Nickel-Cadmium Battery

European Association for Storage of Energy

Electrochemical Energy Storage

1. Technical description

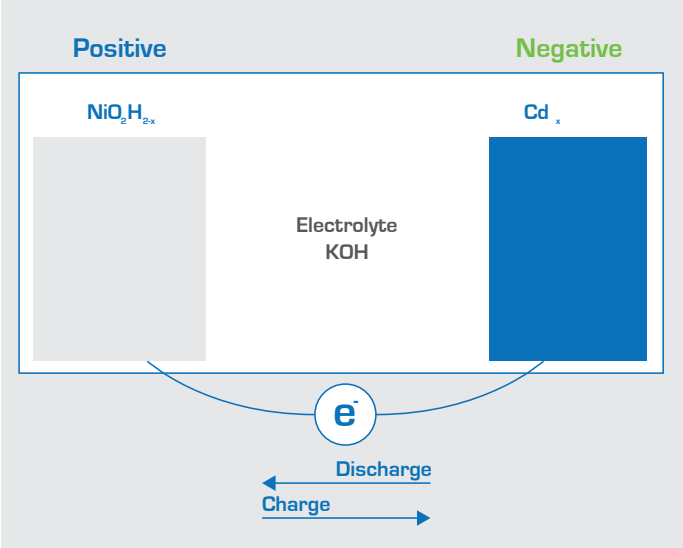
A. Physical principles

A Ni-Cd Battery System is an energy storage system based on electrochemical charge/discharge reactions that occur between a positive electrode (cathode) that contains nickel oxyde-hydroxide as the active material and a negative electrode (anode) that is composed of metallic cadmium.

The electrodes are separated by a permeable membrane which allows for electron and ionic flow between them and are immersed in an electrolyte that is made up of aqueous potassium hydroxide and that undergoes no significant changes during operation.

During discharge, the nickel oxide-hydroxide combines with water and produces nickel hydroxide and a hydroxide ion. Cadmium hydroxide is produced at the negative electrode. To charge the battery the process can be reversed.

Illustration: Charging principle of Ni-Cd



B. Important components

The main components are the following:

- Elementary cell composed of an assembling of electrodes, electrolyte and separators
- Modules composed of serial assembling of cells
- Battery systems composed of a large assembling of cells or modules and of a control system
- Power Conversion System (PCS)

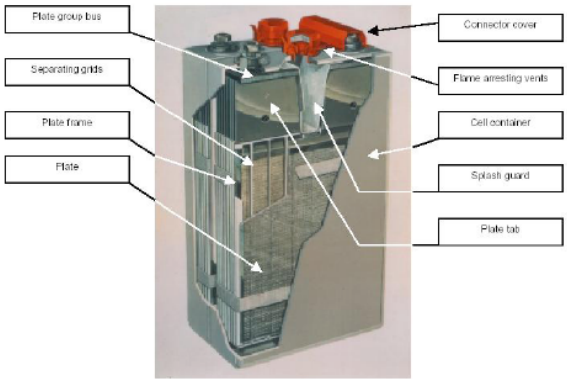
C. Key performance data

Power range	Some kW - some
Energy range	< some 10 M Wh
Discharge time	Some mn – some h
Cycle life	1 000-5 000 cycles
Life duration	10 – 20 years
Reaction time	Some ms
Efficiency	60-70 %
Energy (power) density	30-70 Wh/kg
CAPEX: energy	400 - 700 € / kWh
CAPEX: power	500 – 1 500 € / kW

D. Design variants (non exhausitive)

The following design variants are available:

- Different electrode thickness according to the power/energy ratio
- Different cell size from 2 Ah up to 200 Ah
- Different cell shapes: cylindrical (small cells) or prismatic (large cells),
- Different battery systems according to the size and the application: stationary or transport



2. State of the art

Sealed Ni-Cd batteries are used commonly in commercial electronic products such as a remote control, where light weight, portability, and rechargeable power are important.

Vented Ni-Cd batteries are used in transport applications such as aircraft, diesel engine starters, and railways where large energy per weight and volume are critical. Ni-Cd batteries are ideal for protecting power quality against voltage sags and providing standby power in harsh conditions.

Recently, Ni-Cd batteries have become popular as storage for solar generation because they can withstand high temperatures.

The Recycling technologies and collection circuits are established and operational.

Ni-Cd Battery. Normal voltage: 5,000 V. Storage Capacity: 3,680 Ah

3. Future developments

The Ni-Cd technology is rivalled by other technologies such as Ni-MH or Li-ion and no more development is expected on this technology.

4. Relevance in Europe

Due to its robustness and its low maintenance request, the Ni-Cd technology is used in very harsh environments conditions (low temperature, high temperature, humidity,...). However, the strong request for improved performances (energy & power) induced a shift towards other technologies such as Ni-MH or Li-ion.

5. Applications

As the Ni-Cd technology is considered as extremely reliable and robust, it is considered as indispensable for some security applications in demanding application areas.

Aviation safety

Rail

Reliable networks where access is difficult: off-grid PV, telecom networks

6. Sources of information

- EASE members
- EUROBAT
- ENEA Consulting
- Saft
- A review of Energy Storage Technologies