

**III B.Tech II Semester Supplementary Examinations,
November/December 2005
CHEMICAL REACTION ENGINEERING-I
(Chemical Engineering)**

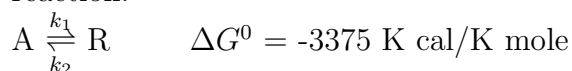
Time: 3 hours

Max Marks: 80

**Answer any FIVE Questions
All Questions carry equal marks**

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 373⁰K for the following aqueous reaction.



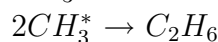
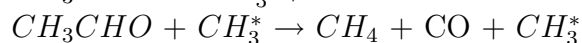
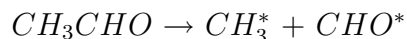
$$\Delta H_r^0 = -18,000 \text{ K cal/K mole}$$

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

2. For the reaction in series $A \rightarrow R \rightarrow S$ 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



observing the rate of first reaction is small in comparison with the second when chains are long, show that

$$\frac{-d[CH_3CHO]}{dt} = K[CH_3CHO]^{1.5} \quad [4+12]$$

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

Space time in Sec: 0.423 5.10 13.5 44.0 192.0

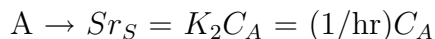
Conversion : 0.22 0.63 0.75 0.88 0.96

Initial concentration is 0.002 mole/lit. [16]

5. Reactant A ($A \rightarrow R$, $C_{AO} = 26 \text{ mol/m}^3$) passes in steady flow through four equal-size mixed flow reactors in series ($t_{total} = 2 \text{ min}$). 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 t_{plug} so as to reduce C_A from $C_{AO} = 26$ to $C_{Af} = 1 \text{ mol/m}^3$? [16]

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





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. $Na_2S_2O_3 + 2H_2O_2 \rightarrow \text{Products}$ 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 $25 \text{ cm}^3/sec$ Volume of CSTR = 4000 cm^3 ; Inlet feed temperature = $25^\circ C$ The heat capacity of the inlet and outlet stream is $4.0 \text{ J/g}^\circ C$ 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]
