B.E / B.TECH. DEGREE EXAMINATION, MAY 2023

Sixth Semester

CH18602 – CHEMICAL REACTION ENGINEERING II

(Chemical Engineering)

(Regulation 2018)

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	List few characteristics of a catalyst.	1	1
2	Highlight the significance of porous catalysts.	1	2
3	Differentiate dissociated and non-dissociated adsorption.	2	2
4	Elucidate the Eley Rideal Mechanism.	2	1
5	Identify the need for Effective Diffusivity in heterogenous reactions.	3	2
6	Mention the significance of Weisz Prater's criterion.	3	2
7	Categorize the models available for Gas-solid non-catalytic reactions with example.	4	2
8	Determine the conversion of a solid by SCM at a time of 1 hr and the time taken for complete conversion is 2 hrs. The chemical reaction step is rate controlling.	4	3
9	List a few industrial fluid-fluid reactors.	5	2
10	Annotate on the significance of Enhancement Factor in Gas-liquid operations.	5	2

PART- B (5x 14=70Marks)

(Restrict to a maximum of TWO subdivisions)

		Marks	CO	RBT LEVEL
11(a)	An 8.01 g sample of Glaucosil is studied with N2 adsorption at – 195.8 ºC. The following data are obtained:	(14)	1	3

Pressure (mm Hg)	6	25	140	230	285	320	430	505
Volume adsorbed, cm^3 at 0^oC and 1 atm:	61	127	170	197	215	280	277	335

(OR)

11(b)	Discuss various methods available for the determination of surface area of a catalyst along with their significance.	(14)	1	3
12(a)	Consider the reaction, A. $\longrightarrow$ B + $C_{(g)}$ Using the LHHW mechanism, derive the rate law considering i) Adsorption as the rate limiting step ii). Surface reaction as rate limiting step	(14)	2	3

(OR)

12(b)	For a bimolecular reaction A + B –>C + D when all the species are adsorbed onto the catalytic surface and if surface reaction is rate controlling derive the rate expression for the formation of the product 'c' Assume A – Isobutene (I), B – Water (C) and D – Tertiary Butyl Alcohol (TBA).	(14)	2	3
13(a)	Derive the expression for the effectiveness factor for an isothermal first order irreversible heterogenous reaction with a cylindrical porous catalyst. Also analyze the relationship between effectiveness factor and Thiele Modulus for the same.	(14)	3	3

(OR)

13(b)	Derive the expression for the effectiveness factor for an nonisothermal first order irreversible heterogenous reaction with a spherical porous catalyst.	(14)	3	3
14(a)	Derive the relationship between Time and Conversion when Diffusion through Ash layer controls a Fluid-Solid reaction as per the Shrinking core model. Also, show that the time 'τ' required for complete burning of the solid particle is proportional to the square of the radius 'R'.	(14)	4	3

(OR)

14(b)	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	(14)	4	3

Q. Code:809780

particles. Find the conversion of solids for a mean residence time of 8 minutes and 12 minutes in the reactor.

15(a) The concentration of an undesirable impurity 'A' in air is to be reduced from 0.10% to 0.02% by absorption in pure water. Find the height of tower required for counter current operations. Data: For consistency, units are given in moles, meters, and hours; **(14) 5 3**

- For the packing used,
- $k_{A(g)a}$ = 32,000 mol/hr-m^3-atm
- $k_{A(l)a}$ = 0.1 hr^{-1}
- The solubility of A in water, H_A = 125 x 10^{-6} atm-m^3/mol
- Liquid mass flow rate, L = 7 X 10^{15} mol/hr-m^2
- Gas flow rate, G = 1 X 10^{15} mol/hr-m^2 at π = 1 atm
- Molar density of liquid, C_T = 56,000 mol/m^3

(OR)

15(b) Derive the rate equation for fluid-fluid reaction for the following cases; **(14) 5 3**
(i) Fast reaction in Liquid film with Low CB
(ii) Fast reaction in Liquid film with High CB
Sketch the concentration profiles of the reactants for these reactions.

PART- C (1x 10=10Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16	Develop the expressions for mass transfer coefficient assuming any three models of gas-liquid reactions and explain the same.	**(10)**	**5**	**5**

****