

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER-VI (NEW) EXAMINATION – WINTER 2020

Subject Code:2160506

Date:03/02/2021

Subject Name:Chemical Reaction Engineering - I

Time:02:00 PM TO 04:00 PM

Total Marks: 56

Instructions:

1. Attempt any FOUR questions out of EIGHT questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

		MARKS
Q.1	(a) Discuss the classification of Chemical Reaction based on Thermodynamics and Stoichiometry with suitable examples of each.	03
	(b) Define Rate of Reaction based on various component and also gives comparison of its.	04
	(c) Derive an expression showing effects of temperature on heat of reaction from thermodynamics.	07
Q.2	(a) What is rate equation? Also mention unit of rate of reaction and rate constant for first, second and third order elementary chemical reactions.	03
	(b) Milk is pasteurized if it is heated to 63°C for 30 min, but if it is heated to 74°C it only needs 15 sec for the same result. Find the activation energy of this sterilization process.	04
	(c) Discuss the Activation energy and Temperature dependency of rate constant.	07
Q.3	(a) Define zero order reaction with suitable example.	03
	(b) Discuss the method for rate equation interpretation of irreversible unimolecular first order elementary reaction by integral method of analysis.	04
	(c) Experimental studies of a specific decomposition of A in a batch reactor using pressure units show exactly the same rate at two different temperatures: At 400K $-r_A = 2.3 P_A^2$ At 500K $-r_A = 2.3 P_A^2$ Where unit of $-r_A$ is mol/m ³ .sec and unit of P_A is atm. (a) Evaluate the activation using these units (b) Transform the rate expression into concentration units and then evaluate the activation energy.	07
Q.4	(a) Discuss the chemical reaction classification based on molecularity with suitable examples of each.	03
	(b) Discuss the differential method for interpretation of rate equation of n th order unimolecular chemical reaction.	04
	(c) The first order reversible liquid reaction	07

$A \rightarrow R$, $C_{AO} = 0.5 \text{ mol/liter}$, $C_{AO} = 0$

takes place in a batch reactor. After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction.

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- Q.5** (a) Compare batch reactor and steady state flow reactors. **03**
 (b) Discuss the space velocity and space time for steady state flow reactors. **04**
 (c) An aqueous feed of A and B (44 liter/min, 100mmol A/liter, 200mmol B/liter) is to be converted to product in a plug flow reactor. The kinetics of the reaction is represented by **07**
 $A + B \rightarrow R$, $-r_A = 200 C_A C_B \frac{\text{mol}}{\text{liter.min}}$
 Find the volume of reactor needed for 99.9% conversion of A to product.
- Q.6** (a) Compare between space time of mixed flow reactor and time constant in mixing process without chemical reaction. **03**
 (b) Compare ideal batch reactor performance of constant and variable density reaction. **04**
 (c) At 650 °C phosphine vapor decomposes as follows: **07**
 $4\text{PH}_3 \rightarrow \text{P}_4(\text{g}) + 6\text{H}_2$, $-r_{\text{phos}} = (10 \text{ hr}^{-1})C_{\text{phos}}$
 What size of plug flow reactor operating at 649°C and 11.4 atm is needed for 75% conversion of 10 mol/hr of phosphine in a 2/3 phosphine and 1/3 inert feed?
- Q.7** (a) Discuss autocatalytic reactor. **03**
 (b) Prove that N number of plug flow reactor connected in series and its total volume V gives the same conversion as a single plug flow reactor of volume V. **04**
 (c) Derive the performance equation for steady state mixed flow reactor for constant and variable density system and compare its graphical representation. **07**
- Q.8** (a) Differentiate between homogeneous reaction and heterogeneous reaction. **03**
 (b) Discuss the effect of temperature and composition on single homogeneous reaction. **04**
 (c) Derive the performance equation of recycle reactor and discuss its graphical representation for constant and variable density. **07**
