Laboratory of Analytical chemistry

Lab. of the first stage
2023-2024

Determination of the percentage of acetic acid in a vinegar sample

Objective of experiment: to determine the percent acetic acid (CH_3COOH) in a commercial vinegar sample by standardization of a solution.

Vinegar can be defined as a solution composed of **acetic acid**, water and perhaps other substances, (concentration of the other substances are usually low compared with the concentration of acetic acid).

Determination of acetic acid percentage in commercially available white vinegar is one of the simplest and easiest titrations.

Scientific principle:

In this experiment, we will determine the percentage of acetic acid in vinegar. A known volume of vinegar will be measured out and titrated with a solution of sodium hydroxide (NaOH) of known concentration (0.1N).

Acetic acid reacts with sodium hydroxide, according to the reaction :

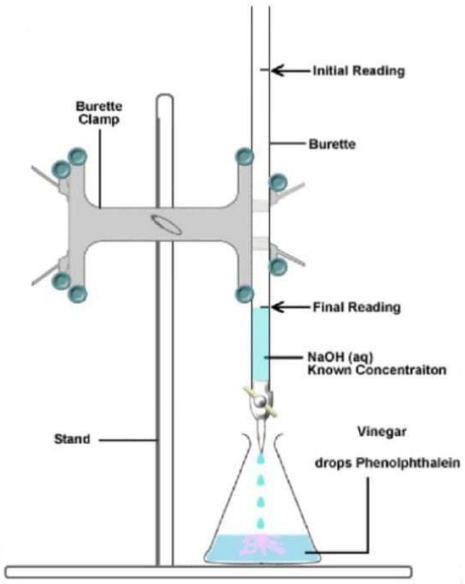
$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

Chemicals:

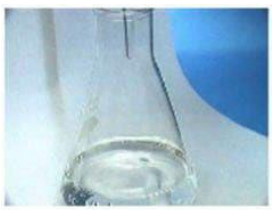
1. Standardized NaOH solution (0.1N)
2. Unknown Vinegar solution
3. Distill Water
4. Phenolphthalein indicator

Note: The normality of NaOH must be determined by titration with standard HCl solution (mentioned before).

Procedure:



1- Wash and fill the burette with 0.1 N NaOH solution.
2- Transfer 10 ml of unknown (white vinegar) into 100 ml volumetric flask, complete the volume with distilled water, stopper the flask and shake well.
3- Take 10 ml of the prepared solution and transfer it into a clean washed conical flask.
4- Add 2 drops of Phenolphthalein indicator into the conical flask.
5- Start titration by the adding the Sodium hydroxide solution from the burette gradually into the titration medium (the solution in the conical flask) with continuous stirring for the titration medium till the color changes from colorless to faint pink. Notice carefully the final reading on the burette.


In acidic solution


In basic solution

6- Repeat the experiment (at least 3 times), till you get concordant readings, and then take the average volume.

Data	Trial 1	Trial 2	Trial 3
Initial burette reading (ml)			
Final burette reading (ml)			
Volume of NaOH consumed (ml)			
Average of the volume NaOH (ml)			

7- Calculate the percent of acetic acid in vinegar.

- At end point

Meq. (base) = Meq. (acid)

Calculations:

1) Firstly, by application of $N_1 V_1 = N_2 V_2$, we will get the weight (gm) of acetic acid in 10 ml of the diluted unknown:

$$N_1 V_{1(NaOH)} = N_2 V_{2\,(HOAc)}$$

$$N_1 V_{1\,(NaOH)} = \frac{wt(HOAc)}{eq.wt} \times \frac{1000}{V\ ml} \times V_{\ ml}$$

$$N_1 V_{1\,(NaOH)} = \frac{wt(HOAc)}{eq.wt} \times 1000$$

$$Wt_{\,(HOAc)} = \frac{N \times V(NaOH) \times eq.wt(HOAc)}{1000}$$

2) After that, we can get the **wt/v%** of acetic acid :

$$wt/v\%_{\,(HOAc)} = \frac{wt\ (HOAc)}{V\ (sample)} \times 100$$

3) The **wt/wt%** of acetic acid can be obtained through :

wt/v% = wt/wt% x sp. gr.

$$\text{wt/wt\%}_{(HOAc)} = \frac{wt/v\%\ (HOAc)}{sp.gr.(HOAc)}$$

Hint: sp. gr. of acetic acid = 1.049

4) All these amounts will be multiplied by **10**, to get the respective amounts in original vinegar bottle.

Note: It is also possible to determine concentration of acetic acid in other types of vinegar like apple vinegar, balsamic vinegar, black vinegar, …etc. (the only problem is that the color of the vinegar can make it difficult to spot the end point).

Safety

Person who prepare the NaOH solution should be especially careful when handling the sodium hydroxide solid base (NaOH), as it is corrosive and can cause chemical burns to the skin.

H.W:

- What would be the effect on the percent acetic acid if 30 ml of vinegar had been used in place of 10 ml ? Explain.

- Why is more than one accurate titration carried out ?

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