# The Domestic Battery, From A Chemical Perspective

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The battery has been used for many years as a power source for the quick application of electricity to various devices. This amazingly simple device is taken for granted by millions of people every day in their flashlights, compact disc players, cameras, toys, and clocks, yet not many people realize the mechanics of this source. The following paragraphs will outline the history of the battery, its anatomy, and its mechanics, with an influence on the chemistry involved in the operation of this life-defining device.

Its concept began as far back as ancient Greece, when Aristotle discussed lodestone, a strongly magnetic material that can attract certain objects. The concept continued with Benjamin Franklin, the first person to actually use the words “battery” and “charge.” In 1800, Alessandro Volta constructed the first apparatus to carry continuous electricity. With silver and zinc coin-sized discs soaked in an alkaline solution, connected by metal strips and guided into a cup full of mercury, he was able to produce a jolt. Thirteen years later, Sir Humphrey Davy put together an 889 square foot battery made of 2,000 pairs of plates and put it to experimental use. He was able to isolate information regarding the combination of elementary substances through electrical attraction in the formation of natural products.

Following Davy was the brilliant Michael Faraday, constructing an electromagnet upon his discovery of induced magnetic field in a current-carrying wire. When he discovered a moving magnet could generate electricity, a monumental barrier in science was surmounted and the timetable for the creation of a portable power source moved up dramatically. Volta’s large battery piles were also improved upon, leading to the development of individual cells containing one metal as an anode and another as a cathode, both immersed in a conducting liquid, called an electrolyte.

In the 1860’s, French scientist George Lelanche constructed the first wet cell. The anode consisted of zinc and mercury, the cathode was crushed manganese dioxide and carbon, and an electrolyte consisting of ammonium chloride. A carbon rod was inserted into the mixture to collect the current, and the construction was considered the forerunner to the first individual battery. The first dry cell replaced the wet cell in 1880, and used a paste rather than a liquid for the electrolyte. The battery process was completed as we know it today when Samuel Ruben made the manganese alkaline battery more compact and durable than any before it.

Today's popular battery consists of nine important components that make it run. First is the positive pip, or the external nub on the battery which is placed in the positive direction for the orientation of a battery in an electronic device. The external shell of the battery, the steel can, is nickel-plated steel and effectively contains the chemicals necessary to make the battery work. On top of the steel can is the outer jacket, the decorative coating identifying cell type and size. Just inside the steel can is a very thin layer made of porous, fibrous material called the separator. The separator separates the electrodes and holds electrolyte between them. Electrolyte throughout the battery consists of potassium hydroxide and carries ionic current. The cathode, or positive terminal, is made of manganese dioxide and graphite, carrying electrons from external circuits. The negative terminal, called the anode, provides the source of electrons and consists of powdered zinc metal. Another important component of the battery is a long thin line of tin-plated brass extending from the bottom of the battery up through the electrolyte. Called the anode collector, it accomplishes a path for the electrons to follow from the anode to the external circuit being powered. The final part of the battery is a seal and vent at the bottom, a molded plastic disk which seals the internal components inside the battery and releases pressure when the battery is mistreated.

A battery operates chemically by a well-known process known as oxidation-reduction, or redox. Oxidation-reduction processes in chemistry rank in importance with acid-base reactions and bonding concepts, and are seen in all aspects of chemistry. It operates on the principle that in many chemical reactions, it is observed that the electrical charges of some atoms change. If an atom becomes more positive it is said to be oxidized, because a similar change occurs when metals react with oxygen. If an atom becomes more negative it is said to be reduced, because a similar change occurs when a metallic ore is converted to its elemental metal.

Specifically in a battery, oxidation and reduction takes place constantly. First of all, when the device being operated by the battery such as a flashlight is turned on, electric currents via electrons provide power for the bulb. This electron flow takes place because the anode material, zinc, gives up two electrons per atom in oxidation. These electrons flow as current toward the light bulb in the flashlight, leaving behind unstable zinc ions with +2 charges behind. The electrons power the light bulb in a circuit and reenter the battery at the cathode where they combine with its material, manganese dioxide, in a reduction. Manganese dioxide is a perfect material for this process, because it has a tendency to gain electrons.

The electrolyte, potassium hydroxide, next comes into play as a way for the electrons to get back to the anode after they enter the cathode. The negatively charged manganese dioxide from the reduction reacts with the water in the electrolyte, taking a hydrogen from the water in order to cancel out the negative charge and form MnOOH. The hydroxide ions left over from the water reaction with the manganese dioxide flow back to the ion in the form of an ionic current. These ions form with the positively unstable zinc ions which were created in the initial release of electrons at the beginning of the entire process. This reaction recreates the zinc oxide and water for the electrolyte solution, completing the chain and allowing the continual process of current flow to the flashlight.

The battery is a very important device used daily by nearly everyone. But almost no one understands how it works and how it came to be discovered and employed in such a wide variety of constant uses. The worldwide use and production of batteries has become so large, their disposal when they are used has now become a substantial problem. However, until a new environmentally battery is discovered and produced, the alkaline form will be used to power various electronic devices used by people all over the world. An important step in dealing with batteries, treating them properly, and disposing of them is to understand what process is employed and what chemicals are responsible for the use of a battery.

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