BATNA2 University
Faculty of Natural and Life Sciences (L1)
Academic year 2023-2024

Lab Practical 3: Titration of a weak acid (Acetic acid in vinegar) by a Strong base

❖ Objectives

At the end of this lab practical, the student will be able to:

- **Recognize** the titration process.
- **To follow** changes in coloration during titration while adding a strong base to a weak acid.
- **Carry out** a colorimetric titration according to an experimental technique.
- **Identify** the Equivalence point.
- **Calculate** the unknown vinegar concentration.

❖ Principle

The principle of this experiment is to determine the percentage of acetic acid, also known as the total acidity, that is stated on the bottle of vinegar.

I- Theoretical part

I-1-Definitions

➢ **A weak acid**

- dissolve incompletely and do not give all their protons in a solution.
- have a greater pKa than strong acid, which liberates all hydrogens in water.

➢ **Vinegar definition**

- Is an acidic liquid, which is made both naturally and synthetically, from the oxidation of Ethanol, CH_3CH_2OH. It has been used since ancient times as an important cooking ingredient,
- The important component of vinegar is acetic acid, CH_3COOH (systematic name: ethanoic acid).

➢ **The percentage of acidity (X°)** is measured in grams of acetic acid per 100 ml of vinegar.

Ex: 5° vinegar has 5 g acetic acid per 100 ml.

$$X° = C_m/10$$

C_m: mass concentration.

➢ **Vinegar Titration**

The amount of acetic acid in the vinegar will be measured using titration.

In a titration, a known-concentration solution (the titrant) and an unknown-concentration solution (the analyte) are subjected to a controlled reaction. Here, **<u>diluted vinegar</u>** serves as the analyte, and sodium hydroxide (NaOH) is used as the titrant. The acetic acid in vinegar and sodium hydroxide combine to produce a neutralizing reaction.

I-2- Acid-base titration

➢ **Titration reaction**

$$CH_3COOH(aq) + NaOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(l)$$

(acid) + (base) ⟶ (salt) + (water)

- **Use of indicator to obtain the equivalence point**
  - The equivalence point is reached by adding NaOH base to vinegar (acetic acid).
  - Just enough base has been added to react with all the acid.
  - Add a few drops of phenolphthalein solution to the Erlenmeyer flask to find the equivalence point.
  - Phenolphthalein is colorless in acidic environments and pink in basic environments.
  - Acid makes the solution colorless. When the solution is slightly pink, it means enough base has been added to react with all the acid. This color change is the titration equivalent point.

To calculate the concentration of the diluted solution of acetic acid in vinegar we use the formula:

$$N_{Diluted\ acid} \times V_{Diluted\ Acid} = N_{Base} \times V_{Base} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$N_{Diluted\ acid}$: unknown normality of diluted acid in the Erlenmeyer flask.

N_{Base}: known normality of base in the burette.

$$N = x \times C \ (x = 1)$$

Equation (1) becomes as follows: $C_{Diluted\ Acid} \times V_{Diluted\ acid} = C_{Base} \times V_{Base}$.

$$C_{Diluted\ Acid} = C_{Base} \times V_{Base} / V_{Diluted\ acid}$$

C_{Base}: known concentration of **NaOH** in the burette.

$C_{Diluted\ Acid}$: unknown concentration of diluted acid CH_3COOH solution in the Erlenmeyer flask.

- To calculate the concentration of a concentered solution (vinegar), we use the formula:

$$C_{Concentred\ acid} = f \times C_{Diluted\ Acid}$$ **(f: dilution factor)** (5%, f = 100/5 = 20).

- To calculate the mass concentration, we use the formula:

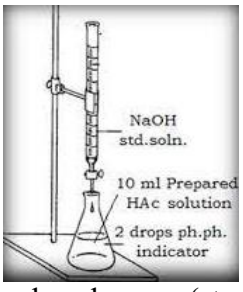
$$C_m = M_{CH3COOH} \times C_{Concentred\ acid}$$

$M_{CH3COOH} = 2M_C + 2M_O + 4M_H = (2\times12) + (2\times16) + (4\times1) = 24+32+4 = 60$ g/mol.

I- Practical part (Experimental protocol)

Material	Products
- Erlenmeyer flask, - graduated cylinder - Graduated burette, -Funnel.	- NaOH solution, -CH_3COOH solution. - Colored Indicator, Distilled water.

To begin the experiment, carefully:



- Measure 5 ml of 5% diluted vinegar solution using a graduated cylinder.
- Transfer the measured volume to an Erlenmeyer flask.
- Add 1-2 drops of colored indicator (phenolphthalein).
- Fill the burette with 0.05 mol/L NaOH solution.
- Titrate the acid solution by adding NaOH solution drop-by-drop until the color changes (stop at the first permanent pale pink color).
- Take note of the volume of NaOH poured at the equivalency point.

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Report

The report must contain:

-A cover page according to the model below.

- A detailed response to the questions at the end of the Lab Practical session.

Dr. Ferhat M. and Dr. Bencherchar I.