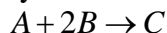


CHG 3127
Assignment#2
 (Due date: Feb 1 /2011)

Problem1

The irreversible gas-phase nonelementary reaction



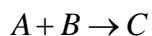
is to be carried out isothermally in a constant-pressure batch reactor. The feed is at a temperature of 227 °C, a pressure of 1013 kPa, and its composition is 33.3% A and 66.7% B. Laboratory data taken under identical conditions are as follows:

X (conversion)	0.0	0.2	0.4	0.6
$-r_A (\text{mol}/\text{dm}^3 \cdot \text{s}) \times 10^3$	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 m³/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



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, nonelementary, 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 ($-r_A = kC_A^n$)