Sodium-Nickel-Chloride Battery

European Association for Storage of Energy

Electrochemical Energy Storage

1. Technical description

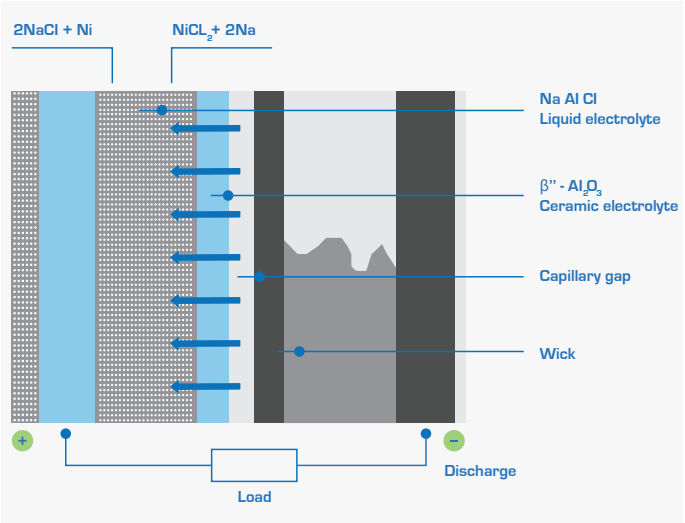
A. Physical principles

$Na/NiCl_2$ secondary battery is an energy storage system based on electrochemical charge/discharge reactions that occur between a positive electrode (cathode) consisting mainly of nickel (Ni) and sodium chloride (NaCl) and a negative electrode (anode) that is typically made of sodium (Na). The electrodes are separated by a beta-alumina ceramic wall that is conductive for sodium ions but an isolator for electrons.

This beta-alumina ceramic acts as an electrolyte and enables the conduction of sodium ions between the anode and the cathode of the cells.

The battery temperature is kept between 270° C and 350° C to keep the electrodes in a molten state, i.e. independent heaters are part of the battery system.

Illustration: Charging principle of $NaNiCl_2$



B. Important components

The main components are the following:

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

C. Key performance data

Power range	Several MW
Energy range	4kWh Up to several MWh
Discharge time	from 2h to several hours
Cycle life	4500 cycles
Life duration	<15 years
Reaction time	Some millisec
Efficiency	85 - 95 % (*)
Energy (power) density	100 - 120 Wh/kg
CAPEX: energy	550 – 750 € / kWh
CAPEX: power	150 – 1000 € / kW

(*) Including auxiliary loads

D. Design variants (non exhausitive)

Different battery systems are possible according to the size, ranging from a case up to a container.

2. State of the art

The $NaNiCl_2$ technology has been introduced into the market over the last decade for electric vehicles (EV), mainly for public transport. Currently a wider range of products is available for stationary backup, railway backup, electric vehicles and on-grid/off-grid energy storage applications. The single battery size ranges from 4 to 25 kWh suitable for a wide range of applications with energy storage capacities from a few kilowatt-hours to several megawatt-hour installations. Due to the ceramic electrolyte the battery has no electrochemical self-discharge. Dependent on operation conditions, the thermal loss is balanced by the internal electrical loss that is converted to heat so that the overall efficiency is in the range of 80-95%.

In contrast to other types of high temperature batteries, $NaNiCl_2$ batteries have inherent overcharge capabilities and lower operation temperatures. Also, unlike other batteries, they may have a flexible power-to-energy ratio and can be cooled to ambient temperatures without component damage.

Sodium Nickel Chloride are high temperature batteries which guarantee high performances and durability regardless of the ambient temperature. During operation, even if the outside ambient temperature varies greatly, the internal temperature of the battery module will remain within the operative temperature range and will not affect its capacity and lifetime.

Both discharge and charge operations are regardless of outside temperature even during the most harsh thermal conditions.

Since 1999, $NaNiCl_2$ batteries have been manufactured in Europe and in US. Many projects are already in operation all over the world (USA, South America, Europe, South Korea).

3. Future developments

After only 15 years in use, there remains a very extensive potential for $NaNiCl_2$ battery technology improvements. On laboratory scale specific power is being improved by using advanced additives to the positive active materials and by lowering the resistance of the solid ceramics electrolyte. Further cost reductions are being realised through automation and process improvements on top of the increase of production volume. Life cycle will be increased through design enhancements such as new glass materials which are more corrosion resistant.

Complete turnkey energy storage systems with a power rate up to the MW size and 2 to 6 hours energy are being already installed.

$NaNiCl_2$ technology is well-suitable for specific solutions in on-grid and off-grid applications.

4. Relevance in Europe

This technology, manufactured firstly in the EU than also in US, can be considered as an alternative to Na/S batteries that are only manufactured in Japan. It was first introduced in the market for automotive applications, and now days this technology is covering multiple application as stationary energy storage, smart grid (on-grid and off-grid), renewables, backup, UPS for data-center applications, electric vehicles.

5. Applications

Due to their high scalability and flexibility in assembling different battery and system sizes, $NaNiCl_2$ batteries are used in a wide variety of applications:

Residential and commercial buildings: time shifting, maximisation of self-consumption of locally produced PV energy, uninterruptible power supplies (UPS), power boost to reduce the contract tariff

Distribution grids: peak shaving, smoothing & energy time shifting for renewable generation, support of smart grids management. Investment deferral

Renewables generation optimization

Transmission grids: energy time shifting, grid frequency regulation

Micro-grid on-grid & off-grid applications

6. Sources of information

- EASE members
- FIAMM
- ENEA Consulting
- ISEA RWTH Aachen

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