

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER-VII (NEW) EXAMINATION – WINTER 2024

Subject Code:2170501

Date:04-12-2024

Subject Name: Chemical Reaction Engineering - II

Time:10:30 AM TO 01:00 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) Distinguish between fixed bed reactor and fluidized bed reactor. **03**
- (b) Write short notes on Tank in series model for the non-Ideal Reactor. **04**
- (c) For diffusion through chemical reaction control, derive relation for time required for unreacted core model for spherical particles of unchanging size; deduce relation for complete conversion also. **07**
- Q.2**
- (a) Mention the procedure for tracer experiment for step response. **03**
- (b) Explain Shrinking core model for spherical particles of unchanging size. **04**
- (c) Discuss segregation model with equation of conversion. **07**
- OR**
- (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 $2\text{ZnS}+3\text{O}_2\rightarrow 2\text{ZnO}+2\text{SO}_2$
- 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 $\check{D}_e=0.08$ cm²/sec
- Q.3**
- (a) Discuss the contacting patterns for two-phase systems. **03**
- (b) Discuss in detail deviations from ideal flow pattern with examples. **04**
- (c) Compare C-curve, E-curve and F-curve along with their physical significance. **07**
- OR**
- Q.3**
- (a) Discuss the various types of tower and tank contactors for gas – liquid reaction. **03**
- (b) Discuss the enhancement factor as a function of rate of infinitely fast reaction and maximum possible conversion. **04**

- (c) A sample of the tracer hythane at 320 K was injected as a pulse to a reactor, and the effluent concentration was measured as a function of time. The measurements represent the exact concentrations at the times listed and not average values between the various sampling tests. 07

t, min	0	1	2	3	4	5	6	7	8	9	10	12	14
C pulse gm/l	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

- i. Construct E (t) curve.
 ii. Determine the fraction of material leaving the reactor that has spent 8 min or more in the reactor.

- Q.4** (a) Explain classification of catalyst. 03
 (b) Derive the rate equation for fast reaction with high concentration of liquid reactant in fluid – fluid reaction. 04
 (c) The concentration of undesirable impurity in air (at 1 bar = 105 Pa) is to be reduced from 0.1% (or 100 Pa) to 0.02% (or 20 Pa) by absorption in pure water. Find the height of tower required for counter-current operations. 07

Data

For consistency let us use SI units throughout.

For Packings

$$k_{Aga} = 0.32 \text{ mol/hr. m}^3 \cdot \text{Pa}$$

$$k_{Aia} = 0.1 \text{ /hr}$$

The solubility of A in water is given by Henry's law constant

$$H_A = p_{Ai}/C_{Ai} = 12.5 \text{ Pa. m}^3/\text{mol}$$

The flow rates per meter squared cross section of tower are

$$F_g/A_{cs} = 1 \times 10^5 \text{ mol/hr m}^2$$

$$F_l/A_{cs} = 7 \times 10^5 \text{ mol/hr. m}^2$$

The molar density of liquid under all conditions is

$$C_T = 56,000 \text{ mol/m}^3$$

OR

- Q.4** (a) Explain the mechanism of solid catalysed reactions 03
 (b) Write a short note on trickle bed reactor. 04
 (c) Discuss about the surface area determination of catalysts by nitrogen desorption method. 07

- Q.5** (a) Define: 1) Accelerator 2) Promoter 3) Inhibitor 03
 (b) Write a short note on slurry reactor. 04
 (c) Discuss various regimes for fluid fluid reaction for mass transfer and chemical reaction both having effect on the rate 07

OR

- Q.5** (a) Give some industrial examples of fluid particle reactions 03
 (b) Describe Progressive Conversion Model (PCM) with appropriate diagram. 04
 (c) Explain various experimental methods for finding reaction rates 07
