



RM-7025-R

B. E. - III (Sem. VI) (Chemical) Examination

May / June - 2010

Chemical Reaction Engg. - I

Time : 3 Hours]

[Total Marks : 100

Instructions :

(1)

नीचे दशांशवले निशानीवाणी विगतो उत्तरवडी पर अवश्य लपवी. Fillup strictly the details of signs on your answer book.	Seat No. :
Name of the Examination :	<input type="text"/>
<input type="checkbox"/> B. E. - 3 (Sem. 6) (Chemical)	<input type="text"/>
Name of the Subject :	<input type="text"/>
<input type="checkbox"/> Chemical Reaction Engg. - I	<input type="text"/>
Subject Code No. : <input type="text"/> 7 <input type="text"/> 0 <input type="text"/> 2 <input type="text"/> 5	<input type="text"/>
Section No. (1, 2,.....): <input type="text"/> 1&2	<input type="text"/>
	Student's Signature

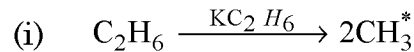
- (2) Answer each section in the **separate** answer books.
- (3) Figures indicated at right side of the question is full marks.
- (4) Assume appropriate data and give sketches wherever necessary.

SECTION - I

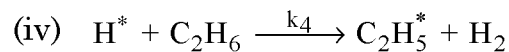
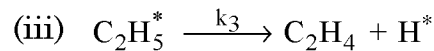
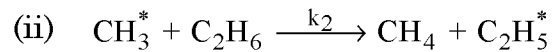
- 1 (a) Answer the following : 10
- (i) Write down the reaction rate in terms of 2
surface of solid occupied and with respect to
the volume of the reactor used.
- (ii) Write down true or false : 5
- (a) The order of a reaction is always an integer value.
- (b) Reactions with low activation energies are very temperature sensitive, while reactions with high activation energies are relatively temperature insensitive.
- (c) The frequency factor K_0 does not affect the temperature sensitivity of a reaction.
- (d) Reactions with order $n > 1$ can always go to completion in finite time.

- (e) The slope of the plot $\ln t_{1/2}$ Vs. $\ln C_{AO}$ is negative for $n > 1$.
- (iii) Draw a typical concentration Vs. time curve for a consecutive first order reactions. **2**
- (iv) Define order of the reaction. **1**
- (b) The thermal decomposition of ethane to ethylene, methane, butane and hydrogen is believed to proceed in the following sequences : **10**

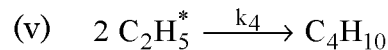
Initiation :



Propogation :



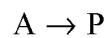
Termination :



Derive a rate law for the rate of formation of ethylene and also derive rate of disappearance of ethane.

2 Answer any **two** : **2×8=16**

- (a) Derive the reaction kinetics for a homogenous catalyzed system.
- (b) Find a rate equation using integral method of analysis for the following reaction,



where A decomposes in a batch reactor. The composition of A in the reactor is measured at various times with results shown below. Find the rate equation to represent the data :

time, s	0	20	40	60	120	180	300
C_A , mol/liter	10	8	6	5	3	2	1

- (c) Derive the relationship between conversion and concentration for isothermal varying density system.

3 Answer any two : 2×7=14

- (a) For the reaction $A \rightarrow R$, 2nd order kinetics and $C_{AO} = 1$ mol/liter, we get 50% conversion after 1 hr in a batch reactor. What will be the conversion and concentration of A after 1 hour if $C_{AO} = 10$ mol/liter?
- (b) For the decomposition $A \rightarrow R$, $C_{AO} = 1$ mol/liter, in a batch reactor conversion is 75% after 1 hour, and is just complete after 2 hours. Find a rate equation to represent these kinetics.
- (c) Consider a feed $C_{AO} = 100$, $C_{BO} = 200$, $C_{20} = 100$ to a steady flow reactor. The isothermal gas phase reaction is $A + 3B \rightarrow 6R$
- If $C_A=40$ at the reactor exit, what is C_B , X_A and X_B there?

SECTION - II

- 4 (a) Answer the following : 10
- (i) Define mean residence time. 1
- (ii) The thermodynamic equilibrium constant is unaffected by the pressure of the system - State True or False. 1
- (iii) If $K \gg 1$, it indicates that practically conversion is impossible and the reaction can be considered reversible - State True or False. 1
- (iv) Give the graphical representation of energy balance equation for adiabatic operation. 2
- (v) State two methods to control product distribution for the reactions of the type :
- $A \xrightarrow{k_1} R$ (desired)
- $A \xrightarrow{k_2} S$ (unwanted)
- (vi) Draw contacting patterns for various combinations of high and low concentration of reactants in non continuous operations. 2
- (vii) Define space velocity. 1
- (b) Define optimum temperature progression. Discuss the effects of temperature on irreversible reactions, endothermic and exothermic reactions. Draw operating lines for minimum reactor size. 10

- 5 Answer the following : (any two) 16
- (i) 100 lt/hr of radioactive fluid having half-life period 8
20 hr is to be treated by passing it through two ideal steel tank mixed reactions in series of volume 40,000 lt. each. In passing through the system, how much has the activity decayed?
- (ii) Discuss quantitative treatment in plug flow or Batch 8
reactor for the reactions :
- $$A \xrightarrow{K_1} R \xrightarrow{K_2} S$$
- (iii) Equimolar quantities of A, B and D are fed 8
continuously to a MFR where they combine by the elementary reaction :
- $$A + D \xrightarrow{k_1} R$$
- $$B + D \xrightarrow{k_2} S \quad \frac{k_2}{k_1} = 0.2$$
- (a) 50% of incoming A is consumed, find out what fraction of product formed is R.
- (b) If 50% of incoming B is consumed, find out which fraction of product formed is S.
- 6 Answer the following : (any two) 14
- (i) Derive a relation for overall fractional yield in PFR 7
for following reaction in parallel :
- $$A \xrightarrow{k_1} R \text{ (desired)}$$
- $$A \xrightarrow{k_2} S \text{ (undesired)}$$
- (ii) A first order reaction is to be treated in a series of 7
2 mix reactors. Show that the total volume of two reactors is minimum when reactors are of equal size.
- (iii) Discuss the effect of temperature and pressure on 7
equilibrium conversion as predicted by thermodynamics.
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