P P SAVANI UNIVERSITY

Sixth Semester of B. Tech. Examination

May 2022

SECH3052 Chemical Reaction Kinetics-I

19.05.2022, Thursday **Time: 9:00 a.m. To 11:30 a.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1 Define the Following: (Any Five) **[05]**

(i) Rate of reaction

(ii) Order of reaction

(iii) Factor affecting rate of reaction

(iv) Elementary and non-elementary reaction

(v) Two examples of homogenous reaction

(vi) Zero order reaction

(vii) Molecularity of reaction

Q - 2 (a) Write five gas solid and gas liquid chemical industry based heterogenous reactions. **[05]**

Q - 2 (b) 1 liter of a 20% ozone-80% air mixture at 1.5 atm and 93°C passes through a plug flow reactor. Under these conditions ozone decomposes by homogeneous reaction **[05]**

$$2O_3 \rightarrow 3O_2, \quad -r_{ozone} = kC_{ozone}^2, \quad k = 0.05 \frac{\text{liter}}{\text{mol} \cdot \text{s}}$$

What size of reactor is needed for 50 % decomposition of ozone?

OR

Q - 2 (a) Drive second order kinetics using integral method analysis. **[05]**

Q - 2 (b) Liquid A decomposes by second-order kinetics, and in a batch reactor 50% of A is converted in a 5-minute run. How much longer would it take to reach 75% conversion? **[05]**

Q - 3 Drive the performance equation for mixed flow reactor PFR. **[10]**

OR

Q - 3 Enzyme E catalyses the fermentation of substrate A (the reactant) to product R. Find the size of mixed flow reactor needed for 95% conversion of reactant in a feed stream (25 liter/min) of reactant (2 mol/liter) and enzyme. The kinetics of the fermentation at this enzyme concentration are given by **[10]**

$$A \xrightarrow{\text{enzyme}} R, \qquad -r_A = \frac{0.1\, C_A}{1 + 0.5\, C_A} \quad \frac{\text{mol}}{\text{liter} \cdot \text{min}}$$

Q - 4 Explain the factors on which rate equation depends. **[05]**

SECTION – II

Q - 1 Answer the Following MCQs **[05]**

(i) Which of the following reactions follows elementary rate law? **[1]**

a) Reversible catalytic decomposition of isopropyl benzene

b) Formation of hydrogen bromide

c) Vapor phase decomposition of ethanol
d) Cis-trans isomerization

(ii) Which of the following is true for the rate law of a reversible reaction? **[1]**
a) Rate law can be written only in terms of concentrations
b) It reduces to irreversible form when product concentration is zero
c) It satisfies thermodynamic relationships at all times
d) Rate law can be written only in terms of partial pressures

(iii) Which of the following represents second-order bimolecular type reversible reaction? **[1]**
a) A+B ↔ R
b) A ↔ R+S
c) A ↔ B
d) A+B ↔ R+S

(iv) Order of a reaction is ___ **[0.5]**
a) Number of molecules of reactants taking part in the reaction
b) Power of any one of the reactant concentrations
c) Concentration of intermediate species formed
d) Sum of the powers of the concentrations of all the reactants

(v) The rate expression for a homogeneous reaction comprises of ___ **[0.5]**
a) A concentration dependent term only
b) A temperature dependent term only
c) A concentration dependent term and a temperature dependent term
d) A catalyst weight dependent term

(vi) The number of molecules involved in an elementary reaction is termed as ___ **[0.5]**
a) Molecularity
b) Order of reaction
c) Unimolecular reaction
d) Rate of reaction

(vii) Which of the following is true about elementary reactions? **[0.5]**
a) They occur in multiple steps
b) They are complex in nature
c) Order of elementary reaction is an integer
d) All first order reactions are elementary

Q - 2 (a) Discuss the effect of pressure and temperature on rate of reaction. **[05]**

Q - 2 (b) The homogeneous gas decomposition of phosphine proceeds at 649°C with the first-order rate **[05]**

$$4PH_3(g) \rightarrow P_4(g) + 6H_2$$

$$-r_{PH_3} = (10/hr)\, C_{PH_3}$$

What size of plug flow reactor operating at 649°C and 460 kPa can produce 80% conversion of a feed consisting of 40 mol of pure phosphine per hour?

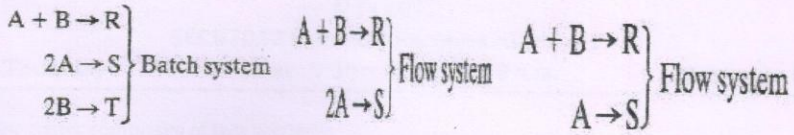
OR

Q - 2 (a) Explain the qualitative discussion about product distribution for series reaction with diagram. **[05]**

Q - 2 (b) What is RTD. Also discuss tracer method for finding RTD. **[05]**

Q - 3 (a) What is graphical design procedure for non-isothermal reactors. Discuss all the steps and draw general shape of the temperature conversion plot for different reaction type and for plug flow reactor. **[05]**

Q - 3 (b) Using separate feeds of A and B sketch the contacting pattern and reactor conditions which would best promote the formation of product R for the following systems of elementary reactions. [05]



OR

Q - 3 (a) Discuss the thermodynamic information required for reactor design. [05]

Q - 3 (b) A stream of aqueous monomer A (1 mol/litre, 4 litre/min) enters a 2 litre mixed flow reactor, is radiated therein and polymerizes as follows: [05]

$$A \xrightarrow{+A} R \xrightarrow{+A} S \xrightarrow{+A} T \ldots$$

In the exit stream C_A =0.01 mol/litre and for a particular reaction product, C_W=0.0002 mol/litre. Find the rate of reaction of A and the rate of formation of W.

Q - 4 Attempt any one. [05]

(i) Define selectivity and yield in parallel reactions.

(ii) Derive the rate expression for autocatalytic reaction.

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