

**CHG 3127**  
**Assignment#4**

(Due date: Assigned March 12/2011, Due March 22/2011)

**Q1 (50%)**

The reversible isomerization



is to be carried out in a membrane reactor (IMRCF). Owing the configuration of species B, it is able to diffuse out the walls of the membrane, while A cannot.

- (a) What is the equilibrium conversion assuming that B does not diffuse out of the reactor walls?
- (b) Plot the conversion profiles to compare a 100-dm<sup>3</sup> conventional PFR with a 100-dm<sup>3</sup> membrane reactor. What statements or generalizations can you make? What parameters have the greatest effect on the exit conversion shape of the plots in part (a)?
- (c) Plot the conversion and the species concentrations and the molar flow rates down the length of the reactor.

*Additional information:*

Specific reaction rate =  $0.05 \text{ s}^{-1}$

Transport coefficient  $k_c = 0.3 \text{ s}^{-1}$

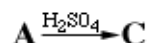
Equilibrium constant =  $K_e = 0.5$

Entering volumetric flow rate  $v_0 = 10 \text{ dm}^3/\text{s}$

$C_{A0} = 0.2 \text{ mol/dm}^3$

**Q2 (50%)**

The irreversible liquid phase acid catalyzed reaction



is carried out in a semibatch reactor containing  $\text{H}_2\text{SO}_4$ . A is fed at a constant rate of 10 mol/min. The volumetric flow rate of liquid entering the semibatch reactor is  $5 \text{ dm}^3/\text{min}$ . The initial volume of a 3 M solution of  $\text{H}_2\text{SO}_4$  catalyst in the reactor is  $100 \text{ dm}^3$  (no A is present initially). The specific reaction rate is  $0.05 \text{ min}^{-1}$ . The reaction is first order in A and zero-order in catalyst concentration.

- (a) Use POLYMATH or MATLAB to determine both the number of moles of A in the tank and the concentration of A and of  $\text{H}_2\text{SO}_4$  as a function of time.
- (b) Obtain an analytical solution for the number of moles of A,  $N_A$ , and the concentration of A,  $C_A$ , as a function of time. What is the concentration of A after 30 min? How many moles of A will there be in a tank after long times (i.e.,  $t \rightarrow \infty$ )? (Ans.:  $N_A = 200 \text{ mol}$ ) Explain why the number of moles remains virtually constant at long times.

(c) Rework part (a) assuming the reaction is first order in  $\text{H}_2\text{SO}_4$  with  $k = 0.02 \text{ dm}^3/\text{mol} \cdot \text{min}$ .

(*Hint:* Do not try to use conversion in solving this problem!)