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Total number of printed pages – 3

B. Tech.
PCCH 4305

Sixth Semester Examination – 2011

CHEMICAL REACTION ENGINEERING

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any **five** from the rest.

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 × 10
- (a) For a given reaction $2A + B \longrightarrow 2C + 3D$, establish a relationship between rates of formation and disappearance of the four components.
- (b) State molecularity and order of a reaction.
- (c) For the chemical reaction $A + B + C \xrightarrow{K} D$, If was found that the rate of the reaction doubled when the concentration of B was doubled, that the rate of reaction doubled when the concentrations of both A and B were doubled, and quadrupled when the concentration of both B and C were doubled. What is the overall order of the reaction ?
- (d) For an autocatalytic reaction $A + R \longrightarrow R + R$, the plot of fractional conversion of A Vs. time is?
- (i) Straight line parallel to the time axis
- (ii) Straight line passing through the origin
- (iii) an S-shaped curve passing through the origin.
- (e) What is space time and mean residence time (explain with suitable example) ?

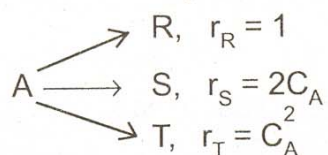
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- (f) A homogeneous liquid phase reaction is conducted in a batch reactor at a speed of agitation of 500 rpm. If the speed of agitation is doubled,?
- the reaction rate will double
 - the reaction rate will be halved
 - the reaction rate will remain unaffected.
- (g) Find ' ϵ_A ' and ' ϵ_B ' (fractional change in volume) for the reaction $A+3B \longrightarrow 5R$, if $C_{B0} = 200$ and $C_{A0} = 100$.
- (h) For a zero order reaction the fractional conversion of the reaction is?
- directly proportional to the initial concentration
 - inversely proportional to the initial concentration
 - independent of the initial concentration.
- (i) What is selectivity? Explain with an example.
- (j) The exit age distribution curve $E(t)$ for an ideal CSTR with the average residence time ' τ ' is given by.....?
- $e^{-t/\tau}$
 - $(1/\tau) e^{-t/\tau}$
 - $1 - e^{-t/\tau}$
2. (a) Derive the performance equation of batch reactor. 5
- (b) Write advantages and disadvantages of a batch Reactor. 5
3. (a) Following gas phase reaction takes place at 500°C.
- $$4PH_3 \longrightarrow P_4(g) + 6H_2$$
- with $-r_{PH_3} = 85 \text{ hr}^{-1} C_{PH_3}$. Find the volume of PFR operating at this temperature and 5 atm giving 75% conversion for a feed of 2.5 Kmol/hr. 5
- (b) The rate of a reaction at 40°C is three times the rate at 20°C. Find the activation energy. 5
4. The degree of increase in recycle ratio increases the degree of back mixing. A first order liquid phase reaction, 92% conversion is taking place in a mixed reactor. It has been suggested that a fraction of product stream, with no additional treatment, be recycled. If the feed rate remains unchanged, in what way would this affect conversion? 10

5. For a constant density isothermal system, the reactor concentration in the effluent stream of a reactor vessel is obtained as follows in response to a pulse of tracer added to the feed :

Time, Sec	0	5	10	15	20	25	30	35
Tracer con., kg/m ³	0	3	5	5	4	2	1	0

- (a) Plot the exit age distribution E (RTD) for the system. 5
- (b) If the reactor as a closed vessel is well represented by dispersion model, calculate the vessel dispersion number D/uL . 5
6. For the parallel decomposition of A, where 'S' is the desired product, $C_{A0} = 2$, What maximum C_s we may expect in isothermal operations :



- (a) In a mixed reactor. 5
- (b) In a plug flow reactor. 5
7. (a) A first order reaction is to be treated in a series of two mixed reactors, show that the total volume of the two reactors is minimum, when the reactors are equal in size. 5
- (b) For the reaction in series, $A \longrightarrow R \longrightarrow S$, K_1 and K_2 are the rate constants and if $K_1 \neq K_2$, find the maximum concentration of R and when it is reached? 5
8. Write short notes on any **two** of the following : 5+5
- (a) Temperature dependency from transition state theory
- (b) Integral method of analysis
- (c) Advantages and disadvantages of plug flow reactor.