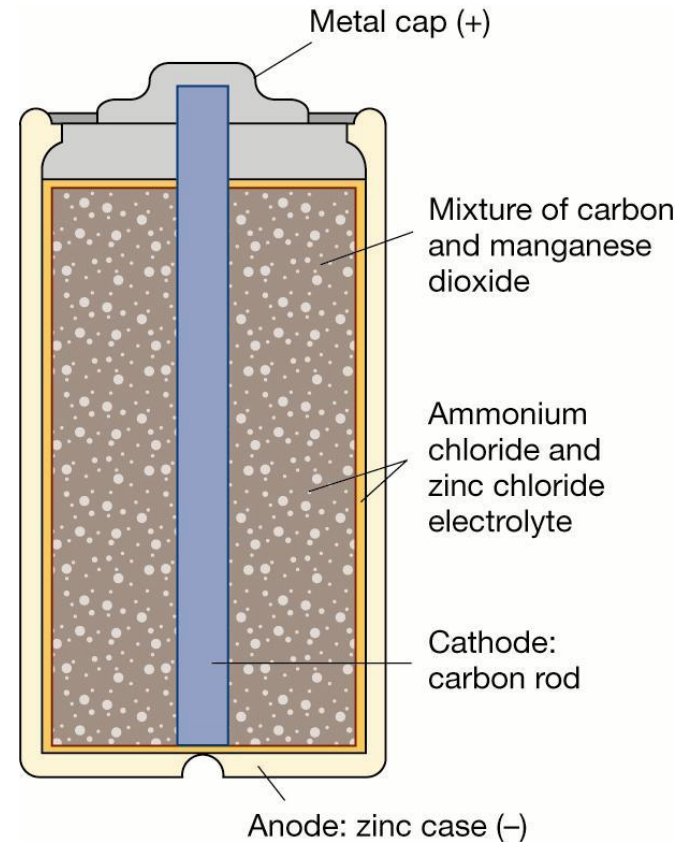


Primary Batteries

The zinc-carbon cell

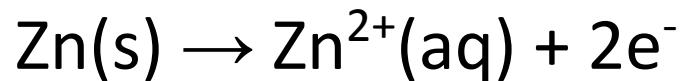
- The first mass-produced and widely used small-scale source of electrical energy.
- Has changed very little in the last 100 years.
- An electrolyte composed of a moist paste of zinc chloride and ammonium chloride plays the same role as the salt bridge.

This [battery](#) was invented by Goerge Lionel Leclanche in 1866

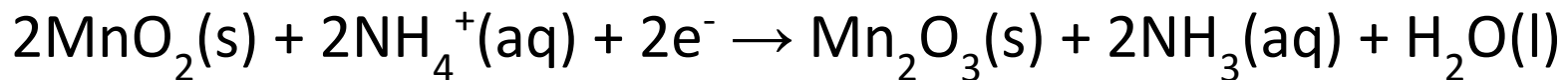


The zinc-carbon cell

- At the anode (-) oxidation of the zinc case produces electrons:



- At the cathode (+) Manganese dioxide is reduced in a complicated reaction that is thought to be:



The zinc-carbon dry cell

- A new cell produces about 1.5 volts, but this diminishes significantly during use.
- To maintain a net forward reaction, the soluble reaction products must migrate away from the electrodes.
- During use the build up of products around the electrodes slows and can even stop the forward reaction.
- This is known as polarisation. If the cell is allowed to rest, the products migrate away from the electrodes and the cell can recover.

Voltage Rating of Zinc Carbon Battery

Standard voltage rating of a zinc carbon battery is determined by type of anode and cathode materials used in the battery cell. In zinc carbon battery cell, zinc is anode material and manganese dioxide is cathode material. Electrode potential of zinc is -0.7 volt whereas electrode potential of manganese dioxide is 1.28 .

Therefore, theoretical voltage of each cell should be $-(-0.76) + 1.23 = 1.99$ V but considering many practical conditions, the actual voltage output of a standard zinc carbon battery is not more than 1.5 V.

Advantages and Disadvantages of Zinc Carbon Battery

Advantages of Leclanche' Battery

- The cost of this battery cell is quite low.
- Various shapes, sizes and capacities of these cells are easily available.
- Long traditional reliability.

Disadvantages of Leclanche' Battery

- Its energy density is quite low.
- It gives poor service in low temperature.
- It has poor leakage resistance.
- Cannot perform efficiently at high current drain application.
- Self life is not very good.
- Its voltage falls steadily with discharge.

Alkaline batteries

- **Alkaline batteries** and **alkaline cells** (a battery being a collection of multiple cells) are a type of disposable battery or rechargeable battery dependent upon the reaction between zinc and manganese(IV) oxide (Zn/MnO_2).
- Alkaline battery is an improved dry cell.
- The alkaline battery gets its name because it has an **alkaline** electrolyte of potassium hydroxide, as opposed to the acidic electrolyte of the zinc-carbon batteries
- Zinc in a powdered form increases the surface area of the anode, allowing more particle interaction. This lowers the internal resistance and increases the power density

Construction

- A cylindrical cell is contained in a drawn steel can, which is the cathode current collector.
- The cathode mixture is a compressed paste of manganese dioxide with carbon powder added for increased conductivity.
- The hollow center of the cathode is lined with a separator, which prevents mixing of the anode and cathode materials and short-circuiting of the cell.
- The separator is made of a non-woven layer of cellulose or a synthetic polymer. The separator must conduct ions and remain stable in the highly alkaline electrolyte solution.
- The anode is composed of a dispersion of zinc powder in a gel containing the potassium hydroxide electrolyte. 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.

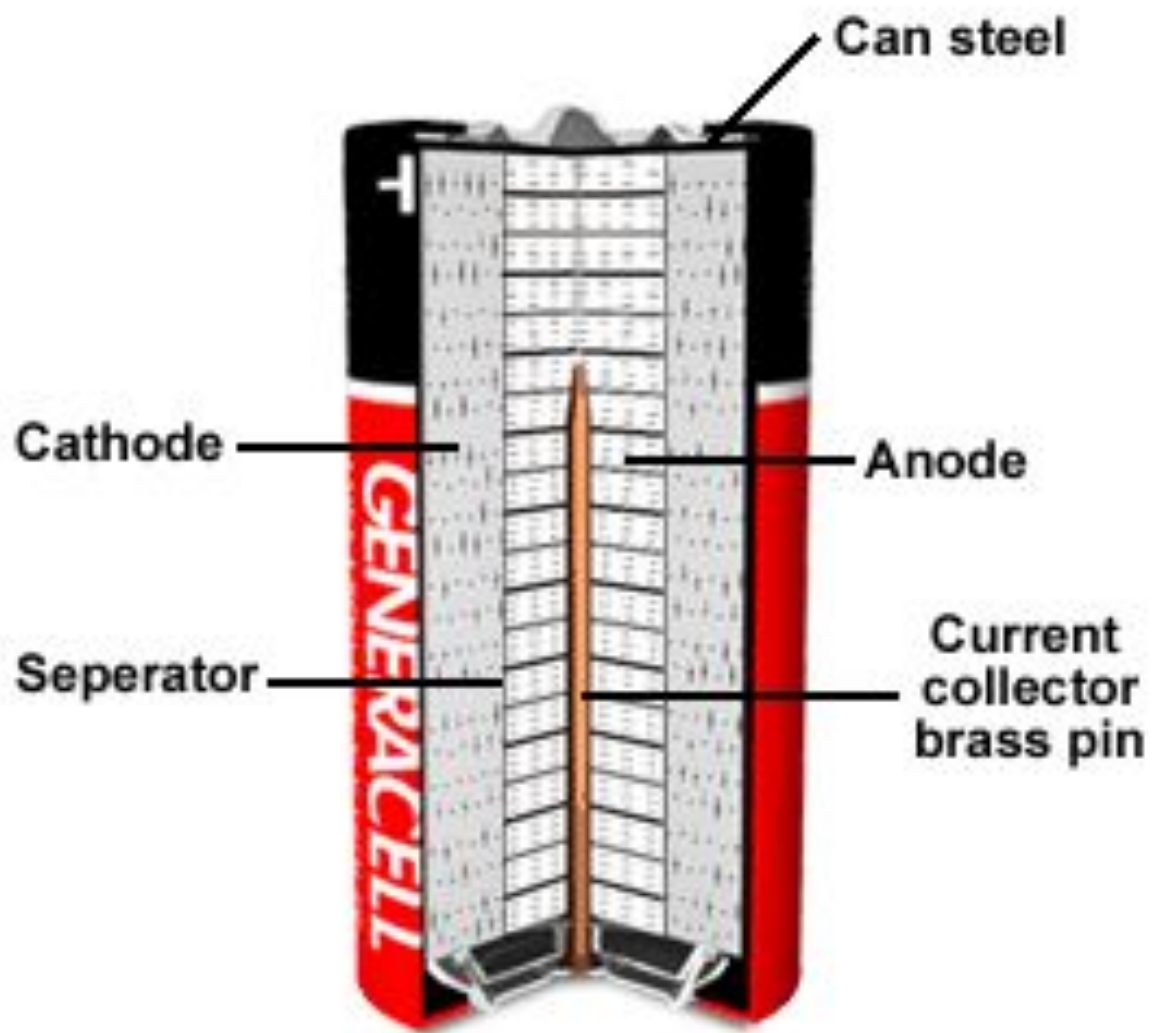


Figure 1

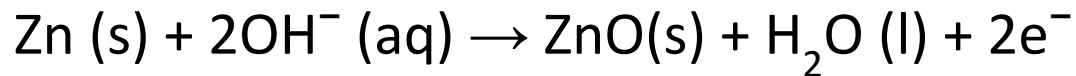
Chemistry

- ❖ Anode : Zinc Powder
- ❖ Cathode : Manganese dioxide(MnO_2) powder
- ❖ Electrolyte : Potassium hydroxide(KOH)

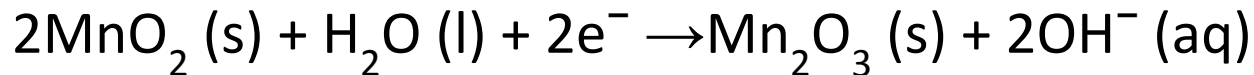


Half cell reactions

- Anode(Oxidation) :



- Cathode(Reduction) :

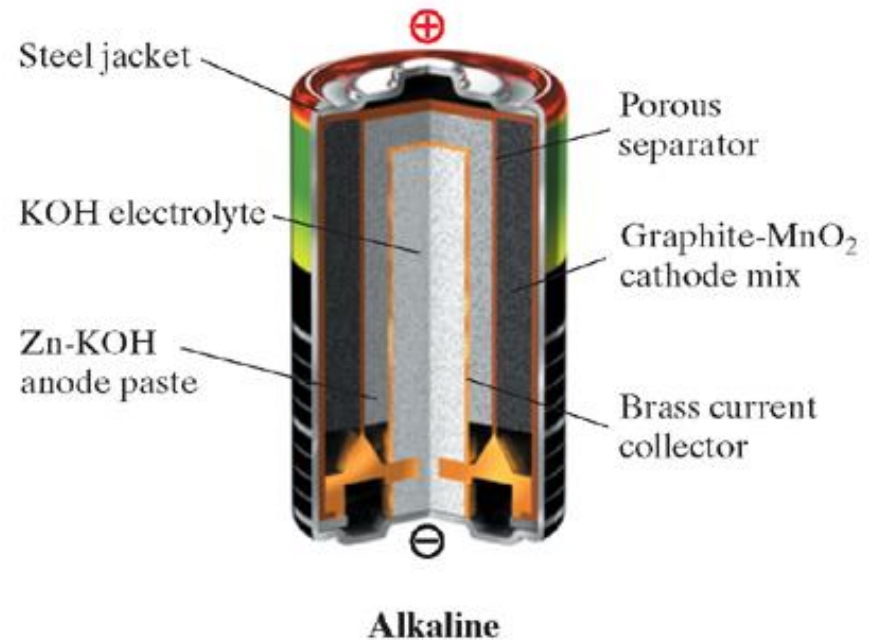
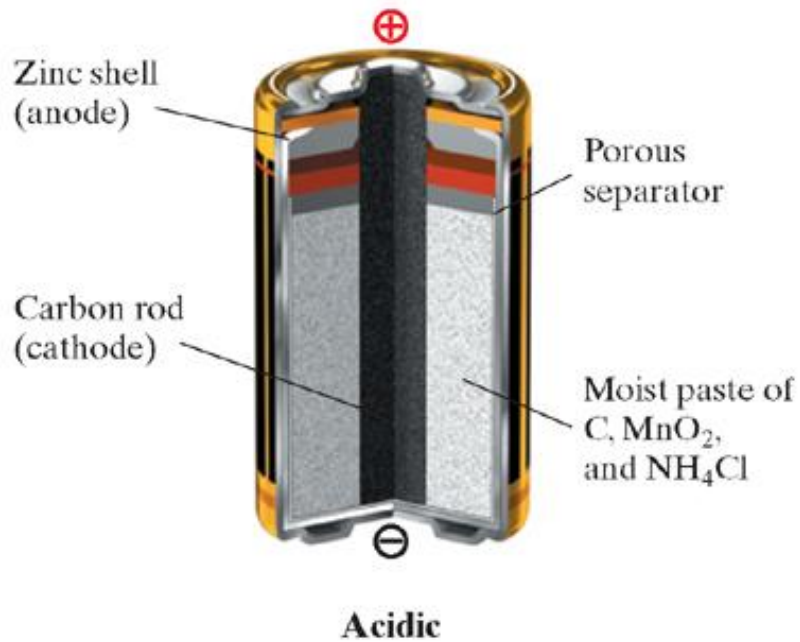


- The overall reaction is:



Advantages

- Better low temperature performance than zinc carbon. Continue to function in sub-zero temperatures.
- Less leakage than Leclanché cells
- Available in a wide range of sizes including AAA, AA, C, D and 9Volt sizes.
- Suitable for a wide range of consumer applications
- Made from non toxic chemicals
- No voltage drop and longer shelf life than dry cell because of alkaline electrolyte



- Alkaline batteries do not have a carbon rod cathode, which allow them to be smaller.