Q. Code: 740357

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

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

Sixth Semester

CH18602 – CHEMICAL REACTION ENGINEERING II

(Chemical Engineering)

(Regulation 2018A)

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

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Explain the preparation and characteristics of catalysts.	**3**
CO 2	Predict the rate equations for heterogeneous reactions.	**3**
CO 3	Evaluate the role of transport effects in isothermal heterogeneous reactions.	**4**
CO 4	Determine an optimal model and predict the rate limiting step for heterogeneous reactions	**4**
CO 5	Employ a qualitative discussion of absorption involved reactions based on mass transfer theories.	**4**

PART- A(10x2=20Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Compare Activity and Selectivity.	**1**	**3**
2.	Identify any four types of catalyst poisons.	**1**	**2**
3.	Obtain the rate expression for a reaction, where an adsorbed molecule reacts with another molecule in the gas phase and name the mechanism.	**2**	**3**
4.	Mention the significance of the rate controlling step.	**2**	**2**
5.	Differentiate Bulk and Knudsen Diffusion.	**3**	**3**
6.	Annotate the significance of Thiele Modulus.	**3**	**3**
7.	Give examples for gas-solid non-catalytic reactions.	**4**	**2**
8.	List the resistances that would have an impact on the rate of reaction, as per SCM.	**4**	**2**
9.	Highlight the importance of Specific interfacial area in reactions.	**5**	**3**
10.	Exemplify Gas absorption systems.	**5**	**2**

PART- B (5x 14=70Marks)

		Marks	CO	RBT LEVEL
11. (a)	Explain in detail about the various methods of preparation of catalyst.	**(14)**	**1**	**3**
	(OR)			
(b)	Discuss various methods available for the determination of the pore volume distribution of a catalyst along with their significance.	**(14)**	**1**	**3**

12. (a) Identify a mechanism for Cumene decomposition and derive the rate law considering the following cases: **(14) 2 3**

i) Adsorption as the rate limiting step

ii) Surface reaction as rate limiting step

(OR)

(b) Tertiary butyl alcohol (TBA) is produced by the liquid phase hydration (W) of isobutene (I) over an amberlyst-15 catalyst. The liquid is normally a multi-phase mixture of Isobutene, water and the solid catalyst. The reaction can be represented as I + W TBA. If all the species set adsorbed on to the catalyst surface and if the adsorption of Isobutene is rate limiting, derive the Rate equation for the reaction. **(14) 2 3**

13. (a) Derive the expression for the effectiveness factor for an isothermal first order irreversible heterogenous reaction with a spherical porous catalyst. Also analyze the relationship between effectiveness factor and Thiele Modulus for the same. **(14) 3 3**

(OR)

(b) The following kinetic data on the reaction A R are obtained in an experimental packed bed reactor using various amounts of catalyst and a fixed feed rate F_A, = 10 kmol / hr. **(14) 3 3**

W, Kg catalyst	1	2	3	4	5	6	7
X_A	0.12	0.2	0.27	0.33	0.37	0.41	0.44

(a) Find the reaction rate at 40% conversion.

(b) In designing a large packed bed reactor with feed rate F_A, = 400 Kmol/hr, how much catalyst would be needed for 40% conversion.

14. (a) Derive the relationship between Time and Conversion when Diffusion through gas film controls a Fluid-Solid reaction as per the Shrinking core model for changing size particles. Also, show that the time 'τ' required for complete burning of the solid particle is proportional to the radius 'R'. **(14) 4 3**

(OR)

(b)	A moving grate is continuously fed with a feed consisting of 30% of 50μm, 40% of 100μm, and 30% of 200μm particles is to be fed continuously in a thin layer onto a moving grate cross-current to a flow of reactant gas. For the planned operating conditions the time required for complete conversion is 5, 10, and 20 minutes for the three sizes of particles. Find the conversion of solids for a mean residence time of 8 mins and 12 mins in the reactor.	**(14)**	**4**	**3**
15. (a)	Derive the rate equation for fluid-fluid reaction for the following cases: (i) Instantaneous reaction in Liquid film with Low C_B (ii) Instantaneous reaction in Liquid film with High C_B Sketch the concentration profiles of the reactants for these reactions.	**(14)**	**5**	**3**
	(OR)			
(b)	Gaseous A absorbs and reacts with B in liquid according to the given equation: $A_{(g.\quad l)} + B_{(l)'}\quad R_{(l)}$; $-r_{Al} = kC_AC_B$ in a packed bed. Calculate the following. i) Rate of the reaction ii) Determine the location of the major resistances and the behaviour in the liquid film (pseudo first order reaction, instantaneous etc.,) at a point in the reactor where p_A = 100 Pa and C_B = 100 mol/m^3 liquid. Data: k = 10^8 m^3 liquid/mol.h ; H_A = 1.0 (Pa.m^3 liquid/mol); $k_{Ag}a$ = 0.1 mol/(hm^3 of reactor.Pa); $k_{Al}a$ = 100 m^3 liquid/(m^3 reactor.h) f_l = 0.01 m^3 liquid/m^3 of reactor; a = 100 m^2 /m^3 reactor; $D_{Al} = D_{Bl} = 10^{-6}$ m^2 /h	**(14)**	**5**	**3**

PART- C(1x 10=10Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	Analyze the models available for fluid- fluid heterogenous reactions and derive the expression for k_g in each case.	**(10)**	**5**	**5**

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