HOPPECKE

Operating Instructions

for vented FNC-T nickel cadmium batteries with fibre-structured electrodes for use in automatic guided vehicles (AGV) and other traction applications

Specifications:
Nominal voltage U_N: 1.2 V x number of cells connected in series
Nominal capacity $C_N = C_5$:
5-hr discharge with nominal current
(see type plate and techn. data in these instructions)
Nominal discharge current: $I_N = I_5$: $\frac{C_N}{5\ h}$
Nominal final discharge volt. U_s: 1.0 V/C
Nominal temperature T_N: 20°C

Installed by: _____

on: _____

Start-up by: _____

on: _____

Safety marking
affixed by: _____

on: _____

Observe operating instructions and affix close within sight of the battery! Work on batteries only under instructions of skilled personnel!

Smoking prohibited!
Do not expose battery to open flame, heat or sparks as explosion and fire hazard exists!

When working on batteries wear protective glasses and clothing! Observe the accident prevention rules as well as DIN VDE 0510, VDE 0105 Part 1!

Lye splashes in the eyes or on the skin must be washed out or off with plenty of water. Then see a doctor immediately! Lye splashes on clothing must be washed out with water!

Explosion and fire hazard, avoid short circuits!
Caution! Metal parts of the battery cells are always live, do not place items or tools on the battery!

Electrolyte is strongly corrosive!

Do not tip the battery!
Only use approved lifting and transport equipment, e.g. lifting equipment in accordance with VDI 3616.
Lifting hooks must not damage cells, connectors or connector cables.

Note:
Non-compliance with operating instructions, repairs made with other than original parts, tampering or use of additives for the electrolyte render the warranty null and void.

Warning:
Never use acid or dilute acid solutions for topping up. Acid destroys the battery.

Caution:
During and after charging the battery produces explosive gases. Ensure adequate ventilation under VDE 0150, Part 3. Up to 1 h after charging electric connections must not be touched. No open flame, heat, electric installations or carriers of static electricity which could produce sparks must come near the battery! Metal parts of the battery installation could be live. Use insulated tools and suitable clothing. Do not wear rings, watches or metal objects when working on the battery installation.

1. General hints

1.1 Before commissioning all cells must be inspected for mechanical damage and correct polarity connection. Connectors must be firmly seated. The following torques apply for screw connectors:
Thread size M8: 16 Nm ± 1 Nm
Thread size M10: 20 Nm ± 1Nm

1.2 With charger off and loads isolated connect battery to the charger (positive terminal to positive post) maintaining correct polarity.

2. Preparing unfilled batteries/cells

2.1 The cells are filled with electrolyte up to a level between the min. and max. mark. See the separate instructions on preparing and handling of electrolyte.
Before filling with electrolyte remove the transport plugs.
After filling, the supplied standard vent plugs are fitted onto the cells.

Note:
If Aqua Gen® vent plugs are supplied, do not fit onto the cells until after initial charging.

2.2 After filling and a waiting period of 12 hours carry out initial charging as described under section 3.2 and 3.3.

2.3 Not less than two hours after completion of initial charge the electrolyte level in the cells must be filled to the max. mark with electrolyte. If Aqua Gen® vent plugs are supplied they are then fitted onto the cells.

3. Preparing filled cells for use

3.1 Replace the transport plugs with standard vent plugs (flip-top vent plugs)

3.2 Initial charging is carried out at the battery's constant nominal charging current for 12 hours. The nominal charging current is calculated as $C_N/5$ h.
Initial charging is not necessary if the cells / batteries are delivered filled and

charged and are put into operation as described under section 4 within 2 months of delivery. Following long transport or storage periods the filled and charged cells / batteries should undergo an equalizing charge as under section 4.6.

Note:
Constant charging currents of up to 50% of the nominal charging current are permissible for initial charging if the charging duration is set so that a quantity of electricity of 2.4 x C_N is charged into the battery.

During initial charging with constant current, cell voltages of up to 1.9 v may occur. The load must therefore be disconnected from the battery, see section 1.2. During initial charging a higher quantity of water is decomposed (gassing) than during normal battery operation. Sufficient ventilation must therefore be ensured according to DIN VDE 0510.

3.3 After long battery transport periods or storage periods of over 36 months, three to four battery charges and discharges are recommended. Charging is carried out with the constant nominal charging current and a charge factor of 1.0 v/cell. The final charge is an equalizing charge as described in section 4.6.

3.4 Not less than two hours after completion of the charge the electrolyte level in the cells must be topped up to the max. mark with distilled water. After cleaning the cells, see section 5.2, the battery is ready for operation.

4. Operation

4.1 For the assembly and operation of traction batteries DIN VDE 0510 Part 3 and DIN VDE 0117 apply. VDE 0100 and VDE 0105 must also be observed.

4.2 Discharging
Unless the manufacturer has specified otherwise, the battery may not be discharged below the nominal final discharge voltage.

4.3 Charging
Charge with direct current only. All charging methods with their limit values may be employed as under
DIN 41773 Part 2 (IU characteristic)
DIN 41776 (I characteristic)

In order to avoid overloading the electric circuits and contacts and to prevent unacceptable gas formation and leakage of electrolyte from the cells, only connect to a charger allocated and approved for the battery size.

If the charger was not procured together with the battery, it is advisable to have it checked for suitability by the battery manufacturer's service department.

During charging it must be ensured that charge gases can escape unhindered. Remove the battery-tray lid or open the cover of the battery installation area. For batteries in AGV systems see special parameters, section 4.4.1.
The vent plugs remain on the cells.

With the charger off the battery must be connected, ensuring correct polarity (plus on plus and minus on minus). The charger is then switched on.

4.4 General operating parameters

4.4.1 Operation in automatic guided vehicle systems (AGV)
With this method of operation the battery is used for running an automatic guided vehicle. These vehicles serve to transport materials.

The characteristic of this battery is a constant cycle (charge - discharge) operation where the battery is only charged with a charge factor of approx. 1.02 to 1.05. After a certain period of operation, usually between 3 and 12 months, depending on the load applied to the battery, an equalizing charge as under section 4.6 is necessary.

For discharging the battery the following general operational parameters apply:
The maximum discharge depth with each cycle is 30% C_N. The daily capacity (in Ah per day) withdrawn from the battery can be up to 4 x C_N at an ambient temperature of up to 30°C without the necessity for additional cooling. Should the daily capacity requirement exceed the above-mentioned values, provision must be made in the battery tray for ventilation. (convection). If this is not possible or should the daily capacity drawn exceed 6 x C_N forced ventilation must be provided for the battery.

The battery loads are generally as follows:
Constant driving current:1 to 2.5 x I_5
Peak current: 10 to 20 I_5
Voltage range: 1 V to ≥ 1.2 V x number of cells connected in series.

The battery is charged under an IUOU characteristic or an IUa characteristic according to 41773. The following parameters are adhered to:
Charge current H types: 5 to 12.5 x I_5
X types: 5 to 20 x I_5

Charge voltage boost charge: 1.55 V/cell to 1.65 V/cell
Float charge: 1.4 V/cell to 1.45 V/cell.

With AGV operation battery gassing is largely avoided so that the battery can be charged in the AGV. With AGV it must merely be ensured that no dangerous accumulation of charge gasses can occur.

FNC-T batteries of type M are not recommended for use in AGV installations.

4.4.2 General traction applications
FNC-T batteries are also used in hand-driven industrial trucks and fork-lift trucks. Depending on battery design the discharge depth can reach up to 100% CN. By sufficient ventilation of the battery it must be ensured that the electrolyte temperature does not exceed 35°C. A temperature of 45°C is also tolerated for short periods.

The battery loads in this operation are as follows:
Constant driving current:
FNC-T H and X types: see section 4.4.1
FNC-T M types: up to 1.5 x I_5

Peak current:
FNC-T H and X types. see section 4.4.1
FNC-T M types: up to 10 x I_5

Voltage range:
1 V to ≥ 1.2 V x number of cells connected in series

The battery is charged using the IUOU characteristic or - preferably - using an IUIa characteristic under DIN 41773 with the following parameters:
Charge current, main charge
X types: see section 4.4.1
H types: see section 4.4.1
M types: up to 7.5 x I_5

Additional charge (IUIa characteristic) for all types: 0.5 x I_5
Charge factor: 1.2
Charge voltage: 1.55 V/cell to 1.65 V/cell

In the Ia part of the characteristic voltages of ≥ 1.75 V/cell can occur. Disconnect the load from the battery.

4.5 Special instructions for the operation of batteries in hazardous areas
These are batteries which operate under VDE 0170/0171 EX I in firedamp con-

ditions or under EX II in areas where explosion hazard exists.

During charging and after-generation of gas the container lids must be lifted or opened such that any developing explosive gas mixture is neutralized by sufficient ventilation.

4.6 Equalizing charge
Equalizing charges serve to extend service life and maintain capacity. They are necessary as part of important maintenance work and after exhaustive discharges and repeated insufficient recharging.

The battery is charged with constant current as in initial charge (section 3.2). The equalizing charge is completed when the battery has reached a minimum voltage of 1.75 V x number of cells connected in series and has been charged at this voltage for 4 hours. As it is possible to exceed the permissible load voltages, appropriate measures must be taken, e.g. disconnect the load from the battery. Sufficient ventilation must be ensured (VDE 0510, Part 3).

On exceeding the maximum charge temperature of 45°C, charging must be interrupted to allow the battery to cool down.

4.7 Superimposed alternating currents
Alternating currents superimposed on the battery's direct current lead to additional warming of the battery. When recharging a battery using the methods described under sections 4.4 to 4.6 the actual value of the alternating current should not exceed a value of 20 A per 100 Ah battery nominal capacity. With an equalizing charge a value of 5 A per 100 Ah should not be exceeded.

4.8 Temperature
The optimal operating temperature range for nickel-cadmium batteries is 0°C to 30°C. The technical data apply for the nominal temperature of 20°C. The operating temperature range lies between -25°C and +45°C for the types of operation under sections 4.4 to 4.6. The operating temperature range can be extended to -40°C if an original HOPPECKE special electrolyte is used. Higher temperatures result in reduced charge acceptance and shorten service life. Lower temperatures reduce the available capacity.

4.9 Temperature-related charge voltage
A temperature-related adjustment of the charge voltage can be made at an operating temperature of above 30°C. The temperature correction factor is -0.002 v/cell per °K.

4.10 Electrolyte
The electrolyte consists of diluted caustic potash solution (KOH) with a lithium hydroxide (LiOH) additive, see the instructions for mixing electrolyte and DIN 43 530 for permissible impurities. The nominal electrolyte density of 1.19 kg/l ± 0.02 kg/l is based on 20°C and an electrolyte level up to the max. mark in the battery's fully charged state.
Higher temperatures reduce the electrolyte density, lower temperatures increase the electrolyte density. The correction factor is 0.0005 kg/l per °K.

Important:
The electrolyte maintains efficiency throughout the entire battery life. The electrolyte never needs changing during the battery's service life.

Important:
With nickel-cadmium batteries the electrolyte density is no measure for the battery's state of charge.

5. Battery maintenance and control (servicing)

5.1 Electrolyte level
The electrolyte level must be checked regularly. If it has dropped to the min. mark while in a charged state, it must be topped up with distilled water under DIN 43 530, Part 4, maximum conductivity 30 S/cm.
See section 4.10 on electrolyte density.
If the electrolyte level drops due to water decomposition, the electrolyte density will increase slightly.
Electrolyte density should not be measured just after topping up with distilled water.

5.2 Cleaning/maintenance
To avoid leakage currents the battery must be kept dry and clean. Cleaning the battery should be carried out as specified in the ZVEI pamphlet on battery cleaning.
The cell plugs must be closed.

Caution:
Dangerous contact potential possible.

Plastic battery components, in particular the cell containers, must only be cleaned with water containing no additives. The vent plugs can be cleaned in warm water.

5.3 Checks at regular intervals

5.3.1 For a standard maintenance (every 3 to 12 months, depending on the load) the following must be carried out:
- measure the open-circuit voltage of all cells
- carry out an equalizing charge as under section 4.6
- measure the charge voltage of all cells just before end of charge

5.3.2 In an extended maintenance (every 12 to 18 months, depending on the load) the following must be carried out in addition to the standard maintenance checks:
- check electrolyte temperature in a few cells
- discharge the battery with nominal current before the equalizing charge
- check that connecting bolts are securely fastened
- under VDE 0117 the insulation resistance of the vehicle and the battery must be checked as required but at least once a year by an electrician.
The check for insulation resistance must be conducted according to DIN 43 539 Part 1.
As specified under DIN VDE 0510, Part 3, the battery insulation resistance recorded should not be less than the value of 50 Ω per V nominal voltage. With batteries with a nominal voltage of 220 V the minimum value is 1000 Ω.

An extended maintenance comprises the following additional points:
- general condition of the battery
- charger running smoothly

6. Tests
Tests must be conducted according to EN 60 896, complemented by DIN 43 530 or also IEC 623.

7. Faults
Should faults be detected in the batteries or charging devices, customer services must be called in immediately. Measurement data under section 5.3 facilitate fault detection and removal.

8. Storage and taking out of operation

Should cells or batteries be stored or taken out of operation for longer periods, they must be placed in a dry room. The cells can be stored unfilled or filled with electrolyte. Before storing, the filled cells must be discharged with nominal current up to the nominal final discharge voltage.

Note:
Dangerous contact potential possible. Only insulated tools may be used. Never place tools on connectors: short circuit and fire hazard.

For storage in excess of 6 months the cells are discharged as described above. The

electrolyte is then emptied out and the standard vent plugs (flip-top vent plugs) are replaced by transport plugs. Following these preparations the cells can be stored indefinitely.
Before using stored cells follow instructions as under sections 1 and 2.

9. Transport

Batteries which do not show any damage are not treated as dangerous goods under the German dangerous goods regulations - roads (GGVS) and dangerous goods regulations - railways (GGVE) as long as they are secured against short circuits, slipping, falling over or damage and are stacked and secured appropriately onto pallets. (German dangerous goods regulations - roads (GGVS, Rand No 2801 a). There must be no external traces of electrolyte solution detectable on the goods to be transported.

10. Dismantling, disposal, recycling of batteries

The dismantling and disposal of batteries may only be carried out by trained personnel. The EC Directives 91156 (EEC) and 9386 (EEC) must be observed.

11. Technical data

The battery's nominal voltage, the number of cells, the nominal capacity (CN = C_5) and the battery type are obtained from the type plate. Other capacities at different discharge currents can be obtained from the manufacturer's type lists.

The following table shows the different FNC-T cell types according to capacity class:

11.1 FNC-T type range X for very high loads, at discharge times ranging from split seconds to a few minutes

FNC-T Type X	Nominal capacity Ah	Nom. current A	Cell weight kg
FNC-T 103 X	10	2.0	1.38
FNC-T 106 X	19	3.8	2.46
FNC-T 110 X	33	6.6	3.74
FNC-T 114 X	45	9.0	5.04
FNC-T 118 X	58	11.6	6.24
FNC-T 203 X	13	2.6	1.80
FNC-T 206 X	25	5.0	3.16
FNC-T 210 X	43	8.6	4.83
FNC-T 214 X	60	12.0	6.31
FNC-T 218 X	77	15.4	7.84

11.2 FNC-T type range H for high loads, at discharge times ranging from a few seconds to approx. 30 minutes

FNC-T Type H	Nominal capacity Ah	Nom. current A	Cell weight kg
FNC-T 101 H	9	1.8	1.2
FNC-T 102 H	17	3.4	1.4
FNC-T 103 H	26	5.2	2.1
FNC-T 104 H	35	7.0	2.3
FNC-T 105 H	44	8.8	3.2
FNC-T 106 H	52	10.4	3.4
FNC-T 107 H	60	12.0	3.6
FNC-T 108 H	70	14.0	4.4
FNC-T 109 H	78	15.6	4.6
FNC-T 110 H	86	17.2	5.4
FNC-T 111 H	95	19.0	5.6
FNC-T 201 H	12	2.4	1.52
FNC-T 202 H	23	4.6	1.77
FNC-T 203 H	35	7.0	2.68
FNC-T 204 H	46	9.2	3.00
FNC-T 205 H	58	11.2	4.17
FNC-T 206 H	69	13.8	4.36
FNC-T 207 H	80	16.0	4.58
FNC-T 208 H	93	18.6	5.58
FNC-T 209 H	104	20.8	5.78
FNC-T 210 H	115	23.0	6.91
FNC-T 211 H	125	25.0	7.21
FNC-T 307 H	140	28.0	8.58
FNC-T 308 H	160	32.0	9.16
FNC-T 309 H	180	36.0	9.24
FNC-T 310 H	200	40.0	11.11
FNC-T 311 H	220	44.0	11.61

11.3 FNC-T type range M for average loads, at discharge times ranging from 20 minutes to a few hours

FNC-T Type M	Nominal capacity Ah	Nom. current A	Cell weight kg
FNC-T 201 M	20	4.0	1.54
FNC-T 202 M	40	8.0	2.58
FNC-T 203 M	60	12.0	2.84
FNC-T 204 M	80	16.0	4.16
FNC-T 205 M	100	20.0	4.46
FNC-T 206 M	120	24.0	5.56
FNC-T 207 M	140	28.0	5.90
FNC-T 208 M	160	32.0	7.11
FNC-T 209 M	180	36.0	7.41
FNC-T 306 M	200	40.0	8.51
FNC-T 307 M	233	46.6	9.23
FNC-T 308 M	266	53.2	10.00
FNC-T 309 M	300	60.0	10.94

HOPPECKE Batterien

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