Q. Code:175921

Reg. No. | | | | | | | | | | | | | |

B. E / B. TECH.DEGREE EXAMINATIONS, MAY 2024

Fourth Semester

CH22403 – CHEMICAL REACTION ENGINEERING-I

(Chemical Engineering)

(Regulation 2022)

TIME:3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Analyze kinetic data and determine the rate of the reaction.	**4**
CO 2	Design ideal reactors for homogeneous reactions	**5**
CO 3	Evaluate reactor systems to carry out multiple reactions and recommend reactor/combination of reactors for the yield of desired product.	**5**
CO 4	Discuss the temperature effects and design non-isothermal reactors	**5**
CO 5	Develop mathematical models for conversion in non-ideal flow reactors	**5**

PART- A (20x2=40Marks)

(Answer all Questions)

		CO	RBT LEVEL
1	The rate constant of a zero order reaction is 0.2 mol/lit.hr. What would have been the initial concentration of the reactant if after half an hour its concentration is 0.05 mol/lit?	**1**	**3**
2	State Arrhenius equation and its significance.	**1**	**2**
3	Write down the rate equation of second order irreversible reaction in terms of concentration and conversion.	**1**	**2**
4	For a certain first order reaction, rate constant is $0.0018 sec^{-1}$. Calculate the half life time of the reaction.	**1**	**3**
5	Differentiate constant density reactor and variable density reactor.	**2**	**2**
6	State space time and space velocity.	**2**	**2**
7	Show how CSTR's in series approximate a PFR graphically.	**2**	**2**
8	Write down the performance equation of isothermal PFR.	**2**	**2**
9	Suggest a way to control the product distribution for irreversible parallel reactions.	**3**	**2**
10	State fractional yield in multiple reactions.	**3**	**2**
11	Give your comments on the product ratio r_R/r_S.	**3**	**2**
12	Give any two examples for series reactions.	**3**	**2**
13	Relate Gibbs free energy change and Equilibrium constant.	**4**	**2**

14	An exothermic reversible reaction is conducted adiabatically, what is the relationship between the equilibrium conversion and temperature?	4	3
15	State 'hotspots' in non-isothermal reactor system.	4	2
16	Analyze the conversion for an exothermic reaction A+B→C, if temperature and inert gas concentration is increased. A, B, C are all gasses.	4	3
17	Compare micro fluid and macro fluid.	5	2
18	Relate F curve with E curve.	5	2
19	Discuss the reasons for non ideality in ideal reactors.	5	2
20	Draw exit age distribution curve.	5	2

PART- B (5x 10=50Marks)

			Marks	CO	RBT LEVEL
21(a)	(i)	Liquid A decomposes by first order reaction in a batch reactor. 50% of A is converted in 5 min. How long will it take to reach 75% conversion? Solve the problem considering the reaction is first order.	(06)	1	3
	(ii)	The half-life period for a certain first order reaction is 1.89×10^{3} sec. Calculate the time needed for ¼ of the reactants to be left behind.	(04)	1	3
		(OR)			
(b)		Describe Arrhenius theory of determining rate constant and justify it is better than collision and transition theories.	(10)	1	3
22(a)		Consider a gas-phase reaction 2A+R 2S with unknown kinetics. If a space velocity of 11 min is needed for 90% conversion of A in a plug flow reactor, find the corresponding space-time and mean residence time or holding time of fluid in the plug flow reactor.	(10)	2	4
		(OR)			
(b)		Construct the performance equations of CSTR to calculate the space velocity and compare the reactor size calculation of CSTR with PFR.	(10)	2	4
23(a)		Discuss the quantitative product distribution of the given reaction in a mixed flow reactor and first order reaction followed by zero order: $A \xrightarrow{n=1} B \xrightarrow{n=0} C$	(10)	3	3
		(OR)			

(b) For the reaction data given in the following table, consider a series arrangement of a mixed flow reactor and a plug flow reactor. If the intermediate conversion is 55% and the final conversion is 90%, formulate the best arrangement of reactors to obtain the smaller total volume (of reactors in series)? **(10) 3 3**

F_{A0} = 0.083mol/s.

X_A	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.85
$-r_A$ (mol/l.s)	0.0053	0.0052	0.005	0.0045	0.004	0.0033	0.0025	0.0018	0.00125	0.001

24.(a) A first order irreversible liquid phase reaction is carried out in MFR. The density of reaction mixture is 1.2 g/cm^3 and the specific heat is 0.9 cal/g °C. The volumetric flow rate is 200cm^3 / s and the reactor volume is 10 litres. K=1.8 x 10 ^{5} e-$^{12000/RT}$, s^{-1}. If the heat of reaction is -46000cal/mol, and feed temperature is 20 degree Celsius. What are the possible temperature and conversion for a stable, adiabatic operation with feed concentration of 4 mol/L? **(10) 4 3**

(OR)

(b) Discuss the effect of temperature on equilibrium conversion for reversible and irreversible reactions with a graph. **(10) 4 3**

25. (a) A first order liquid phase reaction is carried out in a reactor for which the results of (pulse) tracer test are given below. k=0.25 min^{-1} **(10) 5 3**

Time(minutes)	0	1	2	3	4	5	6	7	8	9	10	12	14
C_{pulse}(g/m^3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

Calculate the conversion using

i) Ideal PFR and ii) Ideal MFR

(OR)

(b) Calculate the mean residence time and the variance for a vessel from the following data which are obtained for a pulse input. **(10) 5 3**

Time(minutes)	0	1	2	3	4	5	6	7	8	9	10	12	14
E (min^{-1})	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

PART- C (1x 10=10Marks)

(Q.No.26 is compulsory)

		Marks	CO	RBT LEVEL
26.	It is decided to produce 4000 kmol/day of ethylene glycol. The reactor is operated isothermally. A 15.05 kmol/m^3 solution of ethylene oxide in water is fed to CSTR together with an equal volumentric solution of water containing 85% by weight H_2SO_4. If 82 % conversion is to be achieved, find the volume of reactor. How many CSTRs, each having volume of 3 m^3 would be required if they are arranged in parallel? The first order reaction rate constant is 0.311 min^{-1}.	**(10)**	**2**	**5**

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