



SF-7025

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

May / June - 2011

Chemical Reaction Engineering - I

Time : Hours]

[Total Marks :

Instructions :

(1)

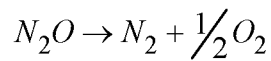
नीचे दर्शायेव निशानीवाणी विगतो उत्तरवडी पर अवश्य लपवी. Fillup strictly the details of signs on your answer book.	Seat No. :
Name of the Examination :	<input type="text"/>
<input type="text" value="B. E. - III (Sem - VI) (Chemical)"/>	<input type="text"/>
Name of the Subject :	<input type="text"/>
<input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

- (2) Figures indicated at right side of the question is full marks.  
(3) Assume the data wherever necessary and mention it clearly.  
(4) Draw neat figures/graphs wherever applicable.

### SECTION - I

- 1 (a) Answer the following : 1×10=10
- (i) What is chemical reaction engineering ?  
(ii) Which variables affect the rate of reaction for the homogenous system ?  
(iii) Define elementary and non-elementary reaction.  
(iv) Write down  $r_{NH_3}$  for :
- $$N_2 + 3H_2 \rightleftharpoons 2NH_3$$
- (v) The temperature dependency of the reactions is determined by the \_\_\_\_\_ and \_\_\_\_\_ of the reaction.  
(vi) Enlist the procedure to analyze the kinetic data.  
(vii) What is zero order reaction ?  
(viii) What is fractional life time ?  
(ix) What is the fractional change in volume for the  $A + 3B \rightarrow C$ .  
(x) Enlist the equipments to perform homogenous reaction.

- 1 (b) The primary reaction occurring in the homogenous decomposition of nitrous oxide is found to be; 1×10=10



with a rate  $-r_{N_2O} = \frac{k_1[N_2O]^2}{1+k^1[N_2O]}$

Derive a mechanism to explain this observed rate.

- 2 Answer any two. 2×8=16

- (a) Derive the reaction kinetic for the homogenous catalyzed reaction.
- (b) Discuss differential method of analysis for the reaction rate.
- (c) For the reaction  $A \rightarrow P$ , the following data were obtained at  $25^\circ C$ , in which the concentration of A is given at different intervals of time ;

$t, \text{min}$	0	10	20	30	40
$C_A; \frac{\text{mol}}{l}$	0.860	0.740	0.635	0.546	0.405

Find the order of reaction and calculate the rate constant and the half life period.

- 3 Answer any two. 2×7=14

- (a) Explain the material and energy balance for element which undergoes the reaction kinetics.
- (b) The first order reversible liquid phase reaction;  $A \rightleftharpoons R$ , takes place in a batch reactor. After 8 min, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation to represent this reaction. Take  $C_{A0} = 0.50 \text{ mol/lit}$  and  $C_{R0} = 0$ .
- (c) Derive the reaction kinetics for the first order, reversible reaction.

## SECTION - II

- 4 (a) Answer the following : 5×2=10
- (1) Give graphical representation of the effect of pressure on equilibrium conversion as predicated by thermodynamics with temperature fixed.
  - (2) For reactions in parallel, a high reactant concentration favours the reaction of \_\_\_\_\_ order, a low concentration favours the reaction of \_\_\_\_\_ order.
  - (3) Define space time and space velocity.
  - (4) Mention any two points for the best arrangement of a set of Ideal reactors in series in order to achieve good conversion.
  - (5) Draw the contacting patterns for various combinations of high and low concentration of reactants in continuous flow operations.
- (b) Answer the following. 10
- (1) Derive an equation of  $T_m$  (optimum) of mixed flow reactor for reactions in series assuming first order kinetics. 8
- $$A \xrightarrow{k_1} R \xrightarrow{k_2} S$$
- (2) Define instantaneous fractional yield and overall fractional yield. 2

- 5 Answer the following. (any two) 16
- (1) It is proposed to operate a batch reactor for converting A into R. This is a liquid phase reaction with the stoichiometry  $A \rightarrow R$ . How long must we react each batch in order to drop the concentration from  $C_{A0} = 1.3 \text{ mol/l}$  to  $C_{Af} = 0.3 \text{ mol/l}$  ?

The rate v/s concentration data are as given below

$C_A, \text{mol/l}$	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
$-r_A, \text{mol/l.min}$	0.1	0.3	0.5	0.6	0.5	0.25	0.10	0.06

$C_A$	1.0	1.3	2.0
$-r_A$	0.05	0.045	0.042

- (2) 100 l/h of radioactive fluid having a half life of 20h is to be treated by passing it through two mixed flow reactors in series. The volume of each mixed flow reactor in series is 40000 l. How much has the activity decayed in passing through this reactor system ? The reaction follows first order kinetics.
- (3) Discuss the method of maximization of rectangles applied to find the optimum intermediate conversion and optimum sizes of two mixed reactors in series.

**6** Answer the following. (any two)

**14**

- (1) Derive the equation for N equal size mixed reactors in series.
- (2) Define recycle ratio and derive the equation for optimum recycle ratio.
- (3) Give qualitative discussion about product distribution for successive First order reactions  $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ .
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