

B.Tech. (Biotechnology) Sixth Semester (C.B.S.)
Biochemical Reaction Engineering - II Paper – III

P. Pages : 2

Time : Three Hours



TKN/KS/16/7956

Max. Marks : 80

- Notes :
1. All Questions carry equal marks.
 2. Answer **any five** questions.
 3. Assume suitable data wherever necessary.
 4. Diagrams and Chemical equations should be given wherever necessary.

1. a) Define Residence Time Distribution (RTD). Derive an equation for exit-age distribution for pulse input. **6**
- b) A sample of the tracer hythane at 320 K was injected as a pulse to a reactor and the effluent concentration measured as a function of time, resulting in following data: **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

The measurement represent the exact concentrations at the times listed and not average values between the various sampling tests.

- i) Construct figures showing C(t) and E(T) as function of time.
 - ii) Determine the fraction of material leaving that has spent between 7.75 and 8.25 min in the reactor and
 - iii) 3 min or less in the reactor.
2. a) How does heat affect the diffusion in solid catalysed reaction. **10**
- b) Describe the resistances that affect the rate of solid catalysed reaction. **6**
3. a) Derive expression for rate equation for mass transfer in a gas-liquid reaction. **8**
- b) Obtain the reaction rate equation for a slow gas-liquid reaction with respect to mass transfer considering the mass transfer resistances. **8**
4. a) If rate of reaction is given by Michaelis Menten equation, obtain the expression to show change in substrate concentration(C_s) in batch and plug flow reactor. **6**
- b) Substrate A and enzyme E flow through a MFR of volume 6 lit. Find the rate equation to represent the action of enzyme on the substrate using following data. **10**

Sr. No.	CE ₀ (mol ℓ)	CA ₀ (mol ℓ)	C _A (mol ℓ)	v(lit hr)
1	0.02	0.20	0.04	3
2	0.01	0.30	0.15	4
3	0.01	0.69	0.60	1.2

5. a) Derive the Hill's equation for reversible binding of a protein having 'n' binding sites. **6**
- b) Derive expression for non-competitive Inhibition of enzyme-substrate reaction. **10**

6. Give the types and mechanism of catalyst deactivation. 16
7. The results of kinetic runs on a reaction $A \rightarrow R$ made in a experimental packed bed reactor using a fixed feed rate $F_{AO} = 10 \text{ kmol/h}$ are 16

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

Find:

- i) The reaction rate at 40% conversion.
 - ii) Amount of catalyst needed for 40 % conversion for a feed flow rate of 400 kmol/h.
 - iii) Amount of catalyst needed for 40% conversion for a feed flow rate of 400 kmol/h if the reactor employed a very large recycle of product stream.
8. CO_2 is to be removed from air. We plan to use NaOH solution to speed up the removal of CO_2 from air at 25°C (instead of pure water). The reaction between CO_2 and NaOH is instantaneous. 16
- $$\text{CO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$$
- i) Suggest a form of rate equation that we would use when $P_{\text{CO}_2} = 1000 \text{ Pa}$ and the solution is 2N.
 - ii) How much can absorption be speeded compared to physical absorption using water?
 Data: $K_{\text{ga}} = 0.80 \text{ mol} \cdot \text{h} \cdot \text{m}^3 \cdot \text{Pa}$,
 $K_{\text{la}} = 25 \text{ h}^{-1}$
 $H = 3000 \text{ Pa} \cdot \text{m}^3 / \text{mol}$.
