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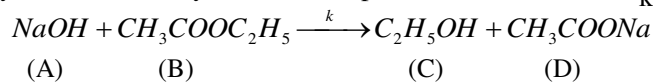
Kinetics of Saponification Reaction in a Batch Reactor

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ABSTRACT: The saponification reaction was carried out at room temperature and the results were analyzed. Using this information we have studied the kinetics for the saponification reaction and calculated the value of important parameters like the rate constant k for the reaction.

The saponification reaction between Sodium Hydroxide and Ethyl Acetate is represented as:



KEYWORDS : saponification , rate constant.

1. INTRODUCTION

Saponification is a process that involves the conversion of fat, oil, or lipid, into soap and alcohol by the action of aqueous alkali (e.g. NaOH).

Mechanism of base hydrolysis:

The hydroxide anion of the salt reacts with the carbonyl group of the ester. The immediate product is called an orthoester.

Expulsion of carboxylic acid and alkoxide.

Creation of alcohol.

A batch reactor is used for small-scale operation, for testing new processes that have not been fully developed, for the manufacture of expensive products, and for processes that are difficult to convert to continuous operations. The reactor can be charged (i.e., filled) through the holes at the top. The batch reactor has the advantage of high conversions that can be obtained by leaving the reactant in the reactor for long periods of time, but it also has the disadvantages of high labor costs per batch, the variability of products from batch to batch, and the difficulty of large-scale production

Here we will carry out the saponification reaction in a

batch reactor and try to analyze the results. We will study the kinetics of the saponification reaction. Further there is also scope to make some variations in the reaction conditions and see their effect on the kinetics of reaction.

Presently we will plot a graph after finding the fractional conversion and find the value of rate constant k .

II. EQUATIONS AND FORMULAS

For the irreversible reaction the rate equation is given by

$$-r_A = \frac{-dC_A}{dt} = kC_A C_B = kC_{AO}^2 (1 - X_A)(M - X_A) \quad (1)$$

where $M = C_{BO}/C_{AO}$ and when A and B are added in equal volumes with concentrations \bar{C}_{AO} and \bar{C}_{BO} respectively, we have

$$C_{AO} = \frac{\bar{C}_{AO}}{2}; C_{BO} = \frac{\bar{C}_{BO}}{2}.$$

The integration of the above equation gives,

Case I, when $M \neq 1$,

$$\ln \frac{(M - X_A)}{M(1 - X_A)} = C_{AO}(M - 1)kt \quad (2)$$

Case II, when $M = 1$, (3)

$$\frac{X_A}{(1 - X_A)} = C_{AO}kt$$

When the left hand side of equation (2) or (3) is drawn as a function of t, we get the value of k from the slope of the plot.

III. EXPERIMENTAL PROCEDURE

Take equal amount of NaOH of concentration \bar{C}_{AO}

and Ethyl Acetate of concentration \bar{C}_{BO}

Add them in to the Batch reactor, start the stirrer and the stop watch. Take 10 ml. of sample at time, t = 0 (and after that at time interval of 5 min.)

Add the sample in a conical flask in which 10 ml. of N/10 HCl is already present. This will neutralize the unreacted NaOH and arrest the saponification reaction.

Titrate the excess of HCl by NaOH of concentration C_{AO} gm-moles/l and note down the NaOH used.

IV. OBSERVATION

S. No.	time t (min)	Concentration of NaOH C_{AO} (gmol/L)	Volume of NaOH used in titration A (mL)	Conversion (X_A)	$X_A/(1-X_A)$	$C_{AO} \times t$
1	0	0.089	6.1	0.67	2.03	0
2	2	0.089	6.2	0.69	2.22	0.178
3	4	0.089	6.5	0.75	2.99	0.356
4	6	0.089	6.7	0.79	3.75	0.534
5	8	0.089	7.0	0.85	5.64	0.712
6	10	0.089	7.1	0.87	6.66	0.89
7	12	0.089	7.1	0.87	6.66	1.068
8	14	0.089	7.1	0.87	6.66	1.246
9	16	0.089	7.1	0.87	6.66	1.424

Table 1. Observation and conversion calculation.

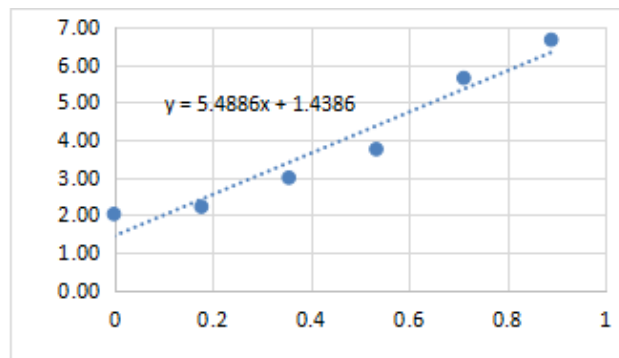


Fig1. Plot of $X_A/1-X_A$ vs $C_{AO} X_A t$

V. RESULT AND DISCUSSION

From the equation $X_A/1-X_A = k C_{AO} t$

We get $k=5.4886$ L/gmol min (rate constant at 22°C).

The maximum conversion is 87%.

From Table 1 we see that the conversion has started at 67%, it has then increased slowly and become constant at 87%. From these observations we have calculated the value of rate constant for the saponification reaction at room temperature.

VI. CONCLUSION

Here we have studied the kinetics of saponification reaction and calculated its rate constant. Table 1 is showing the values of conversion after calculations and Figure 1 is giving a straight line for the calculation of rate constant. There is scope for further investigations by changing the reaction temperature and calculation of activation energy for the reaction.

A change in reaction also gives scope for studying various reactions and calculating their activation energies.

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