Experiment 2: Kinetics of acid catalysed hydrolysis of ethyl acetate

Reagents and solutions used: ethyl acetate, 0.5 N HCl, 0.2 N NaOH, phenolphthalein indicator, ice cubes

Apparatus: 50 mL burette, 5 mL pipette, 10 mL pipette, conical flasks, wash bottle, 250 mL reaction bottle

Tabulation and calculations:

S. No.	Time	Volume of 0.2 N NaOH	$(V_\infty - V_t)$	$\log (V_\infty - V_t)$	$K = \dfrac{2.303}{t} \log \dfrac{(V_\infty - V_0)}{(V_\infty - V_t)}$
	min	mL	mL		min^{-1}
1	0	27.3	24.3	1.386	0
2	10	27.8	23.8	1.377	0.00208
3	20	28.3	23.3	1.367	0.00210
4	30	28.5	23.1	1.364	0.00168
5	40	29.1	22.5	1.352	0.00192
6	50	29.5	22.41	1.344	0.00189
7	∞	51.6	–	–	–

Plot the graph between time and $\log (V_\infty - V_t)$

Time min	$\log (V_\infty - V_t)$
0	1.386
10	1.377
20	1.367
30	1.364
40	1.352
50	1.344

Calculations

1. $K_{10} = \dfrac{2.303}{10} \log \left(\dfrac{24.3}{23.8}\right) = 0.00208$

2. $K_{20} = \dfrac{2.303}{20} \log \left(\dfrac{24.3}{23.3}\right) = 0.00210$

3. $K_{30} = \dfrac{2.303}{30} \log \left(\dfrac{24.3}{23.1}\right) = 0.00168$

4. $K_{40} = \dfrac{2.303}{40} \log \left(\dfrac{24.3}{22.5}\right) = 0.00192$

5. $K_{50} = \dfrac{2.303}{50} \log \left(\dfrac{24.3}{22.1}\right) = 0.00189$

Result:

The rate constant for the hydrolysis of an ester from

1. Calculated value = 0.00193

2. Graphical value = 0.00193

3. Molecularity of the reaction = 2 (bimolecular reaction)

4. Order of the reaction = first order (pseudo first order)

Average K =

$$\frac{0.00208 + 0.00210 + 0.00168 + 0.00192 + 0.00189}{5}$$

$$= \frac{0.00967}{5}$$

$$= 0.00193 \ \text{min}^{-1}$$

Graphical value of K = 2.303 × slope

$$= 2.303 \times \frac{y_2 - y_1}{x_2 - x_1}$$

$$= 2.303 \times \frac{1.386 - 1.344}{50 - 0}$$

$$= 2.303 \times 0.00084$$

$$= 0.00193 \ \text{min}^{-1}$$

Graph: $\log(v_\infty - v_t)$ vs Time (min)

y-axis: $\log(v_\infty - v_t)$

y-axis values: 1.89, 1.88, 1.87, 1.36, 1.35, 1.34

x-axis: Time (min)

x-axis values: 0, 10, 20, 30, 40, 50, 60

X-axis

Scale

X-axis → 1 cm = 5 min

Y-axis → 4 cm = 0.01

Time (min)

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