question (30 points)

5. Propane is a common fuel used for portable gas grills and outdoor heaters. The perfect combustion of propane with oxygen will create water and carbon dioxide. We can treat a propane gas grill as a chemical reactor. Propane gas enters the grill at 103 mmHg, a volumetric flowrate of 14 L/min, and the flame has a temperature of 2000 ºC. The grill has a fractional conversion of 90% for propane. At what rate (moles/min) is CO_2 produced?

   A) Write and balance the chemical reaction describe the perfect combustion of propane
   B) Using the general problem-solving procedure from class, draw and fully label a process flow diagram for the grill, identify what quantities you want to solve for, write additional equations using process variables from your PFD.
   C) Perform a degree of freedom analysis
   D) Regardless of the result of C – write all the material balances for the grill