**CHG 3127**

**Assignment#2**

(Due date: Feb 1 /2011)

**Problem1**

The irreversible gas-phase nonelementary reaction

$$A + 2B \rightarrow C$$

is to be carried out isothermally in a constant-pressure batch reactor. The feed is at a temperature of 227 ºC, a pressure of 1013 kPa, and its composition is 33.3% A and 66.7% B. Laboratory data taken under identical conditions are as follows:

| X (conversion) | 0.0 | 0.2 | 0.4 | 0.6 |
|---|---|---|---|---|
| $-r_A (mol/dm^3.s) \times 10^3$ | 0.010 | 0.005 | 0.002 | 0.001 |

- **(a)** Estimate the volume of a plug-flow reactor required to achieve 30% conversion of A for an entering volumetric flow rate of 2 $m^3$/min.
- **(b)** Estimate the volume of a CSTR required to take the effluent from plug-flow reactor (PFR) above and achieve 50% total conversion (based on species A fed to the PFR).
- **(c)** What is the total volume of two reactors?
- **(d)** What is the volume of a single plug-flow reactor necessary to achieve 60% conversion? 80% conversion?
- **(e)** What is the volume of a single CSTR necessary to achieve 50% conversion?
- **(f)** What is the volume of a second CSTR to raise the conversion from 50% to 60%?

**Problem2**

A 400-L CSTR and a 100-L PFR are available to process 1.0 L of feed per second. The feed contains 41% A, 41% B, and 18% inerts. The irreversible gas-phase reaction

$$A + B \rightarrow C$$

is to be carried out at 10 atm and 227°C. The rate of reaction in g mol/L · min is given below as a function of conversion:

| $-r_A$ | 0.2 | 0.0167 | 0.00488 | 0.00286 | 0.00204 |
|---|---|---|---|---|---|
| X | 0.0 | 0.1 | 0.4 | 0.7 | 0.9 |

- **(a)** What is the maximum conversion that can be achieved with these two reactors connected in series
- **(b)** What would be the overall conversion if two 400-L CSTRs were connected in series for the same feed and operating conditions?
- **(c)** What would be the overall conversion if two 400-L CSTRs were connected in parallel with half of the feed going to each reactor?
- **(d)** What is the volume of a single tubular reactor necessary to achieve 60% conversion if the molar feed rate is 2 g mol A/min?

**(e)** If the total pressure were reduced by a factor of 10, would the conversion increase, decrease, or remain the same?

**(f)** Plot the rate of reaction and conversion as a function of PFR volume.

**Problem3**

The following data were obtained for a nonisothermal, nonelementray, multiple reaction liquid-phase decomposition of reactant A

| $C_{A0}/-r_A$ (min) | 10 | 20 | 45 | 50 | 45 | 30 | 18 | 17 | 34 |
|---|---|---|---|---|---|---|---|---|---|
| X | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |

**(a)** Consider the two systems 1- a CSTR is followed by a PFR ,2-a PFR is followed by a CSTR. The intermediate conversion is 0.3 and the final conversion is 0.7 How should the reactors be rearranged to obtain the minimum total reactor volume?

**(b)** If the volumetric flow rate is 50 L/min, what is the minimum total reactor volume?

**(c)** Is there a better means (i.e, smallest total volume achieving 70%conversion other than either of the systems proposed above?

**(d)** At what conversion would the required reactor volume be identical for either a CSTR or a tubular PFR

**(e)** Using the information in table together with CSTR design equation, make a plot of $t$ versus X. If the reactor volume is 700L and the volumetric flow rate 50L/min, what are the possible outlet conversions for this reactor?

**Problem 4**

The kinetics of the aqueous-phase decomposition of A is investigated in two mixed reactors in series, the second having twice the volume of the first reactor. At steady state with a feed concentration of 1 mol A/liter and mean residence time of 96 sec in the first reactor, the concentration in the first reactor is 0.5 mol A/L and in the second is 0.25 mol A/L. Find specific reaction rate, k, and n for kinetic equation ($-r_A = kC_A^n$)