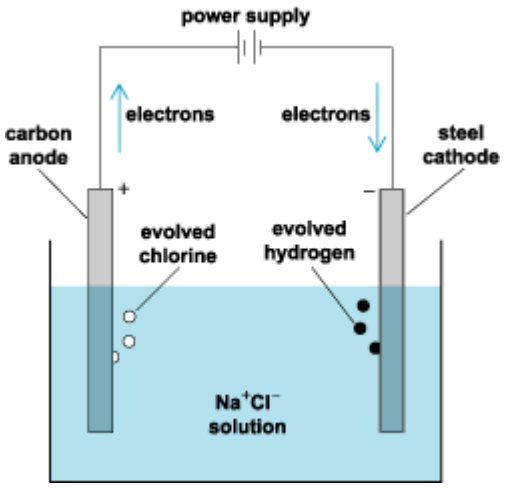
Electrolysis

A means of producing chemical changes through reactions at electrodes in contact with an electrolyte by the passage of an electric current. Electrolysis cells, also known as electrochemical cells, generally consist of two electrodes connected to an external source of electricity (a power supply or battery) and immersed in a liquid that can conduct electricity through the movement of ions. Reactions occur at both electrode-solution interfaces because of the flow of electrons. Reduction reactions, where substances add electrons, occur at the electrode called the cathode; oxidation reactions, where species lose electrons, occur at the other electrode, the anode. In the cell shown in the illustration, water is reduced at the cathode to produce hydrogen gas and hydroxide ion; chloride ion is oxidized at the anode to generate chlorine gas. Electrodes are typically constructed of metals (such as platinum or steel) or carbon. Electrolytes usually consist of salts dissolved in either water or a nonaqueous solvent, or they are molten salts. *See also* Electrochemistry; Electrode; Electrolyte; Oxidation-reduction.

The Electrolytic Process:

The electrolytic process requires that an electrolyte, an ionized solution or molten metallic salt, complete an electric circuit between two electrodes. When the electrodes are connected to a source of direct current one, called the cathode, becomes negatively (−) charged while the other, called the anode, becomes positively (+) charged. The positive ions in the electrolyte will move toward the cathode and the negatively charged ions toward the anode. This migration of ions through the electrolyte constitutes the electric current in that part of the circuit. The migration of electrons into the anode, through the wiring and an electric generator, and then back to the cathode constitutes the current in the external circuit.

For example, when electrodes are dipped into a solution of hydrogen chloride (a compound of hydrogen and chlorine) and a current is passed through it, hydrogen gas bubbles off at the cathode and chlorine at the anode. This occurs because hydrogen chloride dissociates (see dissociation) into hydrogen ions (hydrogen atoms that have lost an electron) and chloride ions (chlorine atoms that have gained an electron) when dissolved in water. When the electrodes are connected to a source of direct current, the hydrogen ions are attracted to the cathode, where they each gain an electron, becoming hydrogen atoms again. Hydrogen atoms pair off into hydrogen molecules that bubble off as hydrogen gas. Similarly, chlorine ions are attracted to the anode, where they each give up an electron, become chlorine atoms, join in pairs, and bubble off as chlorine gas.



The fact that electrical energy can produce chemical changes and the processes based on it, called the „electrolytic processes" are widely used for the extraction of pure metals from their ores (such as aluminum, zinc, copper, magnesium, sodium etc), refining of metals (such as gold, silver, copper, nickel, lead, iron etc.), manufacturing of various chemicals such as caustic soda, potassium permanganate, hydrogen, oxygen, chlorine etc), electro-deposition of metals including electro-plating, electro-typing, electro-forming, building up of worn out parts in metallurgical, chemical and other industries. Though the various processes mentioned are different in apparent detail but fundamentally they are alike, being based on the principle of electrolysis. The mass of chemical deposition due to flow of electric current I through the electrolyte for time t is given by the expression

$M = Zit$

where Z is the electro-chemical equivalent of the substance in kg/coulomb.
Power supply required for electrolytic processes is direct current and at very low voltage. The power required for electro-deposition is usually very small (say 100-200A at 10-12V). Power supply required for extraction and refining of metals and large scale manufacture of chemicals is in very large amounts

Electroplating

In electroplating, the plating metal is generally the anode, and the object to be plated is the cathode. A solution of a salt of the plating metal is the electrolyte. The plating metal is deposited on the cathode, and the anode replenishes the supply of positive ions, thus gradually being dissolved. Electrotype printing plates, silverware, and chrome automobile trim are plated by electrolysis.

The English scientist Michael Faraday discovered that the amount of a material deposited on an electrode is proportional to the amount of electricity used. The ratio of the amount of material deposited in grams to the amount of electricity used is the electrochemical equivalent of the material. Actual electric consumption may be as high as four times the theoretical consumption because of such factors as heat loss and undesirable side reactions.

Electric Cells

An electric cell is an electrolytic system in which a chemical reaction causes a current to flow in an external circuit; it essentially reverses electrolysis. A battery is a single electric cell (or two or more such cells linked together for additional power) used as a source of electrical energy. Metal corrosion can take place by electrolysis in an unintentionally created electric cell. The Italian physicist Alessandro Volta discovered the principle of the electric cell. Within a few weeks William Nicholson and Sir Anthony Carlisle, English scientists, performed the first electrolysis, breaking water down into oxygen and hydrogen.

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