Assignment 1

Q1. The first order ($-r_A = kC_A$,) reaction A→B is carried out in a tubular reactor in which F_{Ao}=8 mol/min. The volumetric flow rate, v, is constant. i.e. $v = v_o$ Determine the reactor volume necessary to reduce the exiting concentration to 80% of the entering concentration when the volumetric flow rate is 8 dm^3/min (i.e. litre/min) and the specific reaction rate k is 0.13 min^{-1}.
Calculate the volume of a CSTR for the conditions used to figure the plug-flow reactor volume. Which volume is larger the PFR or the CSTR? Explain why.

Q2 The reaction is to be carried out isothermally in a continuous-flow reactor. Calculate both the CSTR and PFR reactor volumes necessary to obtain a conversion of 90% when the entering molar flow rate is 10 mol/h, assuming the reaction rate $-r_A$ is:

(a) $-r_A$, = k with k = 0.01$molh^{-1}dm^{-3}$
(b) $-r_A = kC_A$, with k = 0.1h^{-1}
(c) $-r_A = kC_A^2$: with k = 1 $dm^3mole^{-1}h^{-1}$
The entering volumetric flow rate is 5 dm^3/hr

(d) Repeat (a), (b), and (c) to calculate the time necessary to consume 99.9% of species A in a 800 dm^3 constant volume batch reactor with C_{Ao} = 2 mol/dm^3.

Q3 A gas phase reaction in a constant volume batch reactor at 20 atm is carried out isothermally at 127^{o}c with a mixture of 80% A and 20% B inert.

A→ Product

Volume of reactor = 100 dm^3
Pressure = 20 atm
Temperature = 127^{o}C

a. Assuming that the ideal gas law is valid, how many moles of A are in the reactor initially? What is the initial concentration of A?
b. If the reaction is first order calculate the time necessary to consume 99.9% of A. (k=0.2min^{-1})
c. If the reaction is second order calculate the time to consume 90% of A. Also calculate the pressure in the reactor at this time if the temperature is 227^{o}C. (k=0.7 $dm^3/mol^{-1}min^{-1}$)

Q4 Two stirred tank reactors are available at a chemical plant, one of volume 100 m^3 and the other of volume 40 m^3. It is suggested that these tanks be used as a two stage CSTR for carrying out an irreversible liquid phase reaction,

A + B → Products

The two reactants only will be present in the feed stream in equimolar amounts, $C_{Ao} = C_{Bo}$ = 2.5 gmol/lit. The volumetric feed rate will be 20 lit/min. The reaction is first order with respect to each of the reactants A and B i.e., second order overall. The rate constant is 0.02 lit/(gmol.min). Which tank should be used as the first stage for higher overall conversion? With this arrangement, calculate the overall conversion obtainable under steady state conditions.