

Electrical Principles - Part 1

Storage and transfer of electrical energy

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Slides: `github.com/mariopineda/electrical-principles-slides`



Objectives

- ▶ Describe the major features of cells
- ▶ Know the two major types of cells

Battery Classification

- ▶ Primary Cells: Cannot be recharged as the chemical reactions cannot be reversed.
- ▶ Secondary Cells: Can be recharged by passing a current through the cell in the opposite direction.

Battery Chemistries: Lithium Polymer (LiPo)

- ▶ Type: Secondary cell
- ▶ Chemistry: Lithium-ion and polymer (gel) electrolyte
- ▶ Pros: High energy content, light, can be produced in any shape
- ▶ Cons: Physical damage, over charge or too high temperature can cause cells to fail catastrophically (fire, explosion)
- ▶ Voltage: 2.7-4.2V
- ▶ Usage: personal electronics (laptops, cell phones), RC vehicles, International Space Station (since 2017)
- ▶ Invented by Sony in 1991

Battery Chemistries: Lithium Ion Phosphate (LiFePO₄)

- ▶ Type:
- ▶ Chemistry:
- ▶ Pros:
- ▶ Cons:
- ▶ Voltage:
- ▶ Usage:

Battery Chemistries: Lead-Acid Battery

- ▶ Type: Secondary cell
- ▶ Chemistry: Lead, lead dioxide, electrolyte concentrated sulfuric acid
- ▶ Pros: High energy density, many recharge cycles, cheap
- ▶ Cons: Effectiveness reduced at low temperatures, self-discharges, contains lead and concentrated sulfuric acid
- ▶ Voltage: 2V per cell
- ▶ Usage: Vehicle starter and ignition, backup power supplies (computer UPS units)
- ▶ Oldest type of rechargeable

Battery Chemistries: NiCd

- ▶ Type: Secondary cell
- ▶ Chemistry:
- ▶ Pros: Long Shelf life, many recharge cycles, good performance at low temperatures, can produce very large instantaneous currents (1000-8000A for a second)
- ▶ Cons: Contains Cadmium (heavy, expensive and toxic), corrosive electrolytes
- ▶ Voltage: 1.2V per cell
- ▶ Usage: Portable electronic equipment, e.g. flash lights, aircraft and satellite systems, starting large diesel engines and turbines.

Battery Chemistries: NiMH

- ▶ Type:
- ▶ Chemistry:
- ▶ Pros:
- ▶ Cons:
- ▶ Voltage:
- ▶ Usage:

Fuel Cells

- ▶ Fuel and oxidant are continuously supplied from the outside while waste products are removed.
- ▶ Pros: High-efficiency of energy conversion, no harmful waste products, no need to recharge
- ▶ Cons: Expensive, fuel gases must be stored in high-pressure tanks, moderate power output
- ▶ Use: The space shuttle and Apollo space program, military submarines