Batteries: Rechargeable vs. Non-rechargeable Batteries

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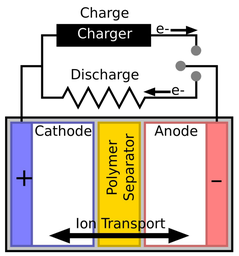
Abstract

Batteries are used to store energy for use when needed by converting chemical energy into electrical energy. A simple battery is comprised of multiple cells attached in series. A cell is made up of three part: two electrodes (an anode and cathode) in a chemical called an electrolyte. A rechargeable battery is capable of reversing the chemical reaction by forcing a current in the opposite direction. As society has progressed, rechargeable batteries have been progressively replacing non-rechargeable batteries. Laptops, phones, and other electronic, all high drain devices, are hosts to a variety of rechargeable batteries, while non-rechargeable batteries are prime choice for low drain applications such as alarm clocks or radios. Non-rechargeable batteries are known as primary batteries and have some very important uses. Primary batteries are used in some pacemakers, remote controls, electronic keys and kids toys. Non Rechargeable batteries are often higher capacity and are easily accessible.

What Are Batteries?



Rechargeable Vs. Non-rechargeable Batteries

Non-rechargeable:
- Irreversible
- Galvanic
- Lower initial cost

Rechargeable:
- Reversible
- Galvanic and Electrolytic
- Lower cost over time

Both:
- Chemical Energy ↓ Electrical Energy
- Redox Chemistry
- Electrolyte and Electrode
- Portable

- Anode (-) and cathode (+) in a circuit
- One metal compound is reduced while the other is oxidized
- Redox reaction between metals produces an electric potential and leads to a flow of electrons from anode to cathode
- **Rechargeable batteries**- the electron potential can be *reversed* by applying an external voltage onto the battery, resulting in a reversal of the galvanic discharge that took place initially.

The exact energy can be calculated using the following equations:

- $E°_{cell} = E°_{cathode} - E°_{anode}$
- $\Delta G = -nFE°_{cell}$

Examples of Batteries

Non-Rechargeable:
- Zinc-Carbon
- ZnCl
- $LiMnO_2$
- Alkaline

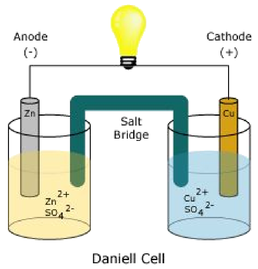
Rechargeable:
- Lithium Ion
- Lead-Acid
- NiCd
- NiMH

Battery Uses

Non-Rechargeable:
- Alarm clocks
- Radios
- Pacemakers
- Remote controls
- Electronic keys
- Kids toys

Rechargeable:
- Laptops
- Cell phones
- Portable devices

Galvanic Cells

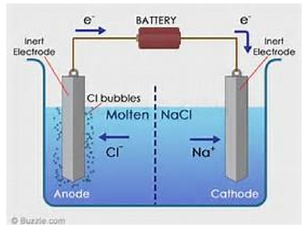


Daniell Cell

- Spontaneous oxidation-reduction reaction
- Oxidation occurs at the anode
- Reduction occurs at the cathode
- Electrons flow from the anode to the cathode.
- A salt bridge allows for the flow of ions from cathode to anode
- Since it is spontaneous, it can be used in rechargeable or non rechargeable batteries.

Electrolytic Cell

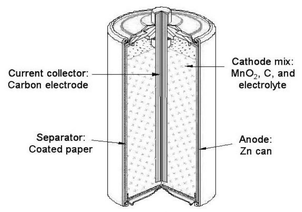
- Non-spontaneous oxidation-reduction reaction,
- Used in rechargeable batteries
- Has a semipermeable membranes for the flow of ions.
- Oxidation occurs at the cathode
- Reduction occurs at the anode



Zinc-Carbon Battery

Pros
- Cheap
- Very long shelf life
- High

Cons
- Low storage capacity.
- Hazardous to environment when disposed.
- Non-rechargeable



$$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$$

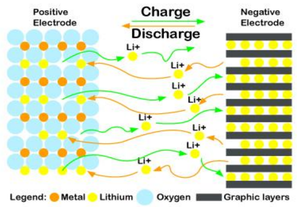
$$2MnO_2(s) + 2e^- + 2NH_4Cl(aq) \rightarrow Mn_2O_3(s) + 2NH_3(aq) + H_2O(l) + 2Cl^-$$

$$Zn(s) + 2MnO_2(s) + 2NH_4Cl(aq) \rightarrow Mn_2O_3(s) + Zn(NH_3)_2Cl_2(aq) + H_2O(l)$$

Lithium Ion Battery

Pros
- 5% charge loss per month
- Stores 150 watt-hours of electricity per 1 kg
- High voltage
- Rechargeable

Cons
- Expensive
- Thermally delicate
- Class 9 hazardous material

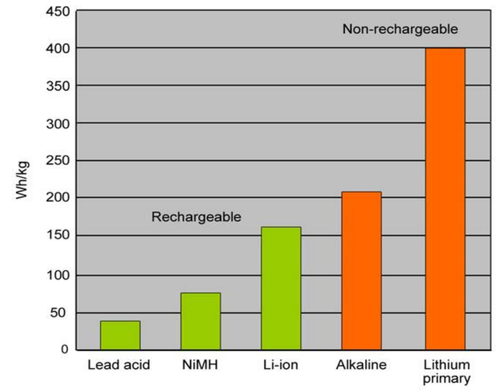


$$LiCoO_2 \leftrightarrow LiCoO_2 + Li^+ + e^-$$

$$Li^+ + e^- + C_6 \leftrightarrow LiC_6$$

$$Li^+ + e^- + LiCoO_2 \rightarrow Li_2O + CoO$$

Specific Energy Comparison



Conclusion

There are two types of batteries, rechargeable and non-rechargeable. Each type has its advantages and disadvantages for example, non rechargeable batteries typically store more energy however they can only be used once. Because of the differences, both batteries types have specific uses. Most batteries have 3 parts: the anode, cathode and electrolytic solution. Current flows between the anode and cathode generating voltage.

Acknowledgments

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