Experiment No: 01

Name of the Experiment: Standardization of NaOH solution with standard oxalic acid solution

Course: Chem 114

Name: SYEDA RIFAH TASFIA

Roll: 1905019

Group: A1

Department: CSE

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Objectives:

The objectives of this experiment are the determination of concentration of secondary standard NaOH solution, and understanding the pH curve for acid-base titrations.

Theory:

Titration: Titration or neutralization is the process of chemical analysis in which the quantity of some constituent of a sample is determined by adding to the measured sample an exactly known quantity of another substance, with which the desired constituent reacts in a definite proportion; in presence of a suitable indicator.

The fundamental reaction in a titration is -

$$H^+ + OH^- \rightleftharpoons H_2O$$

Two protons from oxalic acid are replaced with Na^+ in two consecutive steps:

1) $\begin{matrix}COOH\\|\\COOH\end{matrix}(aq) + NaOH(aq) \longrightarrow \begin{matrix}COONa\\|\\COOH\end{matrix}(aq) + H_2O(l)$

2) $\begin{matrix}COONa\\|\\COOH\end{matrix}(aq) + NaOH(aq) \longrightarrow \begin{matrix}COONa\\|\\COONa\end{matrix}(aq) + H_2O(l)$

(+) $\begin{matrix}COOH\\|\\COOH\end{matrix}(aq) + 2NaOH(aq) \longrightarrow \begin{matrix}COONa\\|\\COONa\end{matrix}(aq) + 2H_2O(l)$

Indicator: An indicator is a chemical substance that detects the equivalent point of titration by changing its color. For example, litmus, methyl orange, phenolphthalein etc.

Equivalent Point: The point in a titration when a stoichiometric amount of reactant has been added.

Normality: The number of gram equivalent weight of a solute per liter of solution is called normality.

Normality (N) = gm equivalent of solute / liter solution

In this experiment, we will use the formula

$$V_1N_1 = V_2N_2$$

Apparatus:

① Burette
② Pipette
③ Conical flask
④ Volumetric flask
⑤ Stand
⑥ Wash bottle
⑦ Electronic balance

Name of the Chemicals used:

① Sodium Hydroxide ($NaOH$)
② Oxalic Acid ($HOOC-COOH$)
③ Phenolphthalein (Indicator)

Data Collection:

Table: Data for determining the Volume of oxalic acid

No.	Volume of NaOH soln taken (mL)	Burette Reading (mL)		Difference (mL)	Average volume of $(COOH)_2$ (mL)
		Initial	Final		
1	10	a	b	(b-a)	$\frac{(e-a)}{4}$
2		b	c	(c-b)	
3		c	d	(d-c)	
4		d	e	(e-d)	

Calculations:

We know, $V_1 N_1 = V_2 N_2$

V_1 = Volume of $(COOH)_2$ solution = $\frac{(e-a)}{4}$ mL

N_1 = Concentration of $(COOH)_2$ solution = 0·1 N

V_2 = Volume of NaOH solution = 10 mL

N_2 = Concentration of NaOH solution = ?

$$\therefore N_2 = \frac{V_1 N_1}{V_2} = \frac{\frac{(e-a)}{4} \times 0{\cdot}1}{10} \text{ N}$$

$$= (e-a) \times 2{\cdot}5 \times 10^{-3} \text{ N}$$

Result:

Determined concentration of NaOH solution, $N_2 = (e-a) \times 2{\cdot}5 \times 10^{-3}$ N

Error Calculation:

Standard value = 0·1 N

Experimental value = $(e-a) \times 2{\cdot}5 \times 10^{-3}$ N

$$\therefore \% \text{ of error} = \frac{|\text{known value} - \text{observed value}|}{\text{known value}} \times 100$$

$$= \frac{|0{\cdot}1 - (e-a) \times 2{\cdot}5 \times 10^{-3}|}{0{\cdot}1} \times 100$$

$$= |100 - (e-a) \times 2{\cdot}5|$$

$\therefore$ Error = $\{|100 - (e-a) \times 2{\cdot}5|\}$ %

Discussion:

In this experiment, there are a few precautions needed to be taken in order to minimize error. The burette readings are to be observed properly. The meniscus of the solution is the surface that is to be measured. We have to keep a close eye on the solution to catch the exact moment when it changes color. However, despite all the precautions, some error is inevitable. This can occur due to mechanical errors.

Questions:

① Oxalic acid is the primary standard substance in this experiment. A primary standard substance is one that is very pure, does not react with the components of atmosphere, easily measurable and the concentration of its solution remains unchanged for a long time. When a substance does not have one or more than one of these characteristics, then it is called a secondary standard substance. Oxalic acid satisfies all these conditions, thus it is a primary standard. As for NaOH, it reacts with the moisture in the atmosphere and

dilutes itself, changing its concentration. That is why it's a secondary standard substance.

② In this experiment, Phenolphthalein is chosen as the suitable indicator. For phenolphtelein,

Coloring		pH interval of the color change
Acidic medium	Basic medium	
Colorless	Pink	8.0 - 9.8

Since the pH is in the basic range, this indicator is neutralized in an acidic solution and becomes colorless. It gives pink color in basic solution. In this experiment, NaOH is a strong base and Oxalic acid is a weak acid. So the end point of titration resides in a basic range, and phenolphthalein turns ~~pink~~ pink. Thus phenolphthalein is the suitable indicator to determine the equivalent or end point of this reaction.

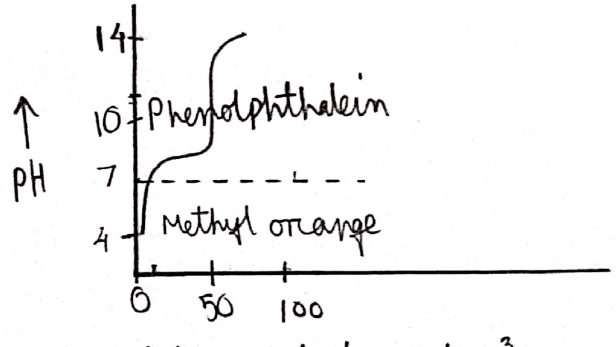

Fig. 1 - Titration curve of strong base with weak acid