CHEMICAL EFFECT OF ELECTRIC CURRENT

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INTRODUCTION

When amber is rubbed with fur, it acquires the force to attract small pieces of matter. Electron came into existence from the word amber as amber in Greek is called elektron.

STATIC ELECTRICITY

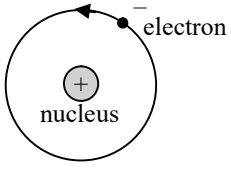
Static electricity is produced when electrical charges build up on the surface of a material hence it is called static electricity as the charges are not in motion.

Common examples of static electricity in action are :

- Sometimes when you touch the door knob you may get a mild shock. The electric shock arises due to the accumulation of static charges on the knob.
- You enter your room after coming back from your school and as soon as you pull of your woolen cap, all of a sudden all your hair stand on end. It happens because of static electricity caused due to accumulation of charges on your hair.
- During winter when you take off woolen or synthetic clothes in a dark room you might see some sparkling light with a crackling sound. The sparkles are also produced because of static electricity.

ELECTRICAL CHARGES

As protons, neutrons and electrons have characteristic properties, hence, they are very different from each other. One of the properties of these constituents of atoms is an electrical charges.



Protons are said to have a "positive" (+) charge, electrons have a "negative" (–) charge while neutrons are neutral, i.e., have no charge.

◈ **Interaction between electrical charges**

Two static charges of opposite types attract each other and two static charges of the same type repel each other.

➢ TYPES OF CHARGED BODIES

Since there are two types of charges (+ve and – ve), there are two types of charged bodies :

- Positively charged bodies
- Negatively charged bodies.

When an electron moves away (due to any reason) from an atom, it carries its negative charge with it. The number of electrons also becomes less than the number of protons in the atom. It results in the body having excess positive charge. Thus on loosing an electron, a body is said to get *positively charged.*

Vice versa, when an electron moves towards an atom it brings its negative charge with it. The number of protons becomes less than the number of electrons in the atom. It results in the body having excess of negative charge. Thus on gaining electrons, a body is said to get *negatively charged.*

Thus, we conclude that a body gets positively charged if, its protons are more and negatively charged if the electrons are more.

➢ ELECTRICAL CONDUCTIVITY

Electrical conductivity is a measure of the ability of a substance to carry electric current. Substances that are good conductors of electricity have high electrical conductivity as compared to substances that are poor electrical conductors (also called insulators). Same liquids, but not all, are also good conductors of electricity.

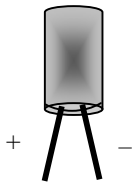
(a) Conductivity of Water:

Pure water is a poor conductor of electricity. But the water that we use in our houses is not pure water. Generally, water (tap water, pond water, well water, etc.) contains a lot of impurities, most of which are usually dissolved salts. The presence of even a small amount of impurity makes water a good conductor of electricity. Touching an electrical appliance with wet hands could, therefore, be dangerous.

(b) Conductivity of Other Liquids (Lemon Juice:

A lemon is a citrus fruit, an excellent source of Vitamin C and makes a cool and refreshing summer drink. But did you know we can generate electricity using a lemon ? Lemon juice contains an acid called citric acid. To test the electrical conductivity of lemon juice, we arrange four to five lemons using strips of copper and zinc, a few alligator clips and connecting. The electricity produced, although not very strong, is enough to light an LED (light emitting diode).

NOTE: An LED means a light emitting diode. It is similar to a bulb but it runs on very low voltages and requires very small amount of current to glow as compared to a bulb. The coloured lights that you see in retail stores, stages, bridges and even in the keypads of mobile phones are all LED's



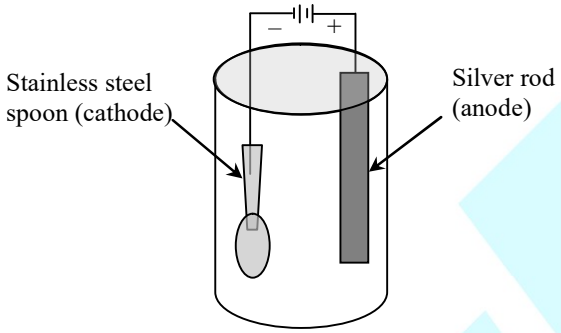
➢ CHEMICAL EFFECT OF ELECTRIC CURRENT

Electrical energy is a very useful form of energy. It can be converted into chemical energy of certain types of substances. This is what we call as the chemical effects of current.

When an electric current is passed through water containing sulphuric acid, the water breaks up into its components hydrogen and oxygen. Therefore an electric current can cause a chemical change.

This effect of electric current is used in electroplating i.e. coating a thin layer of a metal on another metal. The metal which is to be electroplated is made cathode and the metal to be deposited is made anode while the soluble salt of the same metal serves as the electrolyte. When a current is passed, a thin film of metal is deposited on the metal, which becomes electroplated.

Ex.. Let we are having a spoon which is to be electroplated with silver. The spoon is made the cathode and the piece of silver is made the anode. $AgNO_3$ salt is used as electrolyte. When a current is passed through the electrolyte the atoms of silver gets deposited on the spoon.



(i) General terms associated with the passage of current through solutions:

(A) Electrolyte:

A solution of a chemical compound which conducts electric current and at the same time undergoes a chemical change is called electrolyte.

Examples:

(i) Aqueous solutions of all acids, such as HCl, HNO_3, H_2SO_4 etc.

(ii) Aqueous solutions of all alkalis, such as NaOH, KOH etc.

(iii) Aqueous solutions of salts, such as common salt, copper sulphate, sodium nitrate, zinc chloride, etc.

(B) Non-electrolyte:

A solution of a chemical compound which does not conduct electric current and hence does not undergo any chemical change is called non-electrolyte.

Example :

Petrol, kerosene oil, diesel oil, vegetable oil, chloroform, carbon tetrachloride, alcohol, ether, benzene, distilled water etc.

(C) Electrolysis:

The process due to which a solution of a chemical compound conducts electric current and at the same time undergoes a chemical change is called electrolysis.

(D) Electrodes:

The metal wires/plates/rods through which the current enters or leaves an electrolyte are called electrodes.

(E) Cathode:

The electrode connected to the negative terminal of a cell/battery is called cathode.

(F)Anode:

The electrode connected to the positive terminal of a cell/battery is called anode.

(G) Ions :

The electrically charged atoms/group of atoms formed when a chemical compound is dissolved in water are called ions.

(H) Cations:

The positively charged ions formed, when a chemical compound dissolves in water are called cations. During electrolysis, the cations are discharged at cathode by taking electric charges from it.

(I) Anions :

The negatively charged ions formed, when a chemical ~ compound dissolves in water are called anions. During electrolysis, the anions are discharged at anode by losing electric charges to it.

(J) Voltameter :

An apparatus in which electrolysis is carried out, which consist of a vessel, two electrodes and electrolyte is called voltameter.

◈ **ELECTROPLATING :**

The process of depositing a thin layer of any superior metal over an object of a cheaper metal,

with the help of electric current is called electroplating.

For example, deposition of silver on brass or copper objects and that of copper, nickel, chromium etc., on objects made of iron is done by electroplating.

Electroplating is done with the following purpose/objectives.

- For decoration purposes : Silver or gold plating of brassware such as flower vase.
- For preventing corrosion : Iron objects, such as, bathroom fittings etc., are electroplated with chromium.

◈ PROCESS OF ELECTROPLATING :

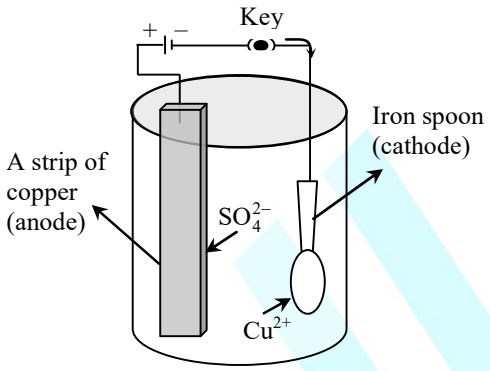
The process of electroplating involves the followings steps :

- Clean and wash the object to be electroplated thoroughly.
- The object to be electroplated is made cathode.
- A sheet of pure metal (to be electroplated) is made anode.
- The electroplating tank is filled with the solution of a salt of the metal to be electroplated.
- Connect the cathode to the negative (–) terminal and the anode to the positive (+) terminal of the battery.
- Pass the currnt for a certain time to deposite a thin layer of the metal.

The process of electroplating is illustrated below.

◈ ELECTROPLATING OF COPPER :

The experimental set up for electroplating copper on any object, such as a metallic spoon is shown in fig. given below :



Sat. solution of copper sulphate

Here,

- The object to be electroplated, say iron spoon is made cathode (–ve electrode).
- A thin sheet of pure copper is made anode (+ve electrode).
- An acidified solution of copper sulphate ($CuSO_4$) is used as the electrolytic solution.

When electricity is passed through the solution, Cu—2+— ions move towards the cathode and get reduced to copper metal. This copper metal gets electroplated on the objects, i.e., metallic spoon.

The sulphate ions (SO_4^{2-}) move towards anode. Here SO_4^{2-} ions do not get oxidised. Instead, the copper metal of the anode gets oxidised to Cu^{2+}ions. These copper ions (Cu^{2+}) go into the solution. As a result of this reaction at the anode, concentration of Cu^{2+} ions in the solution is maintained.

At cathode :

$$\underset{\text{from solution}}{Cu^{2+}} + \underset{\text{from cathode}}{2e^-} \longrightarrow \underset{\substack{\text{gets electrplate}\\ \text{on the spoon}}}{Cu(s)}$$

At anode :

$$\underset{\text{impure copper}}{Cu(s)} \longrightarrow \underset{\text{goes in to the solution}}{Cu^{2+}(aq)} + \underset{\substack{\text{gets transfered to}\\ \text{cathode}}}{2e-}$$

APPLICATION OF ELECTROLYSIS

The principle of electrolysis is employed in the following processes :

- Manufacture of industrial chemicals
- Extraction of metals
- Refining of metals
- Electroplating

MANUFACTURE OF INDUSTRIAL CHEMICALS

Many chemicals which are used in industry in large quantities are prepared by electrolytic method.

Some of these are :

(i) Sodium hydroxide, NaOH (caustic soda) and Chlorine gas, $Cl_2(g)$ are prepared by the electrolysis of brine (20% common salt solution).

(ii) Hydrogen gas, $H_2(g)$ is prepared by the electrolysis of acidified water, or 20% , NaOH solution. Oxygen is obtained as by-product.

EXTRACTION OF METALS–ELECTROMETALLURGY :

More electropositive metals, such as sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), aluminium (Al), etc. cannot be obtained by carbon reduction process. These metals can be obtained by the electrolysis of their molten chlorides, hydroxides or oxides.

For example,

- Sodium and potassium are obtained by the electrolysis of their molten chlorides and hydroxides.
- Calcuium and magnesium are obtained by the electrolysis of their molten chlorides.
- Aluminium is obtained by the electrolysis of its molten oxide (in the presence of some other compounds).

REFINING OF METALS :

The metals obtained by chemical reduction methods generally contain many impurities. Such metals can be refined very easily by electrolytic method. The method of purifying metals by using electricity is called electro refining. Metals, such as zinc, copper, silver, nickel, gold, aluminium, etc are refined by electrical method.

MAGNETIC EFFECT OF CURRENT

We know that a moving magnet can generate an electric current. Also we can say that electric current can produce a magnetic effect. A coil, through which when an electric current flows behave like a magnet with its two poles.

Ex. Electric bell shows magnetic effect of current.

DANGER OF ELECTRICITY

(i) If the current happens to pass through the heart, it cause the heart muscles to contract and generally death occurs.

(ii) A strong electric shock can give the body a big shock that can damage the body cells. Such a shock occurs on touching a live electric wire suddenly.

(iii) Handling electrical appliances in wet places is very dangerous.

(iv) Electricity could turn dangerous due to loose connections in switches, improper wiring, overloading (i.e. passing excess current above the rated capacity), improper earthing.

SAFETY MEASURES IN USING ELECTRICITY

(i) The wires used in the circuit should be of good quality and with good insulation.

(ii) Defective and damaged plugs, sockets and switches must be immediately replaced.

(iii) All connections in plugs, switches and sockets must be made of a proper insulating material.

(iv) Extension cords must not be overloaded and must be regularly tested.

(v) Switches and plugs should not be touched with wet hands.

(vi) The main switch should be immediately switched off in case of fire or short circuit.

(vii) Always use a safety fuse of proper rating and material in an electric circuit.

(viii) All appliances must be properly earthed.

(ix) Rubber soled shoes should be worn while repairing electric circuit. This protect the body from) electric shocks.

(x) The inside of socket are made of conducting material and therefore must not be touched.