Ch En 386

**Winter 2014 Homework**

**Homework #5 (15 points)**

**Due Friday, February 7**

*Conditioning Problems (0.5 points each- you may not work with other students):*

1. For a batch reactor with dCA/dt = -kCA for A🡪 2B what is the key assumption regarding the volume? Explain your answer.
2. For A + 2B 🡪 C in a steady state flow reactor, show the relationship between XA and XB in terms of inlet flow rates of the two species.
3. Under what conditions (name two) is v=v0 for a flow reactor involving a liquid.
4. Show how v is related to v0 for a flow system containing gas.

Magnitude and Reasonableness Problems *(0.5 points each)*

1. If A + B🡪 C + 2D for a gas reaction at constant T and P in a PFR, the gas flow rate increases according to the equation we derived in class. Rather than using an equation, briefly explain in layman terms (to a non-engineering audience) what is happening.
2. For a constant-volume, isothermal batch reactor with a first order reaction, does the volume affect the time it takes to convert the reactant? Show your reasoning

*Lesson 10 and 11: ChemCad: Reactor applications*

1. (6 points) Using the problem statement (and reaction rate data) of Fogler P8-10, solve for the outlet temperature and conversion of a 500-liter adiabatic PFR. Plot T and XA vs inert molar flow rates of 0, 5x, and 10x of the reactant molar flow rate. Comment on why you see the trends of your plots. Provide a printout of your process flow diagram. Also provide printouts of the stream summaries and stream properties for each inert flow rate scenario.   
     
   The reactant is 2-propanone and the products are methane and ketene. You may assume no pressure drop. Note that you can input the volume rather than the dimensions of tubes. Remember that you will need a mixer unit and a PFR unit. For the streams, you only specify properties of inlet streams. Assume the inert is nitrogen. Caution: Watch your number of steps in the iterations.

*Lesson 12: Batch Reactor*

1. (3 points) Using the rate information and initial conditions in Fogler P3-11 a (ignore the question being asked), find the time necessary to convert 80% of ethylene oxide in a constant-volume batch reactor at a) 300 K and b) 350 K. Compare your two answers and comment. Solve by hand. Note that Equation A-8 in Appendix A will be helpful.
2. (3 points) The fumarase enzyme is used in a constant-volume batch reactor as a catalyst to make a product (P) from a substrate (S). The rate law for P is:  
     
     
     
   where k1 = 109 M-1s-1, k2= 4.4 x 104 s-1, and k3 = 10 s-1. rS = -rP. The amount of fumarase added to the reactor (CEO) is 10-6M and the initial substrate concentration is 10-3M. Plot the concentrations of S and P with time up to 200 seconds. Also plot the rate of P (RP) with time (up to 200 seconds) and comment as to why RP appears to be mostly independent of time at the beginning?