

Introduction

A method in which we determine the point where reaction is completed with the help of conductometer that measures the changes in conductance of solution produced by the ions in the solution. Conductometer works on the principle of ohm's law. If we are to find the strength of an acid then we take that acid into a beaker and dip the electrode of conductometer into the acid solution. This measures the conductance of acid. Now, we titrate this acid solution against the base of known molarity, the conductance starts decreasing. This is due to the binding of H^+ ions of acid with the OH^- of Base until a point is reached where conductance is minimum. When we move forward the conductance starts increasing again. This is now due to the free ions of Base present in solution.

This point at which this transition occurs is called Equivalence point. At Equivalence point we measure the volume of base used to neutralize the acid ions completely in the solution. Putting these values in formula we can get the strength of acid.

To Find out the strength of an Acid using Conductivity Method

They ask thee about the (final) Hour— when will be its appointed time? Say: "The knowledge thereof is with my Lord (alone): none but He can reveal as to when it will occur. Heavy were its burden through the heavens and the earth. Only, all of a sudden will it come to you. They ask thee as if thou wert eager in **search** thereof: Say: "The knowledge thereof is with Allah (alone), but most men know not." (**Al-Araf** [7:187])



Conductance

“The conductivity of a solution depends on the ions that are present in it. During many titrations, the conductivity changes significantly.”

Explanation:

The total conductance of the solution depends also on the other ions present in the solution (such as counter ions). Not all ions contribute equally to the conductivity ; this also depends on the mobility of each ion and on the total concentration of ions. Thus , predicting the change in conductivity is harder than measuring it.

Example:

For instance , during an acid-base titration , the H^+ and OH^- ions react to form neutral H_2O .

Experiment

To find the Strength of an acid using conductivity method

Principle:

Basic principle is the changes in conductivity of a solution when no. of ions that are the responsible for the conduction of electricity is changing.

Explanation:

Conductance:

This is the method in which the capability of analyte **to conduct an electrical current** is monitored from **ohm's law**.

Ohm's law says that...

$$V = IR$$

V = VOLTAGE

I = ELECTRIC CURRENT

R = ELECTRICAL RESISTANCE

CONDUCTOMETRIC TITRATION

The conductance method can be employed to follow the course of a titration, provided that there is a significant difference in conductance between the original solution and the reagent of the product of reaction. It is not necessary to know the cell constants, since relative values are sufficient to permit locating the equivalence point.

The conductance produced by an ion is proportional to its concentration (at constant temperature), but the conductance of a particular solution will in general not vary linearly with added reagent, because of the dilution effect of water being added along with reagent added. Hydrolysis of reactants or products, or partially solubility of a precipitated product, will also cause departures from linearity.

The shape of the titration curve can be predicted easily. The concentration of each ion at any point in the titration is calculated by the usual methods based on stoichiometry, equilibria, and dilution.

Theory

The conductance of the solution mainly depends on two factors

1. Size of the ions

The conductivity of the solution is inversely proportional to the size of the ions. If the size of the ions is increasing then the conductivity of the solution will decrease because the mobility of the ions will decrease by increasing the size of the ions. So the mobility of the hydrogen ions will be greater than the sodium ions so the conductance of the solution containing sodium ions will be less than the solution containing hydrogen ions. Same principle is used here in this experiment, initially solution contains the hydrogen ions when this solution

is titrated against the base solution, the base reacts with the acid and the number of the hydrogen ions go on decreasing. Finally a stage reaches when there is no hydrogen ion in the solution so the conductivity decreased and remains constant. If further base is added then the number of negative ions increases and the conductivity go on increasing. The point at which the conductivity becomes constant is the equivalence point. The volume of base used at equalance point is used to calculate the molarity of acid and then the strength of acid. Consider a solution of a strong acid, hydrochloric acid, HCl for instance, to which a solution of a strong base, sodium hydroxide NaOH, is added. The reaction occurs. For each amount of NaOH added equivalent amount of hydrogen ions is removed. Effectively, the faster moving H^+ cation is replaced by the slower moving Na^+ ion, and the conductivity of the titrated solution as well as the measured conductance of the cell fall. This continues until the equivalence point is reached, at which we have a solution of sodium chloride, NaCl. If more base is added an increase in conductivity or conductance is observed, since more ions are being added and the neutralization reaction no longer removes an appreciable number any of them. Consequently, in the titration of a strong acid with a strong base, the conductance has a minimum at the equivalence point. This minimum can be used instead of an indicator dye to determine the endpoint of the titration. Conductometric titration curve that is a plot of the measured conductance or conductivity values against the number of milliliters of NaOH solution

2. Temperature:

By increasing the temperature, the mobility of the ions in the solution will increase. So temperature has a direct effect on conductance of solution. E.g. by increasing the temperature the conductance will increase and vice versa.

Procedure

1. 100 ml of acid was taken in beaker.
2. Solution was kept at room temperature for at least 10 minutes.
3. Then Dip the electrode of conductometer in solution.
4. Measure the initial conductance of solution.
5. First reading of conductometer was noted.
6. Then this solution was titrated against the Base solution of known strength using burette.

7. Observe the change in conductance of acid solution after every 5 ml addition of base.
8. Plot these values to find the equivalence point.
9. Volume of base used till the equivalence point is the volume which is required to fully neutralize the acid.

Calculations

Acid **Base**

$$M_1 V_1 = M_2 V_2$$

$M = \text{molarity}$

$v = \text{volume used}$

$$M_1 = \frac{M_2 V_2}{V_1}$$

Volume of Base used (mL)	Conductance
0	28.2
5	28
10	27.7
15	27.2
20	26.6
25	21.8
30	20.6
35	19.4
40	18.6
45	17.6
55	16.6
65	13.6
75	12
85	10.6
95	9
105	7.8
110	7.2
115	6.6
120	6
130	5

135	5.1
140	5.3
150	5.9
160	6.3
170	6.8
185	7.4

$$M_1 = \frac{M_2 V_2}{V_1}$$

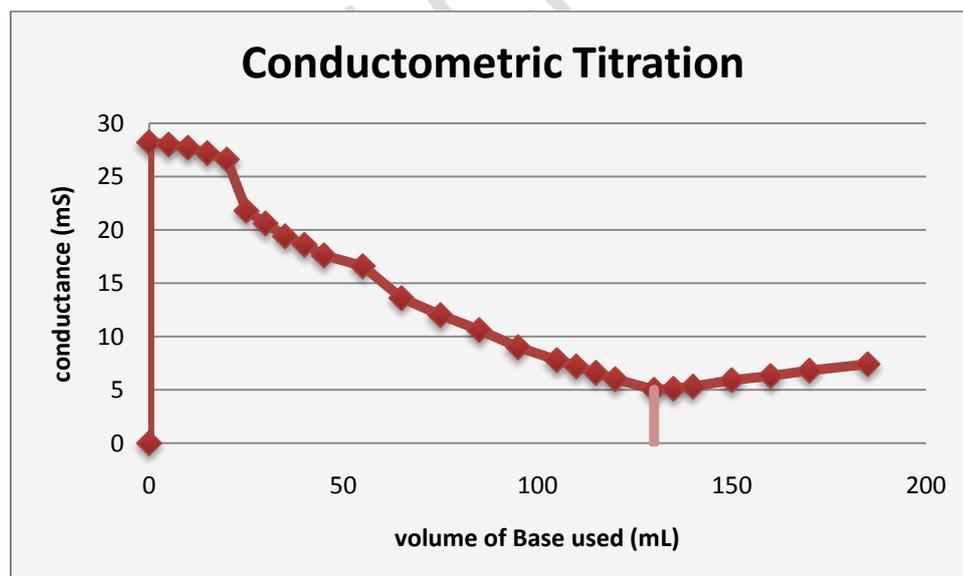
$$M_1 = \frac{0.1 \times 130}{100} M$$

$$M_1 = 0.13 M$$

Strength of acid = molarity x molecular wt.

$$= 0.13 \times 36.5 = 4.745 \text{ g/mL}$$

GRAPHICAL REPRESENTATION



APPLICATIONS OF CONDUCTOMETRIC TITRATIONS

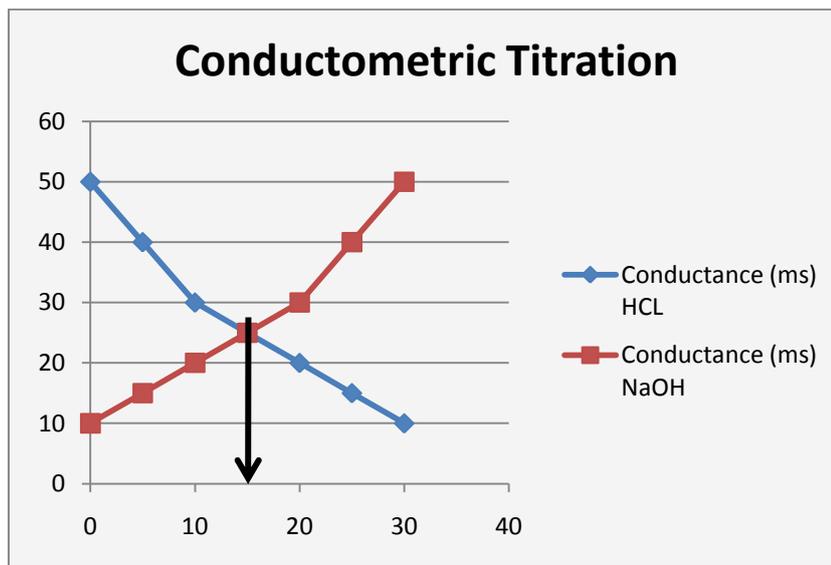
Acid-base titrations redox titrations are known to us in which commonly indicators are used to locate the end point e.g., methyl orange, phenolphthalene for acid base titrations and starch solutions for iodometry type redox process. However electrical conductance measurement can be used as a tool to locate the end point.

- This method can be used with much diluted solutions
 - This method can be used with colored or turbid solutions in which end point can not be seen by eye
 - This method can be used in which there is no suitable indicator
 - has many applications, i.e. it can be used for acid base, redox, precipitation, or complex titrations
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- ❖ Determination of sulphur dioxide in air pollution studies
 - ❖ Determination of soap in oil
 - ❖ Determination of accelerators in rubber
 - ❖ Determination of total soap in latex
 - ❖ Specific conductance of water

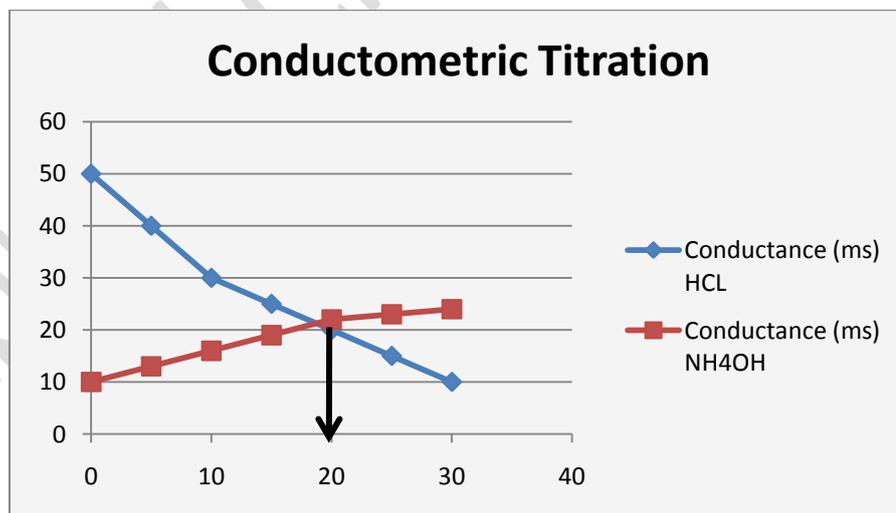
TYPES OF CONDUCTOMETRIC TITRATION

GRAPHS

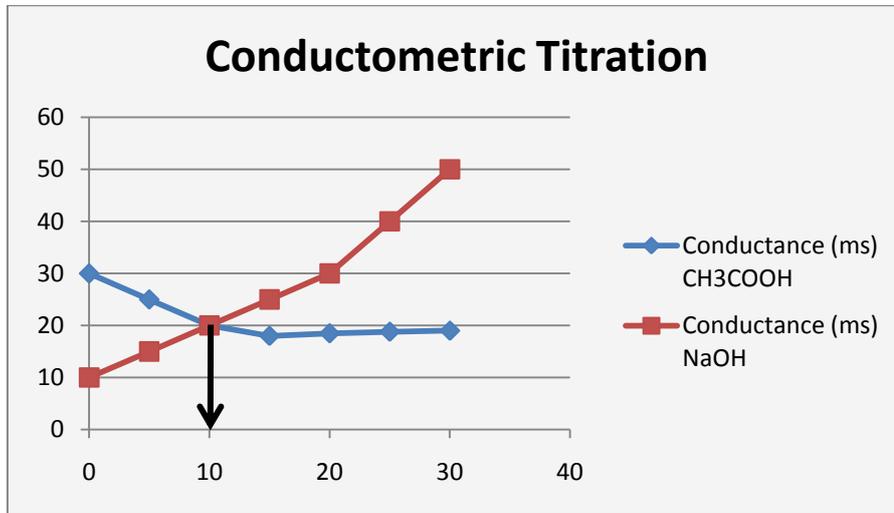
Strong Acid-Strong Base



Strong Acid-Weak Base



Weak Acid-Strong Base



Weak Acid-Weak Base

