編號：G155　系所：化學工程學系甲組　　科目：化學反應工程

可使用工程型計算機

1. A 0.5 liter CSTR is used to carry out the reaction 2A + 3B → C + D. Each reactant is fed to the reactor in a separate stream, at the rate of 4×10^{-3} liter/sec each. The concentrations of A and B in these two streams are 2.0 mol/liter and 3.2 mol/liter, respectively. The reactor temperature is 50 °C. Calculate the concentration of A and B in the effluent stream. (13%)

   $-r_A = kC_AC_B$ mol A/(liter·sec)

   $k = 1.41\times10^3 \exp[-3230/T]$ liter/(mol A·sec)

2. A first-order homogeneous gas-phase reaction, A → 3R, is first studied in a constant-volume batch reactor. At a pressure of 2 atm and starting with pure A, the pressure increase by 50% in 8 min. If the same reaction is carried out in a constant-pressure reactor, and the initial pressure is 2 atm, what is time required for the volume increase by 100%? (20%)

3. The rate for the decomposition of ammonia into nitrogen and hydrogen on a Pt catalyst, $2\,NH_3 = N_2 + 3\,H_2$, is

$$-r = \frac{kK_AP_A}{K_HP_H}$$

   where k the rate constant, P_A and P_H indicate the pressures of ammonia and hydrogen, and K_A and K_H are the adsorption constants for ammonia and hydrogen. Suggest a mechanism and the assumptions consistent with the rate equation, and prove it. (13%)

4. The first-order reaction $A \rightarrow B$ is taking place on the walls of a cylindrical catalyst pore. Show the effectiveness factor was given by

$$\eta = \frac{\tanh\phi}{\phi}$$

$$\text{where } \phi = L\sqrt{\frac{2k_s}{rD}}$$

   with k_s=surface reaction rate constant (length/time), r = pore radius (length), D = effective molecular diffusivity (area/time), and L = pore length (length) (13%)

5. Describe the main mechanisms of catalyst deactivation. (7%)

6. Suppose that two experiments are conducted in a constant-volume batch reactor for the reaction of "A → products" and that the following data are obtained.

   Experiment 1　$t_{1/2}$ = 0.125 h,　C_{A0} = 2 gmol/liter

   Experiment 2　$t_{1/2}$ = 0.500 h,　C_{A0} = 1 gmol/liter

   $t_{1/2}$ is the half-life of an experiment. On the basis of these data, predict the order of the reaction. (13%)

(背面仍有題目，請繼續作答)

可使用工程型計算機

7. For the competitive liquid-phase reactions

$$A + B \rightarrow R \text{, desired} \qquad r_R = 1.0(C_A^{0.5})(C_B^{0.5})$$

$$A + B \rightarrow S \text{, unwanted} \qquad r_S = 1.0(C_A^{2})$$

Two streams, pure A and pure B (each has a concentration of 20 mol/liter), are introduced to a reactor. The volumetric flow rate is 10 liter/min for each stream and the required conversion of A is 90%.

(a) To have a less impurity S content in the product stream, what type of reactor should be used, a CSTR or a PFR? Please discuss qualitatively. (5%)

(b) Find the fraction of impurity (i.e., $C_S/-\Delta C_A$) generated in the product and the reactor volume if a PFR is used. (9%)

(c) Find the fraction of impurity (i.e., $C_S/-\Delta C_A$) generated in the product and the reactor volume if a CSTR is used.(7%)