

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (NEW) EXAMINATION – SUMMER 2024****Subject Code:2170501****Date:24-05-2024****Subject Name:Chemical Reaction Engineering - II****Time:02:30 PM TO 05:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- Q.1** (a) Explain E, F and C curves with their relation. **03**
 (b) Describe with diagram various contacting patterns for two phase reacting system. **04**
 (c) Describe all eight cases for mass transfer and reaction for fluid-fluid reactions with neat sketch. **07**

- Q.2** (a) Explain Micro fluid and Macro fluid in detail. **03**
 (b) Define and discuss enhancement factor and Hatta Modulus for fluid – fluid reactions **04**
 (c) Discuss various types of tower and tank contactors for gas – liquid reaction. **07**

OR

- (c) Air with gaseous A bubbles through a tank containing aqueous B. **07**
 Reaction occurs as follows: $A(g) + B(l) \rightarrow R(l)$, $-r_A = kC_A C_B$
 $k = 10^6 \text{ m}^3/\text{mol.hr}$
 For this system
 $k_{Ag} a = 0.10 \text{ mol/hr.m}^3.\text{Pa}$ $f_l = 0.01 \text{ m}^3 \text{ liquid/m}^3 \text{ reactor}$
 $k_{Al} a = 100 \text{ m}^3 \text{ liquid/m}^3 \text{ reactor.hr}$ $H_A = 104 \text{ Pa.m}^3/\text{mol}$
 $D_{Al} = D_{Bl} = 10^{-6} \text{ m}^2/\text{hr}$ $a = 100 \text{ m}^2/\text{m}^3 \text{ reactor}$
 For a point in the absorber-reactor where
 $P_A = 100 \text{ Pa}$ and $C_B = 100 \text{ mol/m}^3$
 (a) Locate the resistance to reaction
 (b) Calculate the rate of reaction ($\text{mol/m}^3 \text{ hr}$)

- Q.3** (a) On doubling the particle size from R to 2R the time needed for complete conversion of a particle triples. Determine the contribution of ash diffusion to the overall resistance for particles of size (i) R and (ii) 2R. Neglect the gas film resistance. **03**
 (b) State and discuss the various stimulus response techniques. **04**
 (c) Derive the rate equation for straight mass transfer (Absorption) of A in fluid-fluid reaction. **07**

OR

- Q.3** (a) Give some industrial examples of fluid particle reactions. **03**
 (b) Give merits and demerits of fixed bed and fluidized bed reactor. **04**

- (c) Gaseous reactant A diffuses through a gas film and reacts on the surface of a solid B according to a reversible first order reaction: **07**

$$-r = k_s (C_{As} - C_{Ae})$$

Where C_{Ae} is the equilibrium concentration of A. Develop an expression for the rate of reaction accounting for both the mass transfer and reaction steps.

- Q.4 (a)** Define the following with suitable examples. **03**

(i) Promoter (ii) Inhibitor (iii) Carrier

- (b) Discuss about the surface area determination of catalysts by nitrogen desorption method. **04**

- (c) A sample of trace hytane at 320 k was injected as a pulse to a reactor, and the effluent concentration was measured as a function of time as shown in table: **07**

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

i) Construct E(t) curve

ii) Determine both the fraction of material leaving the reactor that has spent between 3 and 6 min in the reactor.

OR

- Q.4 (a)** Discuss the limitation of Shrinking Core Model. **03**

- (b) Describe Progressive Conversion Model (PCM) and Shrinking Core Model (SCM) with appropriate diagram **04**

- (c) In slurry reactor pure reactant gas is bubbled through liquid containing suspended catalyst particles. Initially the reactant gas which enters the liquid must diffuse through the liquid film into the main body of liquid, and then through the film surrounding the catalyst particle. At the surface of particle reactant yields product according to first order kinetics. Derive an expression for the rate of reaction in terms of resistances encountered in the reactor. **07**

- Q.5 (a)** Describe the physical properties of catalyst. **03**

- (b) Discuss classification of catalyst. **04**

- (c) Spherical particles of Zinc blends of size $R=1$ mm are roasted in an 8% oxygen stream at 900°C and 1 atm. The stoichiometry of the reaction is **07**



Assuming that reaction proceeds by the shrinking core model calculate the time needed for complete conversion of a particle and the relative resistance of ash layer diffusion during this operation. Film resistance can safely be neglected as long as a growing ash layer is present.

Data:

Density of solid $\rho_B = 4.13$ gm/cm³

Reaction rate constant $k'' = 2$ cm/sec

For gases in the ZnO layer $\tilde{D}_e = 0.08$ cm²/sec

OR

- Q.5 (a)** Differentiate between physical adsorption and chemisorption. **03**

- (b) Explain various experimental methods for finding reaction rates. **04**

- (c) Derive the expression for fractional conversion for the reaction between solid and fluid when particles of solid are changing in size and Diffusion through Gas film controls. **07**
