Electrolysis

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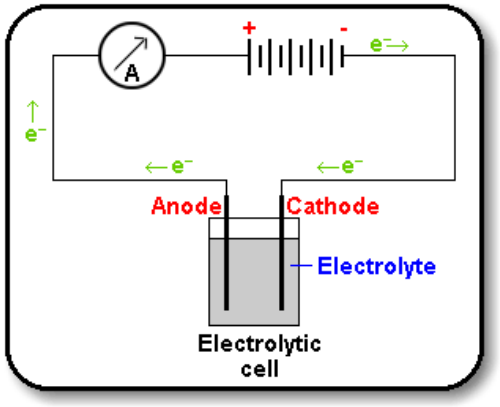
Introduction to Electrolysis



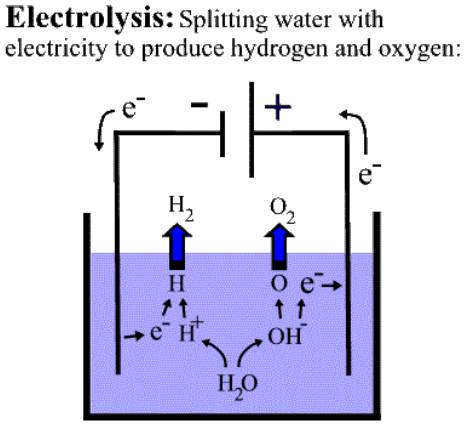
What is Electrolysis

Electrolysis is the process that people use to generate hydrogen (and oxygen) from water. The word "lysis" means to dissolve or break apart, so the word "electrolysis" literally means to break something apart (in this case water) using electricity.

Electrolysis is very simple -- all you have to do is arrange for electricity to pass through some water between electrodes that are placed in the water, as the diagram above shows. It's as simple as that! Michael Faraday first formulated the principle of electrolysis in 1820.

The key process of electrolysis involves the interchange of atoms and ions that occurs through the removal or addition of electrons from the external circuit. The desired products of electrolysis are in a different physical state from the electrolyte and can be removed through various physical processes. For example, whenbrine is subjected to electrolysis to produce hydrogen and chlorine, the products are gaseous. These gaseous products bubble from the electrolyte and are easily collected.

Components of Electrolysis



The main components that are needed to achieve electrolysis are:

- Anelectrolyte: an electrolyte is asubstance containing freeions. These ions are the carriers of theelectric current in the electrolyte. If theions are not mobile, as in solidsalt, then electrolysis cannot occur.
- Adirect current**(DC)** supply: a DC supply provides theenergy necessary to create or discharge theions in theelectrolyte . The electric current is carried byelectrons in the external circuit.

- Twoelectrodes: these function as anelectrical conductor which provides the physical interface between theelectrical circuit providing theenergy and theelectrolyte.

At the cathode (the negative electrode), the battery creates a negative charge. Consequently, there is electrical pressure to push electrons into the water at this end. At the anode (the positive electrode), there is a positive charge, so that electrode would like to absorb electrons. But the water isn't a very good conductor. Instead, in order for there to be a flow of charge all the way around the circuit, water molecules near the cathode are split up into a positively charged hydrogen ion, which is symbolized as H^+ in the diagram above, and a negatively charged "hydroxide" ion, symbolized as OH-:

$H_2O \rightarrow H^+ + OH^-$.

A positively charged hydrogen ion, or H^+, is just the hydrogen atom without its electron, i.e. the nucleus of the hydrogen atom, which is just a single proton.

You might have expected that H_2O would break up into an H and an OH (the same atoms but with neutral charges), but this doesn't happen because the oxygen atom more strongly attracts the electron from the H -- it steals it. (Officially, we say the oxygen atom is more "electronegative" than hydrogen). This theft allows the resulting hydroxide ion to have a completely filled outer shell, making it more stable.

But because of this transfer, the H^+, which is just a naked proton, is now free to pick up an electron (symbolized as e^-) from the cathode, which is trying hard to donate electrons. When H+ picks up an electron, it will become a regular, neutral hydrogen atom:

$H^+ + e^- \rightarrow H$

When this hydrogen atom meets another hydrogen atom, they will form a hydrogen gas molecule:

$H + H \rightarrow H_2$,

And this molecule will bubble to the surface -- we have hydrogen gas!

Meanwhile, the positive anode has caused the negatively charged hydroxide ion (OH^-) to travel across the container to the anode. When it gets to the anode, the anode removes the extra electron that the hydroxide stole from the hydrogen atom earlier, and the hydroxide ion then recombines with three other hydroxide molecules to form 1 molecule of oxygen and 2 molecules of water:

$4\ OH^- \rightarrow O_2 + 2\ H_2O + 4e^-$

The oxygen molecule is very stable, and bubbles to the surface.

In this way, a closed circuit is created, involving negatively charged particles -- electrons in the wire, hydroxide ions in the water. The energy delivered by the battery is stored as the production of hydrogen.

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Reference links:

- http://en.wikipedia.org/wiki/Electrolyte

- http://www.en.wikipedia.org/wiki/Cathode
- http://www.aip.org/history/electron/
- http://en.wikipedia.org/wiki/Direct_current

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