B6 BATTERIES

HOUSEHOLD BATTERIES

CHEMICAL INDUSTRIES
RESOURCE PACK

Zinc-carbon cells

Zinc-carbon cells are used in all regular AA, C and D dry-cell batteries which are used for general appliances such as remote controls, flashlights and toys.

The structure

The zinc-carbon cell (also known as the dry Leclanché cell) is a primary cell. It consists of an outer zinc container, which acts as the anode, and a carbon (graphite) rod surrounded by a mixture of carbon powder and manganese dioxide, which forms the cathode. The manganese dioxide converts the protons that are formed to water. The carbon powder increases the surface area of the electrode and lowers the internal resistance of the cell. The electrolyte used is a paste of zinc chloride and ammonium chloride dissolved in water. The old Leclanché cell was a wet cell consisting of an electrolyte of a strong solution of ammonium chloride. The anode and cathode of the zinc-carbon cell are separated by a sheet of porous material such as paper or cardboard which is soaked in the electrolyte and is called the separator. If the electrode materials were to react together, it would result in the zinc anode being worn away which would decrease the life of the battery. The zinc-carbon cell has an emf of 1,5 volts.

The reactions

The **oxidation reaction** takes place at the anode:
$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$

The **reduction reaction** takes place at the cathode:
$2MnO_2(s) + 2H^+(aq) + 2e^- \rightarrow Mn_2O_3(s) + H_2O(\ell)$

The H^+ comes from the $NH_4^+(aq)$ when the electrolyte is dissolved in water: $NH_4^+(aq) \rightarrow H^+(aq) + NH_3(aq)$

The overall reaction is:
$Zn(s) + 2MnO_2(s) + 2NH_4Cl(aq) \rightarrow Mn_2O_3(s) + H_2O(\ell) + Zn(NH_3)_2Cl_2(aq)$

Advantages and Disadvantages:

- The zinc casing of the zinc-carbon cell begins to thin because the ammonium found in the electrolyte is acidic; it therefore reacts with zinc which causes the zinc to be eaten away. This causes the electrolyte to leak out of the battery.
- The zinc-chloride cell is an improvement on the zinc-carbon cell as it has a longer shelf-life and gives a steadier voltage output as it is used. The electrolyte mixture of the zinc-chloride cell is a zinc chloride paste rather than an ammonium chloride paste.

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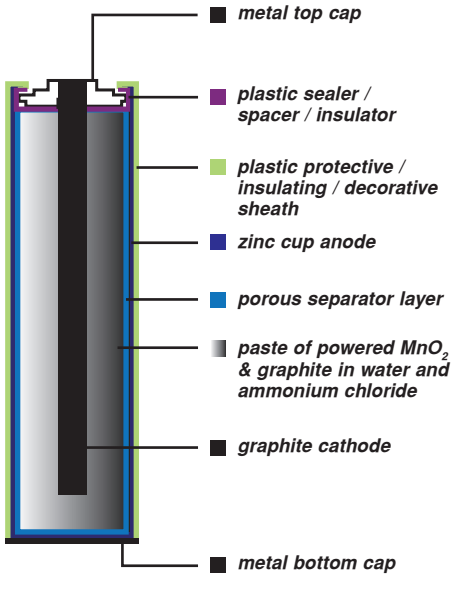
Zinc-carbon cell



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Household items that use batteries

Alkaline cells

Alkaline primary cells resemble zinc-carbon cells very closely because they have the same materials for the electrodes, which both undergo similar reactions. However, there are a number of differences between these two types of cells - primarily that an alkaline paste (hence the name) such as potassium hydroxide is used as the electrolyte. Alkaline cells have the ability to deliver more current. They also last from five to eight times as long as zinc-carbon cells, and produce an emf of 1,5V. Essentially, the energy is derived from a reaction of a metal to form the metal oxide.

The structure

The structure and functioning of this cell is similar to the dry Leclanché cell. However, the anode is made of zinc powder, which allows for an increased rate of reaction and therefore an increased current and a decreased internal resistance. The cathode is a mixture of high purity electrolytic manganese dioxide and carbon, like the carbon-zinc cell. A highly reactive paste of potassium hydroxide (which is an alkali solution) is the electrolyte. Alkaline cells are your general torch, clock and toy batteries. The negative terminal of the cell is the flat end and the positive terminal is the end with the raised button. There is a separator electrically separating the anode and the cathode, and graphite is added to the cathode to increase conductivity.

The reactions

The **anode reaction** is:

$Zn(s) + 2OH^-(aq) \rightarrow ZnO(s) + H_2O(\ell) + 2e^-$

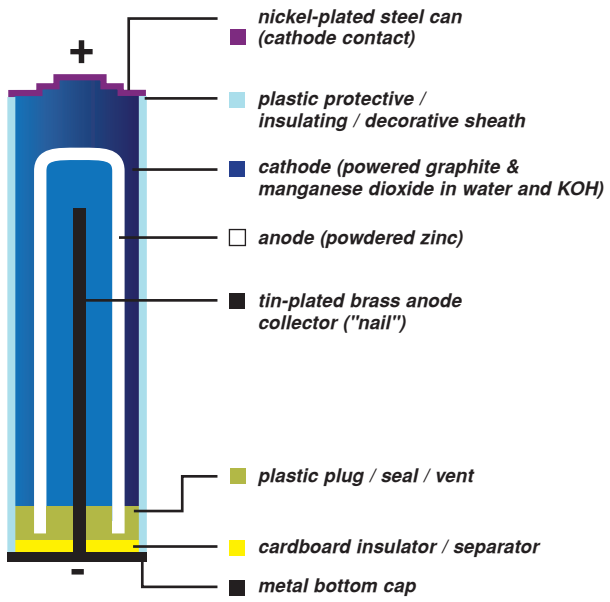
The **cathode reaction** is:

$2MnO_2(s) + H_2O(\ell) + 2e^- \rightarrow Mn_2O_3(s) + 2OH^-(aq)$

Some properties of the alkaline cell

- The faster the alkaline cell is drained, the higher percentage of the load it gives out as heat energy. Therefore the capacity of such a battery is determined by the load. An AA-sized battery might have a high capacity when used in an alarm clock, for example, but when used in a digital camera, the capacity decreases greatly.
- The zinc anode oxidises more readily than that of a zinc-carbon cell. The electrolyte of this cell conducts electricity inside the cell better than the electrolyte in the zinc-carbon cell. Therefore, an alkaline cell can deliver a higher current for a longer period of time.
- No gases are formed during the reaction.
- It has a good shelf-life.
- Better low temperature performance than the equivalent zinc-carbon cell.
- 25% heavier than the zinc-carbon cell.
- More expensive than the Leclanché cell.
- Less leakage than the Leclanché cell.

Alkaline cell



All cells are covered with a plastic sheath to provide protection, insulation, and labelling. Alkaline cells have about twice the power density of carbon-zinc cells, but are several times more costly. Both carbon-zinc and alkaline cells have a cell voltage of about 1,5 volts, and are both regarded as environmentally friendly, at least by the standards of storage cells. Carbon-zinc and alkaline storage cells are not in general rechargeable, though rechargeable alkaline cells have been produced.

Alkaline cells are used in toys