Part 1

Electrolytic Cells

Voltaic cells "**batteries**" are driven by a **spontaneous** chemical reaction that produces an electric current through an outside circuit. These cells are important because they are the basis for the batteries that fuel modern society. But they aren't the only kind of electrochemical cell. The reverse reaction in each case is **non-spontaneous** and requires electrical energy to occur.

The general form of the reaction can be written as:

Spontaneous ---------->
Reactants >< Products + Electrical Energy
<----------- Non spontaneous

It is possible to construct a cell that does work on a chemical system by driving an electric current through the system. These cells are called **electrolytic** cells, and operate through electrolysis. Electrolysis is used to drive an **oxidation-reduction** reaction in a direction in which it does not occur **spontaneously** by driving an electric current through the system while doing work on the chemical system itself, and therefore is **non-spontaneous.**

Electrolytic cells, like galvanic cells, are composed of two half-cells--one is a **reduction** half-cell, the other is an **oxidation** half-cell. The direction of electron flow in electrolytic cells, however, may be reversed from the direction of spontaneous electron flow in galvanic cells, but the definition of both cathode and anode remain the same, where **reduction** takes place at the cathode and **oxidation** occurs at the anode. Because the directions of both half-reactions have been reversed, the sign, but not the magnitude, of the cell potential has been reversed.

Electrolytic cells are very similar to voltaic (galvanic) cells in the sense that both require a salt bridge, both have a cathode and anode side, and both have a consistent flow of electrons from the anode to the cathode. However, there are also striking differences between the two cells.

Electrochemical cell (Galvanic Cell)a. and Electrolytic cell b.

a. A Galvanic cell converts chemical energy into electrical energy.
b. An electrolytic cell converts electrical energy into chemical energy.

a. The redox reaction is spontaneous and is responsible for the production of electrical energy
b. The redox reaction is not spontaneous and electrical energy has to be supplied to initiate the reaction

a. The two half-cells are set up in different containers, being connected through the salt bridge or porous partition.
b. Both the electrodes are placed in a same container in the solution of molten electrolyte.

a. The anode is negative and cathode is the

positive electrode. The reaction at the anode is
oxidation and that at the cathode is reduction.
b. The anode is positive and cathode is the
negative electrode. The reaction at the anode
is oxidation and that at the cathode is
reduction.

a. The electrons are supplied by the species getting
oxidized. They move from anode to the cathode
in the external circuit.
b. The external battery supplies the electrons.
They enter through the cathode and come out
through the anode.

Some people maybe wondering why I am explaining all this, well, it is important for what I am going to explain in the secound part of my explanation of what happens in a system of electrolysis where we can increase, **"over Faraday"**, the efficiency of electrolysis by 85%, that is a system which runs at 185% compared to a **theoretical** 100% of Faraday.

Part 2

In a battery--the anode is labeled the "negative" electrode because it is where electrons are produced; the cathode is therefore labeled "positive." An electrolytic cell has the opposite signs on its electrodes because of how it is hooked up to a battery. The anode, or negative electrode, of the battery is connected to the cathode of the electrolytic cell. Because the reduction potential of the battery will be greater than that of the electrolytic cell, electrons will still be produced at the battery's anode and its negativity **"overpowers"** the positivity of the electrolytic cell's cathode. The same effect occurs at the electrolytic cell's anode, giving it a positive label.

In a regular electrochemical cell, electrons flow from the anode to the cathode as the result of the spontaneous oxidation-reduction reaction occurring with the cell. In an electrolytic cell hooked up to a battery, this electron flow is reversed; they move from the electrolytic cell's cathode to its anode. Once again this because the reduction potential of the battery overpowers that of the electrolytic cell, so the battery forces the electrons to flow in the direction that is opposite to their normal tendency.

The **spontaneous** oxidation-reduction reaction within the battery forcing the electrons in the opposite direction in the electrolytic cell causes a **nonspontaneous** reaction to occur there. In an electrolysis cell containing an electrolyte dissolved in water and two electrodes, no power is produced because it is at oxidation-reduction equilibrium with a high concentration of water. When a battery is connected to the electrodes, electrons are forced through the solution, oxidizing water at the anode, producing electrons, and reducing it at the cathode and giving up electrons. The result of this reaction is the nonspontaneous production of hydrogen and oxygen gases. These electrons given up at the cathode are normally lost in the rest of the external circuit and so a slow depletion of the electrons produced by the battery until there are no more **"dead battery".**

Here is what can be done so as not to loose those electrons into the external circuit, they can be collected and reused by storing in another medium and then discharged a secound time to do more work. What medium can be used? There are two readly available mediums which can store electron charge, one is a capacitor and the other is a rechargable battery, both have their advantages and disadvantages.

Batteries need time to charge and give up their charge slowly, and capacitors charge quickly and can be discharged quickly, you might say they are opposite to one another. Through time and a lot of development in batteries and capacitors, there now exists what some call battery capacitors which charge very fast and can discharge slowly or fast depending on what is required of them in a circuit. These types of battery capacitors are quite expensive, albeit they are coming down fast in price. For the needs of electron storage in this type of electrolysis that I am explaining, a comprimise can be made by using both a battery and a capacitor in parallel.

To be able to store these electrons, a potencial difference is needed between the main supply voltage and the store medium voltage, for example a supply voltage of 24v and a store battery of 12v with a 10,000uf 50v capacitor in parallel. The charge discharge cycle for this would be around two secounds in this type of circuit, and as so a battery on its own would take quite a lot a punishment, the capacitor helps to smooth this out and extend the life of the battery.

In **figure 1** is shown a block schematic of such a system of electrolysis, I must express that this is only a block schematic and a real working system needs an electronic control and an electrolysis cell confugured properly for this to work to it's full efficiency, also other parameters are needed for it to be succesful.

Fig: 1