Code No: 07A50804 **R07** **Set No. 2**

III B.Tech I Semester Examinations,November 2010
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) A reaction proceeds with an equation $A + B \rightarrow 2R$, what is the order of reaction.
   (b) For a reaction $2NO_2 + {}^1\!/\!_2 O_2 \rightarrow N_2O_5$, what is the relation between the components.
   (c) A reaction with stoichiometric equation ${}^1\!/\!_2 A + B \rightarrow R + {}^1\!/\!_2 S$ has the following rate expression $-r_A = 2.C_A^{0.5}.C_B$,what is the rate expression for the reaction written as $A + 2B \rightarrow 2R + S$.
   (d) Discus in detail about the temperature dependency of reaction rate. [2+2+4+8]

2. Two parallel reactions A+B→D; A+B→U. have the rate expressions $k_1 C_A^a C_B^b$ and $k_1 C_A^c C_B^d$ CB d respectively. Critically analyse the effect of various factors on the composition as a function of time in a batch reactor. [16]

3. At room temperature the Second - Order irrerrsible liquid- phase reaction proceeds as follows
   $\alpha A \rightarrow$ Product
   -rA = [0.005 lt/mol.min].CA^2. $C_{AO} = 1$ mol/lt.
   A batch reactor takes 18min to till & empty. What percent conversion & reaction time should we use so as to maximize the daily output of product R? [16]

4. (a) Derive the performance equation of Mixed flow reactor.
   (b) A gaseous feed of pure A (2 mol/liter , 100 mol/min) decomposes o give variety of products in the plug flow reactor. The kinetics of conversion is represented by: $A \rightarrow 2.5$(products) , $-r_A = (10\text{min}^{-1})C_A$
   Find the expected conversion in 22-liter reactor. [6+10]

5. An elementary series reactions $A \xrightarrow{k_1} B \xrightarrow{k_2} D$ take place in liquid phase in mixed flow reactor. Derive an expression for maximum concentration of B. Represent the result graphically. [16

6. (a) Aqueous A reacts to from R($A \rightarrow R$) and in the first minute in a batch reactor its concentration drops from $C_{AO} = 2.03$ mol/lit to $C_{AF} = 1.97$ mol/lit . Find the rate equation if the kinetics are second order with respect to A
   (b) How to interpret the batch reactor data in rate equation. [8+8]

7. Explain what is meant by a favourable product distribution for multiple reactor system. Describe 3 different possible series parallel reactions schemes that result in desired product through series reaction and two undesired end products through series and parallel reaction from a reactant. [16]

8. The reaction $A \rightarrow B + 2C$ occurs in the gas phase and is first order with respect to A. When the reaction is carried out at 1 atm pressure in a constant volume batch reactor, pressure was increased by 35% in 3 min. estimate the required for the same conversion if the reaction is carried out in constant pressure batch reactor. [16]

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Code No: 07A50804 **R07** **Set No. 4**

III B.Tech I Semester Examinations,November 2010
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. Consider a feed C_{A0} = 100mol/lit, C_{B0} = 200mol/lit, C_{I0} = 100mol/lit. to a steady flow reactor. The isothermal gas phase reaction is $A + 3B \rightarrow 6R$ if the concentration of A (C_A) is 40 mol/lit find conversion of A(X_A), conversion of B(X_B), and concentration of B(C_B). [16]

2. (a) A certain reaction has a rate $-r_A = 0.005C_A^2$ mol/cm^3.min . If the concentration is taken in mol/lit and time in hrs, what would be the value and units of rate constant

   (b) The pyrolysis of ethane proceeds with an activation energy of about 300 KJ/mol. How much faster is the decomposition at 650^{0}C than at 500^{0}C .

   (c) Write about activation energy and temperature dependency. [6+4+4]

3. A certain gas phase reaction with a stoichiometry 0.5A + 1.5 B = C takes place in a vessel of 20 lit at 0^o C. Initially the vessel contains 20% A, 40% B, 20% C and rest inerts, I. The reaction attained equilibrium when the pressure is 4 bars. Find the free energy change for the reaction 2C = A + 3B. [16]

4. (a) Find the first order rate constant for the disappearance of A in the gas reaction $2A \rightarrow R$ if , on holding the pressure constant the volume of the reaction mixture , starting with 80% A , decreases by 20% in 3 min. [16]

5. (a) Explain the following methods

      i. Integral method
      ii. Differential method

   (b) Explain how one can test for irreversible bimolecular second order reaction using integral method of analysis. [8+8]

6. An aqueous phase series reaction R→S→U is carried out in a plug flow reactor. It is desired to produce large quantities of desirable S from 1.0 kilo liter per hour feed containing R only at a concentration $C_{RO}4$ = 0.001 mol/cc. Find the size of reactor for maximum yield of S. The rate constants $4k_1 = k_2 = 0.1$ min-1. [16]

7. (a) Explain different reactor combinations.

   (b) Discuss rate conc curves for auto catalytic reactions. [8+8]

8. Reactant R simultaneously under goes reaction to yield S,T and U as per the stoichiometry
   A →S, A →T and A →U. the rates of disappearance of A by each reaction are k1

$(C_A)^a$; k_2 $(C_A)^b$ and k_3 $(C_A)^c$ respectively. Sketch the fractional yield of T vs. CA for various values of rate constants and the orders of the reaction (a,b,c). [16]

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Code No: 07A50804 **R07** **Set No. 1**

III B.Tech I Semester Examinations,November 2010
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. What is meant by relative rates of two parallel reactions? State and explain 6 various factors that effect the product distribution of two parallel reactions A → S, A →T. [16]

2. (a) Discuss the variable volume zero order reactions and how to test this reactions using Integral method of analysis
   (b) Explain the integral method of analysis. [8+8]

3. (a) For a gas reaction at 400K, the rate is reported as $\frac{-dP_A}{dt} = 3.66\,P_A^2$.atm/hr.
      i. What are the units of rate constant.
      ii. What is the value of rate constant in this reaction,
      iii. if the rate equation is expressed as $\frac{-1}{V}\frac{dN_A}{dt} = k.C_A^2.\frac{mol}{m^3.\sec}$
   (b) Discus in detail about the temperature dependency of reaction rate. [8+8]

4. Derive first order and second order reactions of equal size mixed how reactors in series. [16]

5. Distinguish between ideal temperature profile with optimum temperature progression in a non isothermal reaction. With the help of neat sketches describe the different methods of approaching the ideal temperature profile in plug flow reactor. [16]

6. (a) Write about ideal reactors for single reaction.
   (b) A plan to replace present mixed flow reactor with one having double the volume. For the same aqueous feed (10 mol A/liter) and the same feed rate find the new conversion. The reaction kinetics are represented by A → R, $-r_A$ = k $C_A^{1.5}$. And present conversion is 70%. [8+8]

7. Find overall order of the irreversible reaction $2H_2+2NO \rightarrow N_2+2H_2O$ From the following constant volume data using equimolar amounts of hydrogen and nitric oxide.

Total pressure (mmHg)	200	240	280	320	360
Half - life (sec)	265	186	115	104	67

[16]

8. Define and explain the fractional yield of D in the set of reactions 2A →A_2/2B →B_2 and A+B → D that take place in mixed flow reactor. Assuming the elementary reactions, sketch the fractional yield of D as a function of C_A. [16]

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Code No: 07A50804 **R07** **Set No. 3**

III B.Tech I Semester Examinations,November 2010
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. Find the first - order rate constant for the disappearance of A in the gas reaction $2A \rightarrow R$ if, on holding the pressure constant the volume of the reaction mixture, starting with 75% A, decreases by 30% in 3 min. [16]

2. (a) Define rate of reaction? What are the variables affecting the rate of reaction.
   (b) At 500 K the rate of bimolecular reaction is 10 times that of the rate at 400 K. Find the activation energy from
      i. Arrhenious law
      ii. collision theory [6+10]

3. If one of the products of 2 parallel reactions is desired and is targeted for maximization explain different factors that can be controlled relative to the system intrinsic factors such as activation energy, order of reaction. Sketch the composition. [16]

4. Reactant A undergoes elementary reversible series reactions $A \underset{k_2}{\overset{k_1}{\rightarrow}} B \underset{k_4}{\overset{k_3}{\rightarrow}} C$ Draw the concentration- time curves for various relative values of rate constants in a batch reactor. [16]

5. The data in the table given below have been obtained on the decomposition of gaseous reactant A in a constant volume batch reactor at 100^0C .the stoichiometry of the reaction is $2A \rightarrow R + S$

t, sec	0	20	40	60	80	100	140	20	260	330	420
P_A ,atm	1	0.80	0.68	0.56	0.45	0.37	0.25	0.14	0.08	0.04	0.02

   What size of plug flow reactor operating at 100^0C and 1atm can treat 100 molA/hr in a feed consisting of 20% of inerts to obtain 95% conversion of A? [16]

6. (a) Explain how one can test for irreversible reactions in parallel using integral method of Analysis.
   (b) Aqueous A reacts to from R($A \rightarrow R$) and in the first minute in a batch reactor its concentration drops from $C_{A0} = 2.03$ mol/lit to $C_{AF} = 1.97$ mol/lit. Find the rate equation if the kinetics are second order with respect to A. [8+8]

7. Show that for an exothermic reaction more than one reactor composition may satisfy the material and energy balance. Stating all conditions describe such a situation. [16]

8. A speatic Enzyme E, which act as a homogenious catalyst a harm full organic A is present in industries waste water degrades into harmly chemicals at a given Enzyme conc. EE test in a laboratory mixed flow react gives the following res as

C_{AO} m mol/m^3	2	5	6	6	11	14	16	24
C_A m mol/m^3	0.5	3	1	2	6	10	8	4
τ-min	30	1	50	8	9	20	20	4

We wish to treat 0.1 m^3/min of this waste water having C_{AO} = 10 m mol/m^3 to 90% conv with that Enzyme at conc C_E. Assume PFR with possible recycle exit fluid. What design do you recommend? Calculate size of the reactor Ecu if it should be used with recycle and if so determine the recycle flow rate in m^3/min. Sketch the recomeded design. [16]

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