Q. Code: 313701

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

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

Fifth Semester

CH18502 – CHEMICAL REACTION ENGINEERING-I

(Chemical Engineering)

(Regulation 2018 / 2018A)

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

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Attain familiarity in the fundamentals of reaction engineering and analyze the kinetic data, to determine the rate of reaction.	**3**
CO 2	Perform calculations associated with design equation of reactors and determine the volume of a reactor for a given conversion and vice-versa for single reactions.	**3**
CO 3	Evaluate systems and perform calculations for multiple reactions, to suggest reactor/combination of reactors for the yield of desired product.	**3**
CO 4	Investigate the temperature effects associated with the reactors during reaction and determine conversion.	**3**
CO 5	Explore the various non-idealities in the real reactors and modeling suitable reactors incorporating the effects of various non-idealities.	**4**

PART- A (10x2=20Marks)

(Answer all Questions)

		CO	RBT LEVEL
1	State the variables affecting rate of a reaction.	1	**2**
2	Compare pseudo first order reaction with pseudo second order reaction with example.	1	**2**
3	Differentiate constant density and variable density reactors.	2	**2**
4	State half life period of second order reaction.	2	**2**
5	Sketch the contacting patterns of reactants at various combinations of concentrations in continuous operation.	3	**3**
6	Write the significance of selectivity in multiple reactions.	3	**2**
7	Identify the effect of temperature on K_{eq} and $X_{Ae.}$	4	**3**
8	Differentiate adiabatic and isothermal operation.	4	**2**
9	Build exit age distribution curve.	5	**3**
10	List the models used to characterize the nonideal flow in a reactor.	5	**2**

PART- B (5x 14=70Marks)

		Question	Marks	CO	RBT LEVEL
11. (a)	**(i)**	The thermal decomposition of nitrous oxide (N_2O) in the gas phase at 1030 K is studied in a constant volume vessel at various initial pressures of N_2O. The half-life data so obtained are as follows: Reaction involved is $2N_2O$ $2N_2 + O_2$. Determine the rate equation that fits the data	**(10)**	**1**	**3**
	(ii)	Find the first-order rate constant for the disappearance of A in the gas reaction 2A R if, on holding the pressure constant, the volume of the reaction mixture, starting with 80% A, decreases by 20% in 3 min.	**(04)**	**1**	**3**
		(OR)			
(b)		Derive the rate equation for unimolecular first order reaction and bimolecular - second order reaction for constant volume process.	**(14)**	**1**	**3**
12. (a)		An aqueous feed of A and B (400 liter/min, 100 mmol A/liter, 200 mmol B/liter) is to be converted to product in a plug flow reactor. The kinetics of the reaction is represented by mol A+B gives R, $-r_{A=}$ 200 C_AC_B mol/ liter.min. Find the volume of reactor needed for 99.9% conversion of A to product.	**(14)**	**2**	**3**
		(OR)			
(b)		Analyse the value addition of recycle stream in a reactor and Derive and the performance equation of a recycle reactor along with graphical representation	**(07)**	**2**	**3**
13. (a)		Describe the qualitative treatment of product distribution in plug flow reactor for the following reactions. a). Reactions in series. b).Reactions in parallel.	**(14)**	**3**	**3**
		(OR)			
(b)		Liquid reactant A decomposes as per the following reactions in parallel $A \rightarrow R$, $A \rightarrow S$, $A \rightarrow T$, With $r_A=1$, $r_S=2C_A$, $r_T = C^2{}_A$ Determine the arrangement of reactors that would produce most S in a 2 flow system where recycle of unreacted feed is not possible. Find $C_{s,Total}$ for this arrangement for $C_{A0} = 4$.	**(14)**	**3**	**3**

14. (a)	Calculate the heat of reaction for the synthesis of ammonia from nitrogen and hydrogen at 150 degree celsius in kJ/mol H_2 reacted and kJ/mol N_2 reacted. $N_2 + H_2$ gives 2 NH_3. Standard heat of ammonia formation is -11020 cal/mol N_2. Mean heat capacities of reaction components hydrogen, nitrogen and ammonia are 6.992, 6.984 and 8.92 repectively. C_p of each reacting component is expressed as a quadratic function of temperature. Cp (H_2) : $6.946-0.196 \times 10^{-3} T + 0.476 \times 10^{-6} T^2$; Cp ($N_2$) : $6.457+1.39 \times 10^{-3}T-0.069 \times 10^{-6}T^2$; Cp ($NH_3$) : $5.92+8.963 \times 10^{-3}T-1.764 \times 10^{-6}T^2$	**(14)**	**4**	**3**
	(OR)			
(b)	Describe the optimum temperature progression for reversible endothermic reaction with graph.	**(14)**	**4**	**3**
15. (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}. Calculate the conversion using ideal PFR, Ideal MFR and Tanks in series model	**(14)**	**5**	**4**

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

(OR)

(b)	The concentration readings in the following table represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel t, and tabulate and plot the C-curve and exit age distribution E.	**(07)**	**5**	**4**

t(min)	0	1	2	3	4	5	6	7	8	9	10
c_{pulse} (mg/l)	0	0.1	0.2	0.3	0.4	0.5	0.45	0.4	0.35	0.3	0.25

PART- C (1x 10=10Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	First order reversible aqueous reaction A reversibly forms R $-r_A=k_1C_A - k_2C_R$; $k_1= 34x10^6 exp\ (-48900/RT)\ min^{-1}$; $k_2= 1.57x10^{18} exp\ (-123800/RT)\ min^{-1}$ Where E is in J/mol is to be carried in PFR. For maximum permissible feed temperature of 95 °C (368 K) (maximum permissible operating temperature of 95 °C) and feed rate of 1000 mol/min of reactant A. What is the optimum temperature progression in a PFR? A conversion of 80% is required and feed concentration of A is C_{A0} = 4 mol/lit and C_{R0}=0. Also calculate the space time and volume needed for 80% conversion of a feed of F_{A0}=1000 mol/min with C_{A0} = 4 mol/lit and C_{R0} =0.	**(10)**	**4**	**5**

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