Code No: NR320802 **NR**

III B.Tech II Semester Supplementary Examinations, Apr/May 2006
CHEMICAL REACTION ENGINEERING-I
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define reaction rate constant. Develop an expression that facilitates calculation of units of rate constant for any order. [6]

   (b) Determine equilibrium conversion of A at 373^0K for the following aqueous reaction.

   $A \underset{k_2}{\overset{k_1}{\rightleftharpoons}} R$ ΔG^0 = -3375 K cal/K mole

   ΔH_r^0 = -18,000 K cal/K mole

   Assume specific heats of all solutions are equal to that of water. [10]

2. The gas reaction 2A → R + 2S is approximately second order with respect to A. When pure A is introduced at 1 atm. into a constant volume batch reactor, the pressure rises 40% in 3 minutes. For a constant pressure batch reactor find

   (a) the time required for the same conversion [8]

   (b) the fractional increase in volume at that time. [8]

3. Thermal decomposition of ethane to ethylene, butane and hydrogen is believed to follow the sequence given below.

   $C_2H_6 \rightarrow 2CH_3^*$

   $CH_3^* + C_2H_6 \rightarrow CH_4 + C_2H_5^*$

   $C_2H_5^* \rightarrow C_2H_4 + H^*$

   $H^* + C_2H_6 \rightarrow H_2 + C_2H_5$

   $2C_2H_5^* \rightarrow C_4H_{10}$

   Derive the rate law for formation of ethylene. [16]

4. An aqueous reaction is being studied in a mixed flow reactor of 5 lit. volume. The stoichiometry of the reaction is A → 2 R and the reactant A is introduced at a concentration of one mole/liter. Using following data, determine a rate expression for this reaction. [16]

Feed rate $cm^3/sec.$	Temperature ^0C	Concentration of R in effluent, $mole/liter$
2	13	1.8
15	13	1.5
15	84	1.8

5. A liquid reactant stream (1 mol/liter) passes through two mixed flow reactors in a series. The concentration of A in the exit of the first reactor is 0.5 mol/liter. Find the concentration in the exit stream of the second reactor. The reaction is second-order with respect to A and V2/V1 = 2. [16]

6. A 20 lit. mixed reactor is to treat a reactant which decomposes as follows:

   A $\rightarrow$ R $r_R = K_1 C_A = (4/\text{hr}) C_A$

   A $\rightarrow$ S $r_S = K_2 C_A = (1/\text{hr}) C_A$

   Find the feed rate and conversion of reactant so as to maximize profits. What are there on hourly basis? Data: Feed material A cost Rs. 100/mol at $C_{AO} = 1$ mol/lit. Product R sells for Rs.500/mol and S has no value. The total operating cost is Rs.2500/hr + Rs.125/mol A fed to the reactor unconverted A is not recycled. [16]

7. The decomposition of Phosphine is irreversible and first order at 650^0C.
   $4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$
   The rate constant s^{-1} is reported as:
   Log K = - $\frac{18963}{T}$ + 2 log T + 12.130 where T is in ^{0}k.
   In a closed vessel (constant volume) initially containing Phosphine at 1 atm. pressure, what will be the pressure after 50, 100 and 500s. The temperature is maintained at 650^0C. [16]

8. Write brief notes on:

   (a) Series and parallel reactions

   (b) Multiple reactor network. [8+8]

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