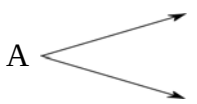
ChE 7033 Homework #1 Due: August 29, 2011

1. An isothermal 100 lt CSTR is fed with an aqueous solution containing reactant A at C_{A0} = 3 mole/lt and flowrate V_0 = 25 lt/min. The reactions:



r_1 (moles/lt-min) = 0.3 C_A

r_2 (moles/lt-min) = 0.2 C_A

$B + C \rightarrow D$ r_3 (moles/lt-min) = 0.05 $C_B C_C$

(all concentrations in moles/lt)

take place. Find the product distribution leaving the reactor (C_{AF}, C_{BF}, C_{CF}, and C_{DF}), if $C_{B0} = C_{C0} = C_{D0} = 0$.

2. A constant volume batch reactor was used to measure kinetic data for the reaction:
$A \rightarrow B$
at constant temperature. The following data were obtained:

Time (minutes)	Run 1, C_A (moles/lt)	Run 2, C_A (moles/lt)	Run 3, C_A (moles/lt)
0	0.50	1.00	1.50
20	0.41	0.86	1.33
40	0.32	0.74	1.18
60	0.25	0.62	1.03
80	0.18	0.52	0.89
100	0.13	0.42	0.77
120	0.08	0.34	0.65

Assuming power law kinetics, find the reaction order and rate constant. Predict the concentration which would exist in the reactor after 10 minutes if the initial concentration was 2.0 moles/lt.

3. The parallel reactions:

$A + B \rightarrow C$ $r_1 = k_1 C_A C_B$

$A \rightarrow D$ $r_2 = k_2 C_A$

take place in a constant volume reactor at constant temperature. $C_{A0} = C_{B0} = 1$ mole/lt., $k_1 = 2.0$ lt/mole-min, $k_2 = 0.5$ min^{-1}.

Write out rate expressions for all four species (r_A, r_B, r_C, and r_D) and write the equations in terms of the time derivatives (dC_A/dt, dC_B/dt, dC_C/dt, and dC_D/dt). If the reaction proceeds until C_C = 0.6 moles/lt, what is C_D? How long is required to produce 0.6 moles/lt of C?

4. An autocatalytic reaction:

$$A \rightarrow B + C \qquad r = k C_A C_B$$

takes place in a CSTR-PFR series. Each reactor has a volume of 0.1 m^3, the reaction takes place in the liquid phase so that constant density may be assumed, and the rate constant is 500 m^3/kmole-ksec. The initial concentration of A entering the reactor is 2.0 kmoles/m^3 with no B or C present in the feed stream.

If the flowrate of reactant to the CSTR is 150 kmoles/ksec, what is the fractional conversion of A leaving the CSTR, and what is the fractional conversion of A leaving the PFR?

What are the production rates of A, B, and C leaving the PFR in kmoles/ksec for conditions given in part A?