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

III B.Tech I Semester Examinations,May 2011
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. For the reaction A → R , what size of mixed flow reactor would be needed for 75% conversion of a feed stream of 1000 molA/hr at C_{AO} =1.2 mol/liter?

C_A ,mol/liter	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.3	2.0
r_A ,mol/lt.min	0.1	0.3	0.5	0.6	0.5	0.25	0.10	0.06	0.05	0.045	0.042

[16]

2. Discuss in detail with the help of sketches the contacting patterns for various combinations of concentrations of reactants and flow reactors (mixed flow and plug flow singularly or multiple and in series). [16]

3. (a) For the complex reactions with the stoichimetry $A + 3B \rightarrow 2R + S$ and with second order rate expression $-r_A = k[A][B]$
   Are the reaction rates related as follows $r_A = r_B = r_R$? If the rates are not so related, then how are they related? Please account for the signs,+ or -.
   (b) For a reaction $2NO_2 + \frac{1}{2}O_2 \rightarrow N_2O_5$, what is the relation between the components.
   (c) Write in detail about the temperature dependent term of rate equation. [6+2+8]

4. Distinguish between planning for maximum concentration and maximum production rate of a product. A desirable product S is an intermediate of series reaction R→ S→ U is investigated for maximum production rate. State and explain the various alternatives (including the type of reactor) for production of S. [16]

5. (a) Explain how one can test for homogeneous catalyzed reaction using integral method of Analysis.
   (b) An ampoule of radioactive Kr- 89 (half life = 76 minutes)is set aside for a day. What does the this do to the activity of the ampoule? Note that the radioactive decay is a first order process. [8+8]

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

7. A gas phase reaction 2A → 3R is carried out in an isothermal batch reactor and the relative change in volume is measured with time. The initial concentration of A is 1Kmol/m^3 . Calculate the order of reaction and the rate constant by the differential method of analysis.

t(s)	150	250	350	450	550	650
Relative change in volume	2.00	1.35	1.38	1.45	1.55	1.60

[16]

8. If two reactions takes place parallel in a system then a high temperature favours the reaction of higher activation energy and a lower temperature favours the lower activation energy reaction - enumerate with suitable examples. [16]

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

III B.Tech I Semester Examinations,May 2011
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) Discuss the procedures for analyzing the kinetic data
   (b) A 10- minute experimental run shows that 75% of liquid reactant is converted to product by a 1/2- order rate. What would be the fraction converted in a half hour run? [8+8]

2. A planning to operate a batch reactor to convert A into R. this is a liquid reaction, the stoichiometry is A → R , and the rate of the reaction is given in table how long must react each batch for the concentration to drop from (C_{AO}= 1.3mol/liter) to (C_{Af}= 0.3mol/liter)?.

C_A, mol/liter	01	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.3	2.0
r_A, mol/lt.min	0.1	0.3	0.5	0.6	0.5	0.25	0.10	0.06	0.05	0.045	0.042

[16]

3. With the graphs explain the effect of temperature on equilibrium conversion for exothermic and endothermic reactions.
   Enumerate the various factors other than temperature that affect the equilibrium conversion of a reversible reaction. [16]

4. 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

5. The first order homogeneous decomposition, A → 2.5R is carried out in an isothermal batch reactor at 2 atm. With 20% inerts present, the volume increases by 60% in 20 min. In a constant volume reactor, find the time required for the pressure to reach 8 atm., if the initial pressure is 5 atm., 2 atm of which consists of inerts. [16]

6. Explain
   (a) Mixed flow reactors or different sizes in series.
   (b) Reactors or different types in series. [8+8]

7. Describe a detailed procedure with explanation to determine the best system of two mixed flow reactors for desired conversion of a reaction. [16]

8. Chemical A,B,D combine to give R and S with stoichiometry A + B + D → R + S the observed rate is $r_R = C_A C_B C_D / C_R$
   (a) What is the order of the reaction.

(b) The following two mechanisms involving formation of active intermediate have been proposed to explain the observed kinetics

Mechanism - I: $A + B \Leftrightarrow Y* + R$

$B + X* \rightarrow S$

Mechanism - II: $A + D \Leftrightarrow X* + R$

$D + Y* \rightarrow S$

Are these mechanisms consistent with the kinetic data?

(c) If neither is consistent, devise a scheme that is consistent with the kinetics. If only one is consistent, what line of investigation may strengthen the convection that the mechanism selected is correct? If both are consistent, how would you be able to choose between them? [2+8+6]

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

III B.Tech I Semester Examinations,May 2011
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 liquid reactant stream (1 mol/lt) passes through two mixed flow reactors in a series. the conc of A in the exit of the first reactor is 0.5 mol/lt. Find the conc in the exit stream of the second reactor. Reaction is second order w.r.t. A & $\frac{v_2}{v_1}$. [16]

2. Define and explain: instantaneous fractional yield, overall fractional for mixed flow reactors in series and plug flow reactor in which A+B→C+D; A+B→W +U, where the D is desirable product, the rest all products are undesirable. If the rate constant of first is more than that of second reaction discuss. The effect of contacting pattern on the yields.

   [16]

3. 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]

4. (a) Explain how one can test for irreversible uni-molecular first order reaction using integral method of analysis.
   (b) A 10- minute experimental run shows that 75% of liquid reactant is converted to product by a 1/2- order rate. What would be the fraction converted in a half hour run ? [8+8]

5. What is meant by best path with reference to the optimum design of reactor with appreciable heat effects. Describe the temperature progression with conversion in a plug flow reactor. [16]

6. At 650^0C phosphine vapor decomposes as follows

   $4PH_3 \rightarrow P_4(g) + 6H_2$, $-r_{phos} = (10hr^{-1})C_{phos}$

   What size of plug flow reactor operating at 649^0C and 11.4 atm is needed for conversion of 10 mol/hr of phosphine in a 2/3 phosphine-1/3 inert feed. [16]

7. A reaction proceeds with $2A + B \rightarrow A_2B$ with reaction rate as $r_{A_2B} = k[A][B]$. Suggest a Mechanism that is consistent with the experimental found rates and verify. [16]

8. Zero order homogeneous gas reaction A → rR proceeds in a constant volume batch reactor at initial total pressure is 1atm and final total pressure in 1min is 1.5 atm. if the same reaction same feed composition and initial pressure proceeds in a constant pressure setup find the final volume in 1min if the initial volume is 1liter. [16]

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

III B.Tech I Semester Examinations,May 2011
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. Prove for Auto catalytic reactions mixed flow is max efficient at low conc & plug flow is max efficient at high conv. [16]

2. For the molecular reaction $A + 2B \rightarrow R + S$, if the mechanism suggested for this is $A + B \Leftrightarrow R + X$

   $B + X \rightarrow S$ where X is an unstable intermediate

   (a) Derive the rate expression for the decomposition of A

   (b) Explain how the rate constants can be evaluated using the rate law. [8+8]

3. 2.0% of A is dissociated as per the gas phase reaction 2A = 2B + C at 727 ^oC and 1 bar pressure. Calculate % dissociation at 500 K and 1 bar. How many times the dissociation be at 0.1 bar.
   Data: Average Cp values(cal/mol K) of R,S and T are 6,6,6 respectively. Heat of reaction at 25^o C and 1 bar is -3k cal /g mol. Assume gas phase reaction. [16]

4. 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]

5. (a) Explain how one can test for first order reversible reactions $A \Leftrightarrow R$, using integral method of Analysis.

   (b) Explain about temperature and reaction rate. [8+8]

6. An elementary series reactions $A \xrightarrow{k_1} B \xrightarrow{k_2} D$ take place in liquid phase in mixed flow reactor. Compare the fractional yields in mixed flow reactor with plug flow reactor of B for different relative values of k_1 and k_2 [16]

7. Pure gaseous A at about 3 atm and 30^0C (120mmol/liter) is fed into a 1-liter mixed flow reactor at various flow rates, there it decomposes, and the exit concentration of A is measured for each flow rate. From the following data find the rate equation to represent the kinetics of the decomposition of A. assume that reactant A alone affects the rate.

v_0 ,liter/min	0.06	0.48	1.5	8.1
C_A ,mmol/liter	30	60	80	105

[16]

8. Aqueous A at a concentration C_{AO} = 1 mol/lit is introduced into a batch reactor where it reacts away to form product R according to stoichiometry A → R . The concentration of A in the reactor is monitored at various times, as shown below: [16]

t(min)	0	100	200	300	400
C_A (mol/lit)	1000	500	333	250	200

For C_{AO} = 500mol/m^3 find the rate of reaction

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