

University of Anbar

College of Engineering

**Chemical and Petrochemical Engineering
Department**

Chemical Reaciior Design

Third Year

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Lecture No. 14

1-

A reaction with stoichiometric equation $\frac{1}{2} A + B = R + \frac{1}{2} S$ has the following rate expression

$$-r_A = 2C_A^{0.5}C_B$$

What is the rate expression for this reaction if the stoichiometric equation is written as $A + 2B = 2R + S$?

2-

A certain reaction has a rate given by

$$-r_A = 0.005C_A^2, \quad \text{mol/cm}^3 \cdot \text{min}$$

If the concentration is to be expressed in mol/liter and time in hours, what would be the value and units of the rate constant?

3-

The pyrolysis of ethane proceeds with an activation energy of about 300 kJ/mol. How much faster is the decomposition at 650°C than at 500°C?

4-

A 1100-K *n*-nonane thermally cracks (breaks down into smaller molecules) 20 times as rapidly as at 1000 K. Find the activation energy for this decomposition.

5-

A 10-minute experimental run shows that 75% of liquid reactant is converted to product by a ½-order rate. What would be the fraction converted in a half-hour run?

6-

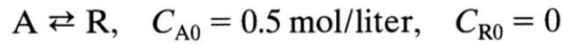
In a homogeneous isothermal liquid polymerization, 20% of the monomer disappears in 34 minutes for initial monomer concentration of 0.04 and also for 0.8 mol/liter. What rate equation represents the disappearance of the monomer?

7-

After 8 minutes in a batch reactor, reactant ($C_{A0} = 1$ mol/liter) is 80% converted; after 18 minutes, conversion is 90%. Find a rate equation to represent this reaction.

8-

The first-order reversible liquid reaction



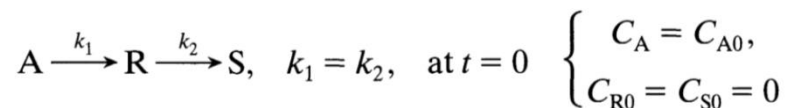
takes place in a batch reactor. After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction.

9-

Aqueous A reacts to form R ($A \rightarrow R$) and in the first minute in a batch reactor its concentration drops from $C_{A0} = 2.03$ mol/liter to $C_{Af} = 1.97$ mol/liter. Find the rate equation for the reaction if the kinetics are second-order with respect to A.

10-

For the elementary reactions in series

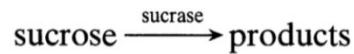


find the maximum concentration of R and when it is reached.

11-

Chemical Reactor Design – Third Year Dr. Suha Akram

At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrase as follows:



Starting with a sucrose concentration $C_{A0} = 1.0$ millimol/liter and an enzyme concentration $C_{E0} = 0.01$ millimol/liter, the following kinetic data are obtained in a batch reactor (concentrations calculated from optical rotation measurements):

C_A , millimol/liter	0.84	0.68	0.53	0.38	0.27	0.16	0.09	0.04	0.018	0.006	0.0025
t , hr	1	2	3	4	5	6	7	8	9	10	11

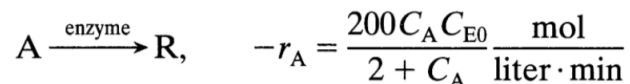
Determine whether these data can be reasonably fitted by a kinetic equation of the Michaelis–Menten type, or

$$-r_A = \frac{k_3 C_A C_{E0}}{C_A + C_M} \quad \text{where } C_M = \text{Michaelis constant}$$

If the fit is reasonable, evaluate the constants k_3 and C_M . Solve by the integral method.

12-

Enzyme E catalyzes the transformation of reactant A to product R as follows:



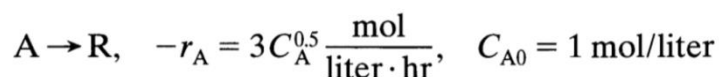
If we introduce enzyme ($C_{E0} = 0.001$ mol/liter) and reactant ($C_{A0} = 10$ mol/liter) into a batch reactor and let the reaction proceed, find the time needed for the concentration of reactant to drop to 0.025 mol/liter. Note that the concentration of enzyme remains unchanged during the reaction.

13-

An ampoule of radioactive Kr-89 (half life = 76 minutes) is set aside for a day. What does this do to the activity of the ampoule? Note that radioactive decay is a first-order process.

14-

Find the conversion after 1 hour in a batch reactor for



15-



Initial concentrations of H_2SO_4 and $(\text{C}_2\text{H}_5)_2\text{SO}_4$ are each 5.5 mol/liter. Find a rate equation for this reaction.

t , min	$\text{C}_2\text{H}_5\text{SO}_4\text{H}$, mol/liter	t , min	$\text{C}_2\text{H}_5\text{SO}_4\text{H}$, mol/liter
0	0	180	4.11
41	1.18	194	4.31
48	1.38	212	4.45
55	1.63	267	4.86
75	2.24	318	5.15
96	2.75	368	5.32
127	3.31	379	5.35
146	3.76	410	5.42
162	3.81	∞	(5.80)

16-

A small reaction bomb fitted with a sensitive pressure-measuring device is flushed out and then filled with pure reactant A at 1-atm pressure. The operation is carried out at 25°C, a temperature low enough that the reaction does not proceed to any appreciable extent. The temperature is then raised as rapidly as possible to 100°C by plunging the bomb into boiling water, and the readings in Table 7 are obtained. The stoichiometry of the reaction is $2\text{A} \rightarrow \text{B}$, and after leaving the bomb in the bath over the weekend the contents are analyzed for A; none can be found. Find a rate equation in units of moles, liters, and minutes which will satisfactorily fit the data.

T , min	π , atm	T , min	π , atm
1	1.14	7	0.850
2	1.04	8	0.832
3	0.982	9	0.815
4	0.940	10	0.800
5	0.905	15	0.754
6	0.870	20	0.728

17-

For the reaction $\text{A} \rightarrow \text{R}$, second-order kinetics and $C_{\text{A}0} = 1$ mol/liter, we get 50% conversion after 1 hour in a batch reactor. What will be the conversion and concentration of A after 1 hour if $C_{\text{A}0} = 10$ mol/liter?

18-

For the decomposition $A \rightarrow R$, $C_{A0} = 1$ 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.

19-

In the presence of a homogeneous catalyst of given concentration, aqueous reactant A is converted to product at the following rates, and C_A alone determines this rate:

C_A , mol/liter	1	2	4	6	7	9	12
$-r_A$, mol/liter · hr	0.06	0.1	0.25	1.0	2.0	1.0	0.5

We plan to run this reaction in a batch reactor at the same catalyst concentration as used in getting the above data. Find the time needed to lower the concentration of A from $C_{A0} = 10$ mol/liter to $C_{Af} = 2$ mol/liter.

20-

The following data are obtained at 0°C in a constant-volume batch reactor using pure gaseous A:

Time, min	0	2	4	6	8	10	12	14	∞
Partial pressure of A, mm	760	600	475	390	320	275	240	215	150

The stoichiometry of the decomposition is $A \rightarrow 2.5R$. Find a rate equation which satisfactorily represents this decomposition.

21-