Ref. No.: Ex/FTBE/PC/B/T/225/2023

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING

SECOND YEAR SECOND SEMESTER EXAM 2023

Subject: CHEMICAL ENGINEERING KINETICS Part-1 (50) FM-100 Time- 3hrs

Answer question no 4 and any two from the following

(Use separate answer script for each Part)

1. In a microbial laboratory, three test tubes containing microbial cultures are placed in three hot baths, maintained at different temperatures 70^0C, 80^0C and 90^0C respectively. The following values of time-temp combination with respect to the no. of microorganisms (N) have been determined from the experiment. (20)

For 70^0C		**For 80^0C**		**For 90^0C**	
Time, t (s)	No. of microorganism, N	Time, t (s)	No. of microorganisms, N	Time, t (s)	No. of microorganisms N
0	10^7	0	10^7	0	10^7
30	10^5	30	10^5	30	$5x10^4$
60	10^4	60	$5x10^3$	60	10^3
120	10^3	120	10^2	120	550
180	500	180	50	180	150
300	10	300	1	300	1

Calculate how long it will take for the reduction of microorganisms to 1 in 1000 at 85^0C.

2. Reactant A decomposes in a batch reactor, $A \longrightarrow B$

The composition of A in the reactor is measured at various times with results shown in the following columns 1 and 2. Find a rate equation using the integral method to represent the data. (20)

Time (t, s)	**Concentration (C_A, mol/liter)**
0	**$C_{A0} = 10$**
30	**8**
50	**7**
70	**5**
90	**3**
110	**2**
130	**1**

[Turn over

3. An enzymatic catalytic reaction A $\rightarrow$B exibit the following behavior
   a) A rate proportional to the concentration of enzyme introduce in to the mixture [E_o].
   b) At low reactant concentration the rate is proportional to the reactant concentration [A].
   c) At high reactant concentration the rate levels off and become independent of reactant concentration.

   Propose a mechanism to account for this behavior. (20)
4. In a milk-pasteurization process, rate constant follows the Arrhenius' Law as follows: $k = k_o\, e^{-E/RT}$. The pasteurization process was carried out at two different temperatures $T_1{}^o$ K and $T_2{}^o$ K (WhereT_1 is higher than T_2). Discuss which temperature would be preferable for effective pasteurization? (10)

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
EXAMINATION 2023 (2nd Year, 2nd Semester)

Subject: CHEMICAL ENGINEERING KINETICS (FTBE/PC/B/T/225)

PART II (50 Marks)

Time: 3 hours Full Marks: 100

Q.4 is compulsory and answer any two from the following:

Q.1. **5×3= 15**

(i) How the heterogeneous reaction kinetics is developed?

(ii) For a Gas-Solid system, if the solid particle is surrounded by a gas film, show the steps involved for such heterogeneous reaction schematically.

(iii) Estimate the ε_A for the reaction **A → 3.2R** containing 20% inert in the feed?

(iv) Estimate the molar feed rate of gaseous reactant A (mol/hr) if 30.5 lit/hr. pure A with concentration 200 mol/m^3 is fed to the reactor?

(v) Is Thiele modulus dimensionless?-justify your answer.

Q.2. Derive the concentration profile of the reactant A inside a purely single cylindrical pore of length L with initial concentration of A at the pore mouth equals to C_{As}. Also estimate the concentration of A at the midway of such cylindrical pore with Thiele modulus value equals to 0.4 **9+6 =15**

Q.3. Write short notes on the following: **5×3 = 15**

(i) Pore blocking (ii) Thiele modulus (iii) Performance equation of catalytic reactor (iv) Shrinking Core Model (v) Catalytic reaction

Q.4. There are two different catalytic reactions to form the same product R as shown below: Both the reaction occurs in a PFR type fluidized reactor utilizing same catalyst but with different gaseous reactant A & B, respectively. Both the reaction was occurred at total pressure 4 atm. and at 107° C. For scheme 1, pure A is to be fed but for scheme 2, feed must contain 25% inert. For both the scheme, molar feed rate of A and B is kept constant at 2 kmol/hr. Estimate (i) the amount of catalyst to achieve 75% conversion of A & B, respectively (ii) If the catalyst cost Rs. 10,000/kg., then which scheme would be preferable for the same conversion?

A → R (scheme 1) $-r_A = 93.5$ (lit/kg. cat-hr) C_A