Experiment Number: - 03
Name of the Experiment: -
Standardization of Hydrochloric Acid with Standard Sodium Carbonate Solution

Course: CHEM-114

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Objective:-

The theme of this experiment is to determine the strength of a given Hydrochloric acid with a standard Sodium Carbonate solution. The neutralization reaction takes place into two steps. So we have to use two indicators that are 'Phenolphthalein' and 'Methyl Orange' to determine the two end point of this reaction.

Theory:-

In this experiment we shall determine the strength of commercial Hydrochloric Acid solution by a secondary standard solution of Na2CO3. This is done by means of 'Titration'. The important matters that are related with the experiment are stated below:

Titration:-

In presence of a suitable indicator, the volumetric analysis in which a standard solution is added in another solution (whose strength is not known) to reach its end point to determine the strength of that solution is called 'titration'.

Standard Solution:

A solution of known concentration is called a 'standard solution'.

Indicator:-

In our acid-base titration there is an important use of indicator. An 'indicator' is a chemical substance that detects the equivalent point (i.e. the end point) of reaction by changing its color. Indicators have different structures in acidic and in basic solution.

Equivalent Point:-

The 'equivalent point' is 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 litre of solution is called normality.

Normality (N) = gm equivalent of solute /litres per solution.

It is known to us that both alkalimetry and acidimetry are based on neutralization reaction. If an acid-base reaction is such like that,

$$a\ ACID + b\ BASE = PRODUCT$$

then we know that

$$V_{base} \times S_{base} = V_{acid} \times S_{acid}$$

so, $$S_{acid} = (V_{base} \times S_{base}) / V_{acid}$$

here 'V' represents the volume and 'S' represents the strength of the substance.

Reaction:

Neutralization reaction between Na_2CO_3 and HCl acid takes place into two steps-

$$Na_2CO_3 + 2HCl \Rightarrow NaHCO_3 + 2NaCl$$
$$NaHCO_3 + HCl \Rightarrow NaCl + H_2CO_3$$

The ultimate reaction,

$$Na_2CO_3 + 2HCl \Rightarrow 2NaCl + H_2CO_3$$

In the first step, the solution is basic due to the formation of a salt where the basic part is stronger than the acidic part ($NaHCO_3$).So, in order to determine the equivalent point of this reaction Phenolphthalein is used. As the salt that forms due to the neutralization reaction, produces more OH^-, so the solution becomes a basic one and thus it have a pH range above 7. We know that the working environment needed for phenolphthalein is basic; thus phenolphthalein becomes the perfect indicator for determining the end point of the first step of the reaction.

In the second reaction, NaCl and Carbonic Acid is formed. Because of the presence of Carbonic Acid in the solution, it becomes acidic. So, 'Methyl Orange' (pH range 2.9-4.6) is used as indicator to determine the equivalent point.

Name of the Indicator pH RangeColour in Alkaline solutionColour in Acid solution Phenolphthalein8.3 - 10.0PinkColourlessMethyl Orange2.9 - 4.6YellowPink***Apparatus:-***

1. Conical flask
2. Burette
3. Pipette

4. Volumetric flask
5. Stand
6. Funnel

Indicator:-

1) Phenolphthalein
2) Methyl Orange

Chemical Reagents:-

1) Standardized Na_2CO_3 solution
2) HCl solution
3) Distilled water

Experimental Data:-

Standardization of HCl acid with standard Na_2CO_3 solution

Number of Obser--vation	Volume of Na_2CO_3 in ml	Burette reading in ml			Volume of Acid in ml	Average Reading in ml
		Initial reading	first end point	Second end point		
01.	10	0	3.6	6.7	6.7	
02.	10	6.7	10.4	14.4	7.7	7.75
03.	10	14.4	17.8	22.2	7.8	
04.	10	22.2	25.8	29.3	7.1	

Weight of Na_2CO_3 in gram=.508 gm.

Calculation: -

Strength of Na_2CO_3 = (.508 X 1000)/(106 X100)
= 0.0488 M.

We know that, V acid X S acid = V base X S base

Determination of the normality of HCl :--

Here,

V base = 10 ml
S base = 0.0488 M
V acid = 7.75ml
S acid = ?

So, S base = (10 X 0.0488)/7.75 M
= 0.15092N

we also know, V concentrated X S concentrated = V dilute X S dilute,

Here,

V HCl(concentrated) = 1.3ml
S HCl(concentrated) = ?
V HCl(dilute) = 100 ml
S HCl(dilute) = 0.15092 N

so, S HCl(concentrated) = (100 X 0.15092) / 1.3
= 11.61 N

Result:-

The strength of the supplied HCl (concentrated) is : 11.61 N

Percentage of error:-

Percentage of error = (known value - observed value) X 100 ÷ known value
= (11.61-11.45) X 100 /11.45
= 1. 39%

so, Percentage of error = 1.39%

Discussion:-

The following causes can be assumed for the possible cause of error:
While the solution of Na2CO3 was prepared, a little amount of extra water might have been added into the volumetric flask, this can be one of the reasons.

If these causes could be avoided we could have get a perfect result of the concentration of Commercial Hydrochloric Acid.