U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

July 2023 Semester End Main Examinations

Programme: B.E. **Semester: VI**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH6DCCR2 **Max Marks: 100**
Course: Chemical Reaction Engineering -2 **Date: 10.07.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			CO	PO	Marks
		UNIT - I			
1	a)	Explain the dispersion model for modeling of non-ideal behavior in a reactor with relevant equations.	*CO1*	*PO3*	**10**
	b)	A sample of tracer at 320 K was injected to a reactor, and the effluent concentration was measured as a function of time, resulting in the table below. The measurement represents the exact concentration at the times listed and not the average values between the various sampling tests. i. Estimate the mean residence time ii. Construct the C and E curve iii. Determine the fraction of material leaving the reactor that has spent 3 min or less in the reactor Data is given in the following table.	*CO2*	*PO4*	**10**

T (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C (g/m^3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

		UNIT - II			
2	a)	Derive the general rate expression for a fluid-fluid reaction system for an instantaneous reaction with a low C_B value	*CO3*	*PO3*	**10**
	b)	Carbon Dioxide is to be removed from air, NaOH solution is used to speed up the removal of CO_2 from air at 25°C (instead of pure water). Reaction between CO_2 and NaOH is instantaneous and is given below $$CO_2 + 2NaOH \Longleftrightarrow Na_2CO_3 + H_2O$$ i) Suggest a form of rate equation that can be used when $p_{CO_2} = 1000\ Pa$ when solution is 2 N. ii) Infer how much can absorption is speeded compared to physical absorption using water? Data: $k_g a$ = 840 mol/(h.m^3.Pa); $k_l a$ = 25 per hour ; H_A= 3000 Pa. m^3/(mol)	*CO3*	*PO3*	**10**
		OR			

	3	a)	Explain the industrial importance of fluid solid reactions.	*CO3*	*PO3*	**04**
		b)	Derive the model equation with all assumptions for a reacting particle when chemical reaction is controlling, the reaction being A(g) + bB(s) $\rightarrow$ Products(s)	*CO3*	*PO3*	**10**
		c)	Discuss the model with a neat sketch, wherein the reaction occurs first at the outer skin of the particle and later the zone of the reaction moves into the solid leaving behind completely converted material and inert solid.	*CO3*	*PO3*	**06**
			UNIT - III			
	4	a)	Briefly describe the method to determine the surface area and pore volume of the catalyst.	*CO4*	*PO3*	**10**
		b)	With a neat sketch explain the steps involved in a heterogeneous catalytic reaction and infer which are the factors influencing the rate controlling step.	*CO4*	*PO3*	**10**
			UNIT - IV			
	5	a)	Explain the various mechanisms for catalyst deactivation.	*CO4*	*PO3*	**07**
		b)	Discuss the various types of catalyst deactivation reactions.	*CO4*	*PO3*	**07**
		c)	What is the Thiele modulus? Summarize its significance for heterogeneous porous catalytic reactions.	*CO4*	*PO3*	**06**
			OR			
	6	a)	Derive an expression for effectiveness factor for a single cylindrical pore of length L.	*CO4*	*PO3*	**12**
		b)	The dehydration of butane is studied at atmospheric pressure and a chromium alumina catalyst at 530°C. Using the following data estimate the effectiveness factor for this catalyst. i) Diameter of catalyst particle = 0.32 cm ii) First order rate constant = 0.94 $cm^3/g\ s$ iii) Surface area of porous catalyst = 70 m^2/g iv) Pore volume, Vg= 0.35 cm^3/g v) Knudsen diffusivity $\mathcal{D} = 9.7 \times 10^3 \times r \times \sqrt{\frac{T}{M}}$ where, r = radius of the pore in cm, M = molecular weight, T is the temperature (K)	*CO4*	*PO3*	**08**
			UNIT - V			
	7	a)	Elucidate on how to determine the experimental rates of catalytic reactions occurring in (i) Integral Reactor (ii) Differential reactor.	*CO5*	*PO4*	**10**
		b)	Derive the overall rate expression for a slurry reactor.	*CO5*	*PO4*	**10**

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