(DC1-10) Electrical Conductivity of an Electrolyte at Different Concentration

Aim of experiment

Determination of the electrical conductivity of an electrolytic solution.

Apparatus

D.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 conductivity of an electrolyte is therefore affected by the following factors:

The **concentration of ions** in solution. The higher the concentration of ions in solution, the higher its conductivity will be.

The **type of substance** that dissolves in water. Whether a material is a strong electrolyte (e.g. potassium nitrate, KNO_3), a weak electrolyte (e.g. acetic acid, CH_3COOH) or a non-electrolyte (e.g. sugar, alcohol, oil) will affect the conductivity of water because the concentration of ions in solution will be different in each case. Strong electrolytes form ions easily, weak electrolytes do not form ions easily and non-electrolytes do not form ions in solution.

Temperature. The warmer the solution, the higher the solubility of the material being dissolved and therefore the higher the conductivity as well.

The resistance of a conductor wire is given by;

$$R = \rho\, L/S$$

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

$$\sigma = Ld/VS$$

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 polarization at electrodes, low frequency A.C. sources are used.

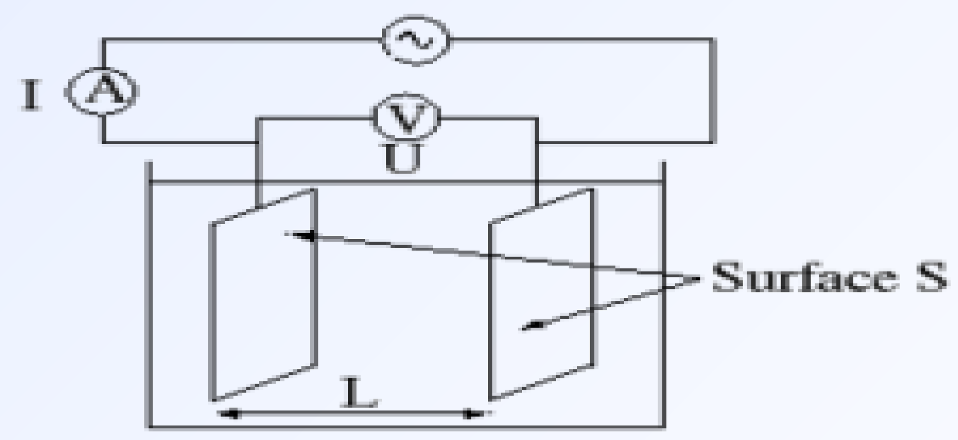

Figure 1 A circuit diagram of electrolyte conductivity measurement

Procedure

1. Start experiment with an electrolyte of 10% concentration.
2. Connect the circuit as shown in *figure 1, where R =50 Ω* and put the power supply on about 5 volt.
3. Measure the area of the electrode that is immersed into the solution.
4. Let the distance between the two electrodes equal ~3 cm.

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6. Switch on the circuit and record the corresponding current and then calculate the conductivity at such concentration.
7. Record the data in a table.
8. Repeat the above steps using electrolytes of 20, 30, 40, …% concentration until current saturation is reached.
9. Draw a graph between the concentration, *C %*, on x-axis and the current, *I*, on y-axis.
10. Comment on the graph

Results

L= *m* *R= 50 Ω*
S= m^2 *U=* *volt*

C %	*I (A)*	σ $(\Omega m)^{-1}$