Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – SUMMER • 2014

Subject Code: 170501 **Date: 22-05-2014**

Subject Name: Chemical Reaction Engineering - I

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **All notations have conventional meaning.**

Q.1 **(a)** Classify chemical reactions and discuss the variables affecting the rate of reaction. **07**

(b) Define reaction rate. Explain molecularity and order of reaction giving typical example. **07**

Q.2 **(a)** Compare Arrhenius law with Collision Theory and Transition-state theory. **07**

(b) Experiments show that the homogeneous decomposition of ozone proceeds with a rate, **07**

$$-rO_3 = k\,[O_3]^2\,[O_2]^{-1}$$

(i) What is overall order of reaction?

(ii) Suggest a two-step mechanism to explain this rate and how that mechanism will be verified?

OR

(b) At 500 K the rate of a bimolecular reaction is ten times the rate at 400 K. Find the activation energy of this reaction using Arrhenius law and Collision theory. **07**

Q.3 **(a)** Derive the integrated rate expression for First order and Second order (2A→products) irreversible reactions. **07**

(b) Derive the integrated rate expression for First order reversible reactions. **07**

OR

Q.3 At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrose as follows: **14**

$$\text{sucrose} \xrightarrow{sucrase} \text{products}$$

Starting with a sucrose concentration C_{A0}=1.0 millimol/liter and an enzyme concentration C_{E0}=0.01 millimol/liter, the following kinetic data are obtained in a batch reactor: (C_A is in millimol/liter and t is in hr)

C_A	0.84	0.68	0.53	0.38	0.27	0.16	.09	.04	.018	.006
t	1	2	3	4	5	6	7	8	9	10

Determine whether these data can be reasonably fitted by a kinetic equation of the Michaelis-Menten type, or

$$-r_A = \frac{k_3 C_A C_{E0}}{C_A + M}$$

where M = Michaelis constant. Calculate the value of constant using integral method of analysis.

Q.4 **(a)** Derive the performance equation for steady-state mixed flow reactor. **07**

(b) Derive the performance equation for ideal batch reactor. **07**

OR

Q.4 **(a)** A homogeneous liquid phase reaction $A \rightarrow R$, $-r_A = KC_A^2$ takes place with 50% conversion in a mixed reactor. **07**

(i) What will be the conversion if this reactor is replaced by one 6 times as large, all else remaining unchanged?

(ii) What will be the conversion if the original reactor is replaced by a plug flow reactor of equal size, all else remaining unchanged?

(b) Assuming a stoichiometry $A \rightarrow R$ for a first order gas phase reaction, the size of a plug flow reactor for 99% conversion of pure A is calculated to be 32 liters. In fact, however the reaction stoichiometry is $A \rightarrow 3R$. With this corrected stoichiometry, what is the required volume of a reactor? **07**

Q.5 **(a)** Write short note on Autocatalytic reactions. **07**

(b) Describe quantitative discussion about product distribution for reactions in parallel. **07**

OR

Q.5 The homogeneous gas reaction $A \rightarrow 2B$ is run at 100 ^{0}C at a constant pressure of 1 atm in an experimental batch reactor. The data in table were obtained starting with pure A. What size of plug flow reactor operated at 100 ^{0}C and 10 atm would yield 90% conversion of A for a total feed rate of 10 mol/sec, the feed consisting of 40% inerts? **14**

Time, min	V/V_0	Time, min	V/V_0
0	1.00	8	1.82
1	1.20	9	1.86
2	1.35	10	1.88
3	1.48	11	1.91
4	1.58	12	1.92
5	1.66	13	1.94
6	1.72	14	1.95
7	1.78		

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