

**B.TECH DEGREE EXAMINATIONS: APRIL/MAY 2014**

(Regulation 2009)

Sixth Semester

**BIOTECHNOLOGY**

BTY120: Chemical Reaction Engineering

**Time: Three Hours****Maximum Marks: 100****Answer all the Questions:-****PART A (10 x 1 = 10 Marks)**

- Liquid A decomposes by first order kinetics and in a batch reactor 50% of A is converted in a five minute run. The value of rate constant is
  - $0.6263 \text{ min}^{-1}$
  - $0.1386 \text{ min}^{-1}$
  - $0.1386 \text{ lit. mol}^{-1} \cdot \text{min}^{-1}$
  - $0.6263 \text{ lit. mol}^{-1} \cdot \text{min}^{-1}$
- The fractional volume change of the system for the isothermal gas phase reaction,  $A \rightarrow 3B$ , between no conversion and complete conversion
  - 0.5
  - 1
  - 2
  - 3
- A first order reaction requires two equal sized CSTR. The conversion is
  - less when they are connected in series
  - More when they are connected in series.
  - more when they are connected in parallel
  - Same whether they are connected in series or in parallel.
- 'N' plug flow reactors in series with a total volume 'V' gives the same conversion as a single plug flow reactor of volume 'V' for \_\_\_\_\_ order reactions
  - first
  - second
  - third
  - any
- The exit age distribution of a fluid leaving a vessel (denoted by E) is used to study the extent of non-ideal flow in the vessel. The value of  $\int_0^{\infty} E \cdot dt$  is
  - 0
  - 1
  - $\infty$
  - $2\pi$
- The 'E' curve for a non-ideal reactor defines the fraction of fluid having age between  $t$  and  $t + dt$ 
  - at the inlet
  - at the outlet
  - in the reactor
  - averaged over the inlet and outlet

- \_\_\_\_\_ is the controlling step in a highly temperature sensitive fluid-solid non-catalytic reaction.
  - Gas film diffusion
  - Ash diffusion
  - Chemical reaction
  - Particle size
- Rate determining step in a reaction consisting of a number of steps in series is the \_\_\_\_\_ step.
  - Fastest
  - Slowest
  - Intermediate
  - Constant
- For a fluidized bed reactor, the most suitable/relevant model is a \_\_\_\_\_ model.
  - Tank in series
  - Bubbling bed
  - Plug flow
  - Fixed bed
- For a packed bed reactor; the presence of a long tail in the residence time distribution curve is an indication of
  - Ideal plug flow
  - Bypass
  - Dead zone
  - Channeling

**PART B (10 x 2 = 20 Marks)**

- Define elementary reaction and non elementary reaction with examples.
- Define order and molecularity of a reaction.
- Define Recycle ratio.
- Define Space-time and Space-velocity.
- What are micro fluids and macro fluids?
- Define vessel dispersion number. Give its significance
- Define shrinking core model.
- Define rate controlling step.
- Write any two applications of slurry type reactors.
- Write the performance equation for an excess of B in G/L reactions on solid catalyst.

**PART C (5 x 14 = 70 Marks)**

- One solution contains substance A in concentration  $1.6 \text{ kmol/m}^3$  and another contains substance B in concentration  $1.0 \text{ kmol/m}^3$ . Equal amount of these solutions is mixed quickly, and measurements of  $C_A$  Versus  $t$  are made. The reaction is believed to be reversible of first order in both directions. Find the forward rate constant  $k_1$  and the equilibrium constant  $K_c$ . The reaction is  $A \leftrightarrow B$ .

time, min	0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	10.0
$C_{A_s}$ kmol/m <sup>3</sup>	0.800	0.670	0.600	0.563	0.543	0.527	0.522	0.520	0.520

(OR)

- b) The reaction  $A \rightarrow B + C$  is a first order irreversible reaction. Using the following data, determine the specific reaction rate constant for an initial mixture of 40% A and 60% inerts.

time, min	0	2	4	8
Pressure, mmHg	200	208	215	226

22. a) Pure gaseous reactant A ( $C_{A_0} = 100$  millimol/liter) is fed at a steady rate into a mixed flow reactor ( $V = 0.1$  liter) where it dimerizes ( $2A \rightarrow R$ ). For different gas feed rates the following data are obtained. Find a rate equation for this reaction.

Run number	1	2	3	4
$v_0$ , liter/hr	30.0	9.0	3.6	1.5
$C_{A_f}$ millimol/liter	85.7	66.7	50	33.4

(OR)

- b) (i) The elementary liquid-phase reaction  $A + 2B \leftrightarrow R$  with rate equation (7)  $-r_A = -(1/2)r_B = (12.5 \text{ liter}^2/\text{mol}^2 \text{ min}) C_A C_B^2 - (1.5 \text{ min}^{-1}) C_R$  [mol /lit min] is to take place in a 6 liter steady state mixed flow reactor. Two feed streams, one containing 2.8 mol A/liter and the other containing 1.6 mol B/liter, are to be introduced at equal volumetric flow rates into the reactor, and 75% conversion of limiting component is desired. What should be the flow rate of each stream? Assume a constant density throughout.
- (ii) We plan to replace our present mixed flow reactor with one having double the (7) volume. For the same aqueous feed (10 mol A /liter) and the same feed rate find the new conversion. The reaction kinetics are represented by  $A \rightarrow R$ ,  $-r_A = k C_A^{1.5}$  and present conversion is 70%.

23. a) Calculate: (a) Mean residence time (2)  
 (b) Variance (2)  
 (c) Dimensionless variance (2)  
 (d) Dispersion number for closed vessel (4)  
 (e) Dispersion number for open vessel (4)

Time (min)	0	4	8	12	16	20	24	28	32
Concentration	0	3	5	5	4	2	1	0	0

(OR)

- b) A specially designed vessel is to be used as a reactor for a first order liquid reaction. Since flow in this vessel is suspected to be non ideal, tracer tests are conducted and the following concentration readings represent the response at the vessel outlet to a delta function tracer input to the vessel inlet. What conversion can we expect in this reactor if conversion in MFR employing the same space time is 82.18%. We suspect that the dispersion and tanks in series models are poor representation of the flow pattern.

Time (min)	10	20	30	40	50	60	70	80
Concentration (g/lit)	0	3	5	5	4	2	1	0

24. a) Explain the performance equation for an excess of B in G/L reactions on solid catalyst.

(OR)

- b) Explain the diffusion through gas film controls in shrinking core model for spherical particles

25. a) Explain the packed bed catalytic reactor.

(OR)

- b) Explain the behavior of turbulent fluidized bed reactor and fast fluidized bed reactor.

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