Alkaline battery

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An alkaline battery (IEC code: L) is a type of primary battery where the electrolyte (most commonly potassium hydroxide) has a pH value above 7. Typically these batteries derive energy from the reaction between zinc metal and manganese dioxide.

The alkaline battery gets its name because it has an alkaline electrolyte of potassium hydroxide (KOH) instead of the acidic ammonium chloride (NH4Cl) or zinc chloride (ZnCl2) electrolyte of the zinc-carbon batteries. Other battery systems also use alkaline electrolytes, but they use different active materials for the electrodes.

When alkaline batteries were introduced in the late 1960s, their zinc electrodes (in common with the then ubiquitous carbon-zinc cells) had a surface film of mercury amalgam. Its purpose was to control electrolytic action on impurities in the zinc; that unwanted electrolytic action would reduce shelf life and promote leakage. When reductions in mercury content were mandated by various legislatures, it became necessary to greatly improve the purity and consistency of the zinc.[10]

In an alkaline battery, the negative electrode is zinc and the positive electrode is manganese dioxide (MnO2). The alkaline electrolyte of potassium hydroxide (KOH) is not consumed during the reaction (it is regenerated), only the zinc and MnO2 are consumed during discharge. The concentration of alkaline electrolyte of potassium hydroxide remains constant, as there are equal amounts of OH- anions consumed and produced in the two half-reactions occurring at the electrodes.

The capacity of an alkaline battery is strongly dependent on the load. An AA-sized alkaline battery might have an effective capacity of 3000 mAh at low drain, but at a load of 1 ampere, which is common for digital cameras, the capacity could be as little as 700 mAh.[12] The voltage of the battery declines steadily during use, so the total usable capacity depends on the cutoff voltage of the application.

The amount of electrical current an alkaline battery can deliver is roughly proportional to its physical size. This is a result of decreasing internal resistance as the internal surface area of the cell increases. A rule of thumb is that an AA alkaline battery can deliver 700 mA without any significant heating. Larger cells, such as C and D cells, can deliver more current. Applications requiring currents of several amperes such as powerful portable audio equipment require D-sized cells to handle the increased load.

Alkaline batteries are manufactured in standard cylindrical forms interchangeable with zinc-carbon batteries, and in button forms. Several individual cells may be interconnected to form a true "battery", such as the 9-volt PP3-size battery.

The negative electrode is composed of a dispersion of zinc powder in a gel containing the potassium hydroxide electrolyte. The zinc powder provides more surface area for chemical reactions to take place, compared to a metal can. This lowers the internal resistance of the cell. To prevent gassing of the cell at the end of its life, more manganese dioxide is used than required to react with all the zinc. Also, a plastic-made gasket is usually added to increase leakage resistance.

The cell is then wrapped in aluminium foil, a plastic film, or rarely, cardboard, which acts as a final layer of leak protection as well as providing a surface on which logos and labels can be printed.

When describing AAA, AA, C, sub-C and D size cells, the negative electrode is connected to the flat end, and the positive terminal is the end with the raised button. This is usually reversed in button cells, with the flat-ended cylindrical can being the positive terminal.

All batteries gradually self-discharge (whether installed in a device or not) and dead batteries eventually leak. Extremely high temperatures can also cause batteries to rupture and leak (such as in a car during summer) as well as decrease the shelf life of the battery.

The reason for leaks is that as batteries discharge – either through usage or gradual self-discharge – the chemistry of the cells changes and some hydrogen gas is generated. This out-gassing increases pressure in the battery. Eventually, the excess pressure either ruptures the insulating seals at the end of the battery, or the outer metal canister, or both. In addition, as the battery ages, its steel outer canister may gradually corrode or rust, which can further contribute to containment failure.

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