MANIPULATION N°5

Titration of vinegar

Acid/base titration (Application to the titration of commercial vinegar)

1- Introduction :

*Vinegar is a wine (alcohol) made sour by acetic fermentation and used as a condiment or preservative. Vinegar is considered to be an aqueous solution of acetic acid with a **density (d)** of about **1**. The objective of this practical work is to determine the **degree of acidity D** or (°) of a vinegar, defined as the **mass** of **pure** acetic or ethanoic acid contained in **100g of solution**. To do this, the acetic (**ethanoic**) acid contained in a known volume of vinegar will be determined using a strong base solution of **known** concentration: sodium hydroxide solution (**NaOH**).*

*During titration, the concentration of the titrating solution (in this case **NaOH**) must be known precisely. In most cases, however, the concentrations of the solutions are not strictly accurate because:*

- *the solution is prepared from a solid product, the purity of which is not guaranteed by the manufacturer.*
- *the solution is prepared from a product whose sampling (weighing, volume) cannot be precise.*
- *the chemical composition of the solution changes over time.*

2- The degree of acidity of the vinegar (D) or (°):

*The degree of a vinegar **D** is the same number as the **mass**, in **grams**, of **pure** ethanoic acid contained in **100g** of **solution**.*

*The degree of acidity of the commercialised vinegar is indicated on each bottle. **1%** acidity corresponds to **1g** of ethanoic acid in **100g** of vinegar solution. The percentage of acidity therefore corresponds to a percentage by mass.*

*For a volume of **100g** of vinegar: (**Ac**: acetic acid)*

$m_{Ac} = n_{Ac} \times M_{Ac} = C_a \times V_a \times M_{Ac}$ *from the formula* $n = C \times V$

For vinegar we also have : $\rho = m/V$ *so* $V = m/\rho$ *:* $m_{Ac} = \frac{m}{\rho} \times C \times M_{Ac} = \frac{100}{\rho} \times C \times M_{Ac}$ ***(g)***

$$\text{Degree of acidity} = D° = m_{Ac} = \frac{100}{\rho} \times C \times M_{Ac}$$

***Example**: vinegar at **6°** contains **6g** of **pure** acetic (ethanoic) acid per **100g** of **vinegar** solution.*

3- Objective of the practical work (TP) :

- *How to control the quality of a product by titration.*
- *Products tested: different types of commercial vinegar.*

4- *Experimental part :*

- ***Titration of commercial vinegar (acetic acid) :***

Materials: *Burette, Erlenmeyer flask, beaker, Graduated cylinder , wash bottle, distilled water, NaOH solution (0.1N), different types of commercial vinegar (CH_3-COOH) and colour indicators.*

1- Preparation of the dilute vinegar solution:

1- *Using a pipette, take precisely 10 mL of commercial white vinegar.*
2- *Put it in a 100 mL volumetric flask.*
3- *Complete with distilled water to the mark.*
4- *Cap the flask and agitate to homogenise the solution.*

2- Titration in the presence of phenophthalein :

1- *Rinse the equipment. Burette, Erlenmeyer flask, etc.*
2- *Fill the burette with the **NaOH** solution of concentration (**N_B= 0.1N**).*
3- *Take (**V_A=10 ml**) of the (**CH_3-COOH**) solution and place it in a 100 mL Erlenmeyer flask.*
4- *Add about **20 mL** of distilled water.*
5- *Add **2 drops** of the colour indicator: **phenolphthalein**.*
6- *Make a rapid titration to estimate the volume of equivalence (**V_B**).*
7- *Record the volume **V_B** of (**NaOH**) added.*
8- *Using a pH paper or pH meter, read the pH of the solution every 2ml until coloured.*
9- *Make 2 titration tests.*

$$M_{CH3-COOH} = 60\ g.mol^{-1}\ ,\ \rho = 1{,}01\ kg.L^{-1}$$

3- Résultats et calculs :

1- *Write down the reaction equation:*
2- *Note the volume **V_B** of (**NaOH**) added and determine the concentration **C_A** of (**CH_3-COOH**).*
3- *Calculate the initial molar concentration **C_0** of the ethanoic acid (commercial vinegar).*
4- *Calculate the degree of acidity of the vinegar (**D**) and compare this result with that on the sticker on the bottle of commercial vinegar.*
5- *Draw the graph representing the value of **pH= f(V_B)** on millimetric paper.*
6- *Determine the volume **V_E** and the **pH** at equivalence using the graph.*
7- *Which of the coloured indicators in the table below is best adapted for identifying equivalence. **Justify your answer**.*

Indicator	*Acidic colour*	*Transition zone*	*Basic colour*
Helianthine	*Red*	*3,1 - 4,4*	*Yellow*
Methyl red	*Red*	*4,2 - 6,2*	*Yellow*
Bromothymol blue	*Yellow*	*6,0 - 7,6*	*Blue*
Phenolphthalein	*Uncoloured*	*8,2 - 10,0*	*Pink-violet*

8- *Why is distilled water **added**? Does the addition of distilled water **change** the volume **V_E** added at equivalence?*

1 - *Write down the reaction equation :*

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2- *Note the volume* V_B *of (NaOH) added and determine the concentration* C_A *of* (CH_3-$COOH$).

The volume of (NaOH) ? : (V_B = ...*)*

The concentration C_A *? :* ....

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3- *Calculate the initial molar concentration* C_0 *of the ethanoic acid (commercial vinegar).*

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4- *Calculate the degree of acidity of the vinegar (**D**)*

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Compare this result with that on the sticker on the bottle of commercial vinegar.

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5- *Draw the graph representing the value of* **pH= f(**V_B**)** *on millimetric paper.*

6- *Determine the volume* V_E *and the* **pH** *at equivalence using the graph.*

(V_E *,* **pH** *) = (*..........*)*

7- *Which of the coloured indicators in the table below is best adapted for identifying equivalence.* ***Justify your answer***.

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8- *Why is distilled water* ***added****? Has this addition* ***changed*** *the volume* V_E *poured at equivalence?*

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Group: .... **Note**: /

Draw the graph representing the value of ***pH= f(V_B)*** *on millimetric paper.*

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