(DC1-9) Electrical Conductivity of an Electrolyte at Constant Concentration

Aim of experiment

Determination of the electrical conductivity of an electrolytic solution.

Apparatus

A.C. Power Supply- Electrolytic Solution- Two Dissimilar Electrodes- Ammeter – Voltmeter.

Theory of experiment

An electrolyte is a compound that ionizes when dissolved in suitable ionizing solvents such as water. This includes most soluble salts, acids, and bases. Electrolyte solutions are normally formed when a salt is placed into a solvent such as water and the individual components dissociate due to the thermodynamic interactions between solvent and solute molecules, in a process called solvation. For example, when table salt (sodium chloride), NaCl, is placed in water, the salt (a solid) dissolvates into its component ions, according to the dissociation reaction

$$NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$$

If a high proportion of the solute dissociates to form free ions, the electrolyte is strong; if most of the solute does not dissociate, the electrolyte is weak.

The resistance of a conductor wire is given by;

$$R = \rho\, d/A$$

Where d, A, is length and cross sectional area of the wire, and ρ, is called its specific resistivity, it is a material parameter. From Ohm's law R= V/I, thus

$$V/I = \rho\, d/A$$

The reciprocal of resistivity is called the conductivity of the conductor, which is given as

$$\sigma = 1/\rho$$

Thus the conductivity can be calculated according to the relation

$$\sigma = d\, I / V\, A$$

Electrolytic solution is considered as a conductor, since it allows electric current to pass through. If two electrodes of overlapping area, S, and separated a distance L are immersed in the electrolyte, the electrolyte volume between these electrodes is considered as a conductor of length L and cross sectional area S. So, one can obtain a conductor of different lengths and areas by changing L and the overlapping area S at a specific concentration, so the electrical conductivity of such electrolyte is given by;

$$\sigma = L\, I / U\, S$$

Where U is the applied voltage across electrodes.

To avoid electrolysis at the electrodes, an AC power supply of low frequency source is used.

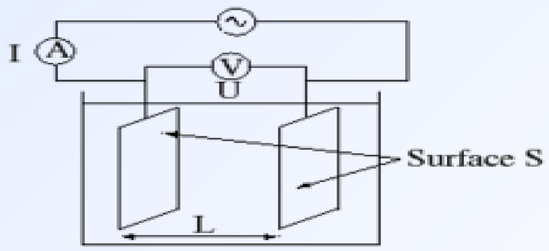

Figure 1 A circuit diagram of electrolyte conductivity measurement

Procedure

1. Connect the circuit as shown in *figure 1,* and put the power supply on 6 volt.
2. Measure the area of the electrode that is immersed into the solution.
3. Let the distance between the two electrodes equal 0.5 cm
4. Switch on the circuit and record the corresponding current.
5. Change the distance between the two electrodes each 0.5 cm up to 5 cm and record the current in each case.
6. Repeat step 4-5 three times at same distance.
7. Record the data in a table.
8. Draw a graph between the separation distances, L on x-axis and the current,$1/ I_{av}$, on y-axis.
   From the slope of the graph find the conductivity.

$$\sigma = \text{slope}/ U\, S$$

Results

L(cm)	0.5	1	1.5	2	2.5	3	3.5	4
I_1 (A)								
I_2 (A)								
I_3 (A)								
I_{av} (A)								
$1/ I_{av}$ $(A)^{-1}$								

S= cm^2 U= volt

σ = $(\Omega.cm)^{-1}$

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