Code No: NR320802 **NR**

III B.Tech II Semester Supplementary Examinations,
November/December 2005
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. For the reaction in series A → R → S with $k_1 \neq k_2$, find the maximum concentration of R and when it is reached in a batch reactor? k_1 and k_2 are the rate constants for the first and second reactions. Show what happens if $K_1 = K_2$. [16]

3. (a) What is a chain reaction? Define chain length.
   (b) Thermal decomposition of acetaldehyde is postulated to proceed by the chain mechanism
   $CH_3CHO \rightarrow CH_3^* + CHO^*$
   $CH_3CHO + CH_3^* \rightarrow CH_4 + CO + CH_3^*$
   $2CH_3^* \rightarrow C_2H_6$
   observing the rate of first reaction is small in comparison with the second when chains are long, show that
   $\frac{-d[CH_3CHO]}{dt} = K[CH_3CHO]^{1.5}$ [4+12]

4. From the following data find a satisfactory rate equation for gas phase decomposition of A → R + S, taking place isothermally in a mixed reactor.

Space time in Sec:	0.423	5.10	13.5	44.0	192.0
Conversion :	0.22	0.63	0.75	0.88	0.96

   Initial concentration is 0.002 mole/lit. [16]

5. Reactant A (A → R, $C_{AO} = 26\ mol/m^3$) passes in steady flow through four equal-size mixed flow reactors in series ($t_{total} = 2min$). When steady state is achieved the concentration of A is found to be 11, 5, 2, 1 mol/m3 in the four units. For this reaction, what must be tplug so as to reduce C_A from $C_{AO} = 26$ to $C_{Af} = 1\ mol/m^3$? [16]

6. A 20 lit. mixed reactor is to treat a reactant which decomposes as follows:
   A → $Rr_R = K_1C_A = (4/\text{hr})C_A$

A $\rightarrow Sr_S = K_2C_A = (1/\text{hr})C_A$

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. Reaction between Sodium thiosulfate and Hydrogen peroxide is irreversible and follows second order kinetics. The reaction is carried out in an adiabatic CSTR. $Na_2S_2O_3 + 2H_2O_2 \rightarrow$ Products Reaction rate constant, k=6.8 $\times$ 10^{11} $e^{-E/RT}$ $m^3/kmole.sec$ Activation energy, E=76 kJ/mole Initial concentration of thiosulfate, $C_{AO} = 0.205$ kmole/m^3 Initial Concentration of Hydrogen peroxide, $C_{BO} = 0.41$ kmole/m^3 The feed rate of the reactor is 25 cm^3/sec Volume of CSTR = 4000 cm^3; Inlet feed temperature = 25^0C The heat capacity of the inlet and outlet stream is 4.0 J/g^0C Calculate: (i) fractional conversion and (ii) temperature of the outlet stream. [16]

8. Write detailed note on:

   (a) Enzyme substrate reactions

   (b) Methods of analysis of kinetic data. [8+8]

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