Kinectics of Inversion of Cane Sugar:-

Whenever Sucrose (Can Sugar extract) is hydrolysed in presence of mineral acid we get Glucose & Fructose (which are functional group isomer to each other).

$$\underset{\substack{\text{Sucrose} \\ \text{(dextrorotation)} \\ (+66.5^\circ)}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underbrace{\underset{\substack{\text{(Glucose)} \\ \text{dextrorotation} \\ (+52.5^\circ)}}{C_6H_{12}O_6} + \underset{\substack{\text{(fructose)} \\ \text{Laevo rotation} \\ (-92^\circ)}}{C_6H_{12}O_6}}_{\text{Laevo rotatory finally.}}$$

When sucrose a dextro rotatory Compound is hydrolysed in presence of mineral acid we get Glucose (a dextro rotatory Compound) and fructose (a laevo rotatory Compound). In this reaction products are Glucose & fructose the degree of rotation shows the laevo-rotatory angle is more than dextro rotatory angle so entire product becomes laevo-rotatory, means reactant sucrose (A dextro rotatory) Compound Converts into product i.e Glucose & fructose but the entire product shows laevo rotatory result, this Conversion from dextro-rotation to laevo-rotation is called Inversion of sugars or sucrose.

We study the kinetics of this reaction by noting the angle of rotation at different interval of time by the help of polarimeter

Reading of polarimeter at zero time = r_0
Reading of polarimeter at time 't' = r_t
Reading of polarimeter at infinite time = r_∞

During experiment the reading at zero time will be positive but as time passes ultimately it becomes ~~eve~~ negative.

It has been observed experimentally that initial concentration of sucrose (a) is $\propto$ to angle of rotation at infinite time $(r_0 - r_\infty)$

hence $a \propto (r_0 - r_\infty)$ ——— (A)

Amount of sucrose hydrolysed (x) $\propto$ angle of rotation at any ~~kus~~ time moment. $(r_0 - r_t)$

hence $x \propto r_0 - r_t$ ——— (B)

By equation (A) and (B)

$$(a-x) \propto (\cancel{r_0} - r_\infty) - (\cancel{r_0} - r_t)$$

or $(a-x) \propto (r_t - r_\infty)$

When we put the above expression value of a & (a-x) in the 1st order kinetic equation we have:

$$\boxed{K = \frac{2.303}{t} \log \frac{r_0 - r_\infty}{r_t - r_\infty}}$$

Kinetics of hydrolysis of Ester: →

Hydrolysis of ester i.e ethyl acetate in presence of mineral acid gives acetic acid (ethanoic acid) & ethyl alcohol (ethanol).

$$CH_3-COOC_2H_5 \xrightarrow[+H_2O]{H^+} CH_3COOH + C_2H_5OH$$

In this reaction there is a product i.e acetic acid or ethanoic acid whose amount can be calculated by titrating it against NaOH solution. In this reaction (CH_3COOH) is acting as a auto-catalyst in the beginning. and it help to increase the rate of reaction.

Volume of NaOH used at zero time (V_0) $\propto$ Amount of acid present in reaction, as auto catalyst, do not CH_3COOH at $t=0$. or not produced. — I

Volume of NaOH solution used at any moment of time 't' (V_t) $\propto$ Amount of acid present as catalyst + Amount of CH_3COOH produced. — II

Taking help from equation I & II we have:

Amount of CH_3COOH produced at any moment of time $\propto (V_t - V_0)$ — III

or Quantity of CH_3COOH produced at any moment of time $\propto$ Quantity of $CH_3COOC_2H_5$ which has reacted (x)

So $x \propto (V_t - V_0)$ — IV

Volume of NaOH used after/during infinite time (V_∞) $\propto$ quantity of acid present as catalyst + Heighest amount of CH_3COOH ~~produced~~ produced. — V

By taking help from equation I & V we have:

Heighest amount/quantity of CH_3COOH produced $\propto$ Initial concn of $CH_3COOC_2H_5$ (a)

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So $a \propto (V_\infty - V_0)$ ——— VI

from equation IV & VI we have:

$$(a-x) = (V_\infty - V_0) - (V_t - V_0)$$

or $(a-x) = (V_\infty - V_t)$ ——— VII

Now we put the value of a, & $(a-x)$ as mentioned above in 1st order Kinetic equation, we have

$$\boxed{K = \frac{2.303}{t} \log \frac{V_\infty - V_0}{V_\infty - V_t}}$$