**Experiment no 7**

**OBJECT:**To determine the strength of an unknown HCl solution by titrating it against a base (NaOH) using conductivity meter/

**APPARATUS REQUIRED:** Conductivity meter, Conductivity cell, Beaker, Titrating flask Burette, pipette, glass rod etc.

**REAGENTS REQUIRED:** Standard N/ Oxalic acid solution.

HCl solution- unknown.

NaOH solution- Intermediate solution.

**THEORY:**

Conductivity measurements find application inwater treatment, leakage detection and interface detection.

Conductivity is a measure of the ability of a solution to carry electric current. The units are mho or siemens. C = I / R, where C=conductance, R= resistance.

We know that Rα l/a or R=ρ./a where ρ is a constant and is known as specific resistance of the material of the conductor.The inverse of specific resistance is known as specific conductance and is designated as K(Kappa).

K=1/ρ = l × 1

a R

Specific conductance is the conductance of one cm cube of the material. But l/a is cell constant so multiplying the measured conductance by cell constant, value of specific conductance is obtained.

When hydrochloric acid solution (HCl) is titrated with sodium hydroxide solution (NaOH), the highly mobile hydrogen ions (λ°H+ = 350 ohm–1 cm–1) are progressively replaced by slower moving sodium ions (λ°Na+ = 50 ohm–1 cm–1) and the conductance of the solution decreases. After the end point, the conductance of the solution rises sharply due to the presence of excess, highly mobile hydroxide ion (λ°OH- = 198 ohm–1 cm–1). Thus the neutralization of a strong acid by addition of a strong base leads to a minimum conductance at the end points. This is due to the disappearance of H+ ions and their replacement by slower moving Na+ ions of the base followed by the presence of highly mobile OH–ions after the end point.

Therefore the nature of the plot (conductance of the solution versus volume of base added) will be as given below:

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**REACTION INVOLVED**:

**H+Cl- (aq)+Na+OH- (aq)→ Na+Cl- (aq)+ H2O**

A graph is plotted between volume of NaOH added and the conductance of solution. The exact end point is intersection of the two curves.

Conductance

Volume of NaOHadded (ml)

**PROCEDURE:-**

**(i)Standardization of NaOH solution:**

The burette is filled with intermediate NaOH solution.

10 ml of the oxalic acid is pipette out into a clean conical flask.

Add 1-2 drop of phenolphthalein indicator.

Titrate with NaOH solution till pink color appears which is end point, take concordant reading=A ml.

1. **Conductometric titration:**

Switch on the conductivity meter, warm it up and adjust knob at room temperature.

Calibrate the conductivity meter

Take 50 ml of unknown HCl solution in clean beaker.

Immerse the conductivity cell in the HCl solution so that the electrodes completely dip in solution.

Take conductance of HCl

Add 1 ml of NaOH solution from burette. Stir with help of glass rod and measure the conductance

This process (addition of 1ml NaOH) is done till equivalence point is reached and a increase in conductance is observed after equivalence point (at least 10 readings)

Plot the graph between the observed conductance values against the volume of NaOH added.

The point of intersection gives the amount of NaOH required for neutralization of HCl= B ml. (graph)

**OBSERVATION TABLE:**

1. **Standardization of NaOH solution:**

| **S.No.** | **Volume of oxalic acid (ml)** | **Burette Reading (ml)**  **Vol. of NaOH consumed** | | **Difference in reading**  **(b-a) ml** | **Concordant**  **Reading A ml** |
| --- | --- | --- | --- | --- | --- |
| **Initial (a)** | **Final (b)** |
| **1.** |  |  |  |  |  |
| **2.** |  |  |  |  |
| **3.** |  |  |  |  |

1. **Conductometric Titration:**

| **S.No.** | **Volume of NaOH solution added from burette (ml)** | **Conductance (mhos)** |
| --- | --- | --- |
| **1.** |  |  |
| **2.** |  |  |
| **3.** |  |  |
| **4.** |  |  |
| **5.** |  |  |
| **6.** |  |  |
| **7.** |  |  |
| **8.** |  |  |
| **9.** |  |  |
| **10.** |  |  |
| **11** |  |  |
| **12** |  |  |
| **13** |  |  |

**CALCULATION:**

1. **Standardisation of NaOH solution:**

**N1V1= N2V2** N1= Normality of NaOH solution=?

(NaOH) (Oxalic Acid) V1= Volume of NaOH solution consumed =A

N2= Normality of oxalic acid

V2= Volume of oxalic acid taken =10ml

N1= (N2V2)/V1

**Strength of HCl solution:**

**N3V3 = N4V4** N3= Normality of HCl=?

(HCl) (NaOH) V3=Volume of HCl taken 50 ml.

N3 =N4V4 N4=Normality of NaOH solution= N1

V3 V4=Volume of NaOHsolutionconsumed

=B ml(graph)

**STRENGTH** = N3 x Equivalent weight of HCl (36.5)

**RESULT:-**

The strength of given HCl solution = ….g/L

**PRECAUTION:-**

1. After every addition of NaOH solution, the solution must be stirred thoroughly.
2. Conductivity cell should be properly immersed in the solution.
3. All precaution regarding the handling of the instrument should be taken.
4. After completion of the experiment, the conductivity cell should be properly washed and dipped into distilled water.
5. Temperature should be constant throughout the experiment.

### Lab Manual: Conductometric Titration of a Strong Acid with a Strong Base

#### **Objective**

To determine the endpoint of a titration between a strong acid and a strong base using conductometric measurements.

### **Pre-Test Questions**

1. **What is the principle behind conductometric titration?**

A) Measurement of color change during the reaction

B) Measurement of pH change during the reaction

C) Measurement of electrical conductivity during the reaction

D) Measurement of temperature change during the reaction

**Answer: C) Measurement of electrical conductivity during the reaction**

1. **In conductometric titration between a strong acid and a strong base, what is expected to happen to the conductivity of the solution as the titration progresses towards the endpoint?**

A) Conductivity increases continuously until the endpoint is reached

B) Conductivity decreases continuously until the endpoint is reached

C) Conductivity initially decreases and then increases after the endpoint

D) Conductivity remains constant throughout the titration

**Answer: C) Conductivity initially decreases and then increases after the endpoint**

1. **Which of the following solutions would have the highest conductivity?**

A) Pure water

B) A solution of a strong acid at low concentration

C) A solution of a strong base at high concentration

D) A solution of a weak acid at high concentration

**Answer: C) A solution of a strong base at high concentration**

1. **What is the role of the indicator in conductometric titration?**

A) To change color at the endpoint

B) To help in visualizing the endpoint of the titration

C) Conductivity does not require an indicator

D) To stabilize the solution during the titration

**Answer: C) Conductivity does not require an indicator**

1. **What type of electrode is commonly used in conductometric titrations?**

A) pH electrode

B) Glass electrode

C) Conductivity electrode

D) Reference electrode

**Answer: C) Conductivity electrode**

### **Post-Test Questions**

1. **How can the endpoint of a conductometric titration be identified?**

A) By a sharp drop in conductivity

B) By a gradual change in pH

C) By a sharp increase in conductivity

D) By the color change of an indicator

**Answer: C) By a sharp increase in conductivity**

1. **What effect does the addition of a strong base to a strong acid have on the conductivity of the solution?**

A) The conductivity increases continuously

B) The conductivity decreases and then increases

C) The conductivity decreases continuously

D) The conductivity remains constant

**Answer: B) The conductivity decreases and then increases**

1. **Why does conductivity initially decrease when a strong base is added to a strong acid during the titration?**

A) The formation of water reduces ion concentration

B) The base neutralizes the acid, reducing the number of ions

C) The conductivity probe is affected by temperature changes

D) The strong base reacts with the strong acid to form a non-conductive compound

**Answer: B) The base neutralizes the acid, reducing the number of ions**

1. **What is the expected shape of the conductivity versus volume of titrant curve in a conductometric titration?**

A) A straight line

B) A curve with a peak

C) A curve with a valley and then a peak

D) A sinusoidal wave

**Answer: C) A curve with a valley and then a peak**

1. **What is the significance of the inflection point in the conductivity versus volume of titrant curve?**

A) It represents the equivalence point of the titration

B) It indicates the start of the titration

C) It marks the end of the titration

D) It shows the initial concentration of the acid or base

**Answer: A) It represents the equivalence point of the titration**