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CHANGHONG NF-S Series Nickel-Iron batteries for solar PV application

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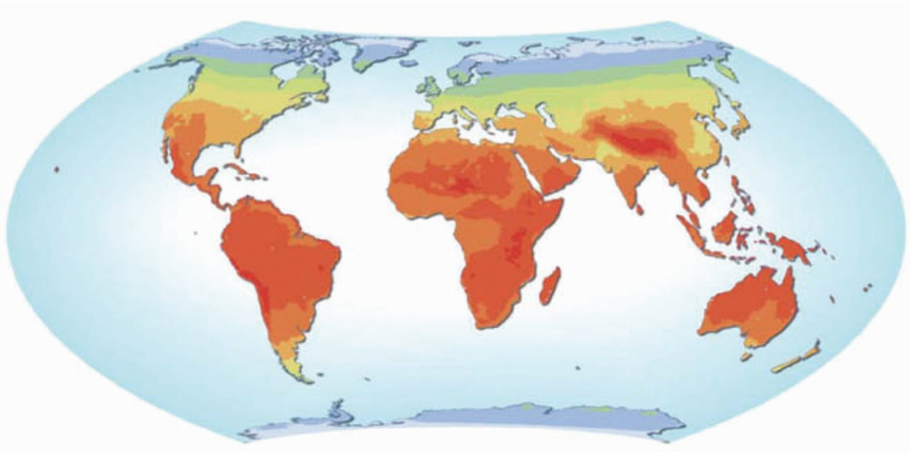
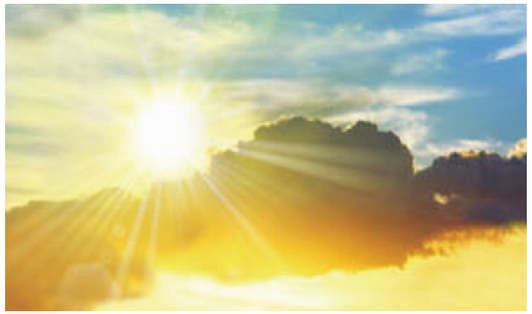
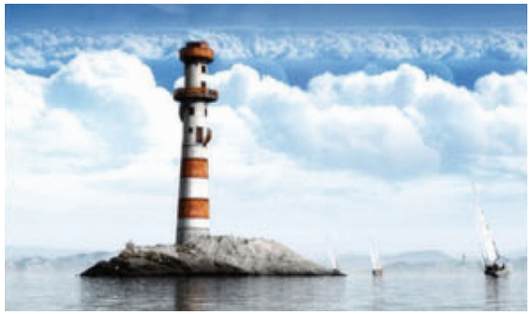
The Power Of Energy







1.1 Introduction

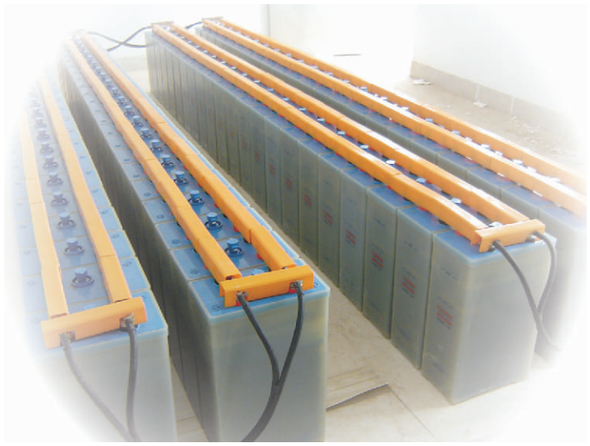
Nowadays, more and more countries have attached the great importance to environmental protection and advocate using green energy. Because of its high reliability, long service life, lower cost, pollution-free and other characteristics, Nickel-Iron(NiFe) batteries are gradually replacing the lead-acid batteries in a wide range of applications, especially for solar PV and renewable energy power systems.

This manual details the technical characteristics of Changhong Solar Nickel-Iron battery NF-S series.

The NF-S series Solar NiFe batteries manufactured by Sichuan Changhong Battery Co., Ltd are specially designed for solar PV and renewable energy applications under critical and harsh circumstances. The NF-S series battery has many advantages such as low operation cost, low self-discharge, long cycling life, environmental friendliness, etc. It can withstand deep discharge, wide temperature variations, mechanical & electrical abuses and still show excellent and reliable performance over a long period.

NF-S series solar NiFe batteries are suitable for all solar photovoltaic power systems. They are widely used as storage power supply for solar photovoltaic system, offshore oil platforms,railway transportation, crossing guards lighting, signaling, isolated BTS station, cathodic protection for pipelines and radio navigation systems. The operational life of NF-S series solar Ni-Fe batteries can last longer than 20 years if they are operated according the recommended method. Special

features include a steel frame with welded plates, shock-resistant polypropylene or MBS casing material and special flame arresting flip-top vent. In addition,the flooded electrolyte reserve is larger and prolongs the topping-up interval period. With the aid of advanced manufacturing methods and excellent design,the NF-S series Ni-Fe batteries are specially suitable for remote and isolated locations requiring minimal maintenance.



1.2 Photovoltaic System

The power generated by solar photovoltaic systems is widely used for different applications: such as pumping water,indoor lighting,supplying power for a microwave tower on top of a mountain,etc. the battery system is able to supply power for the load on cloudy days and at night. The normal solar photovoltaic system is ideal for field & unmanned operation due to easy installation and high reliability.

1.2.1 Photovoltaic Applications

Navigation Aids
- Remote lighthouses
- Beacons
- Offshore

Telecommunication Systems
- Base Stations
- Radio Repeater Stations
- Emergency Telephone Posts

Railway and Light Trains
- Crossing Gates
- Lighting and Signaling

Oil and Gas Fields
- Emergency Lighting on Offshore Platforms
- Cathodic Protection for Pipelines

Utilities
- Electric Power Supply for Remote Areas/Islands

1.2.2 Components of the Photovoltaic System

A photovoltaic system consists of three main parts:

1.Photovoltaic array

2.Electronic components, e.g. blocking diodes, logic circuits in power conditioners & controllers.

3.Batteries

Thus,the ideal photovoltaic power system is a reliable installation which requires infrequent maintenance. The batteries play a crucial role,as premature failure of the battery results in failure of the whole system.

1.2.3 Suitability for photovoltaic applications

- Higher charge ratio and utilization ratio
- Able to withstand abuse and wide temperature variation
- Easy to transport and install in remote and harsh areas
- Resistant to withstand failure of electronic control systems
- Unmanned operation,reliability,low maintenance

1.3 Construction features

1.3.1 Plate Construction

Changhong NF-S series NiFe cell consists of two groups of plates, the positive plate containing nickel hydroxide and the negative plate containing iron oxide. These active materials are retained in pockets formed from nickel plated steel strips which is are doubled perforated by a mechanical rolling process. These pockets are mechanically linked together, cut to the size corresponding to the plate length and compressed to the final plate dimension. Then, these plates are welded to a current carrying bar which further ensures high mechanical strength and electrical stability.

Because the structural component of the plate is steel, the plates are not gradually weakened by repeated cycling, which gives Changhong NF-S series NiFe batteries an exceptionally good cycle life. Besides, the alkaline electrolyte inside doesn't react with steel, which means that the supporting structure of the NF-S series NiFe batteries stay intact and unchanged during their whole life. Since there is no corrosion, there is no risk of "sudden death", therefore, NF-S series NiFe batteries can meet the special requirements of solar photovoltaic applications. In contrast, the structure and the active material of the lead plate brings about shedding of the positive plate material and eventual structural collapse of lead acid batteries.

1.3.2 Electrode Separator

The electrode separator is a key feature of Changhong's NF-S series NiFe battery. Using polypropylene material separation, the distance between the plates is carefully controlled to promote the level of recombination. By providing a large space between the positive and negative plates and a generous quantity of electrolyte between plates, good electrolyte circulation is generated to avoid the phenomenon of electrolyte stratification which exists in lead acid batteries.

1.3.3 Electrolyte

The electrolyte used in NF-S series NiFe battery is a combined solution of potassium hydroxide and lithium hydroxide, which can improve the battery's performance, (e.g. cycling life, energy efficiency, wide operational temperature range, etc) allowing it to reach the optimum level. The different standard concentrations of electrolyte allow NF-S series NiFe battery to be operated within a temperature range of -20℃ ~60℃, which makes the battery able to withstand very high temperature fluctuation that exists in some remote regions.

1.3.4 Terminal Poles

Nickel plated terminal poles made of threaded steel bars are welded onto the current carrying bar to assemble plate groups. The cell cover and terminal pole are sealed by compression rubber washers, which are designed to provide satisfactory sealing throughout the whole life of the battery.

1.3.5 Vents

Changhong NF-S series NiFe batteries are fitted with special flame arresting flip-top vents to provide good ventilation while charging, to ensure the battery works safely and reliably.

1.3.6 Cell Container

The cell container is made of transparent and corrosion-free polypropylene or MBS engineering plastic material.

1.4 Benefits of the Changhong NF-S series NiFe Battery

- ◆ Long cycle life (maximum service life can reach 20 years or more,if operated correctly)
- ◆ Wide operating temperature range
- ◆ Low maintenance

With its specially designed recombination separator and generous electrolyte reserve, the topping-up frequency is reduced so the Changhong NF-S series NiFe battery can be left in remote sites without maintenance for long periods

- ◆ High resistance to mechanical and electrical abuse
- ◆ Low transportation and installation cost

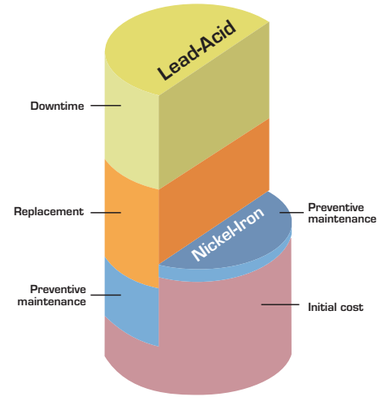
Because of its high mechanical strength, NF-S series NiFe battery is able to withstand harsh treatment during transportation and installation.

1.5 Comparison Between VRLA and NF-S Series NiFe Cell

1.5.1 Table1 Characteristic comparison Sheet

Item Name	Lead Acid Battery	NF-S Battery
Normal Voltage	2V	1.2V
Floating Charge Voltage	2.23V/cell~2.3V/cell	1.45V/cell~1.50V/cell
Temperature factor during floating charge	-3mV/℃ · cell	-3mV/℃ · cell
Operating voltage	Average	Good
Standard charge and discharge current	0.1C10A	0.25C5A
High rate discharge performance	Poor	Good
Overcharge performance	Poor	Good
Over discharge performance	Extremely Poor	Good
Effect from floating charge voltage	When the charge voltage exceeds 2.35V/cell,the service life of VRLA cell will be reduced by 1/2 for every 0.1V/cell increase.	Not affected
Operation life	3 years	20 years
Storage life	2 years	4 years
High temperature performance	When the ambient temperature exceeds 50℃,there is capacity decrease risen from the reduction of the charge acceptance performance,which greatly effect the service life of the VRLA cell.	Not affected
Low temperature performance	Great effect on the service life of VRLA cell	Little effect on the service life of NF-S series NiFe cell
Thermal danger if shorted	Yes	No
Premature capacity loss	Yes	No
Environmentally friendly	No	Yes

1.5.2 Cost Comparison Between VRLA and NiFe Cell



Life-cycle Cost Comparison After Ten Years

Cost effectiveness

There are three distinct parts to the cost of a battery system:

- Initial investment: including the cost of purchase,spares,tools,and installation.
- Maintenance cost: including unexpected and expensive downtime costs,
- Replacement cost: including dismantling, shi pping,disposal and administrative costs

VRLA batteries:

In the case of lead acid batteries,this can also include frequent replacement and all the costs associated with an unexpected battery failure.

NiFe batteries:

Of course,NiFe batteries may cost more than lead-acid cells on the basis of initial investment alone.As for stand-by, like solar photovoltaic applications with large capital investment installed in remote locations, maintenance reliability and replacement cost factors can greatly outweigh the initial cost of the battery.

The performance of NiFe cells are similar to Ni-Cd cells. In addition,NiFe cells are pollution-free. The true maintenance requirements and the life cycle costs are the main factors to be considered to make a cost effectiveness calculation. Considering the extra costs of sudden or premature failure of Lead acid batteries,Ni-Cd and Ni-Fe batteries are cheaper in the long-term.

1.6 Operation Characteristics

1.6.1 Rated Capacity

The capacity of the Changhong NF-S series NiFe battery is rated in ampere hours (Ah), which is the quantity of electricity discharged by 120-hour discharge rate (C120) current to 1.0V end-off voltage at 20℃ after being fully charged.

1.6.2 Nominal Voltage

The nominal voltage of the Changhong NF-S series NiFe battery is 1.2V/cell.

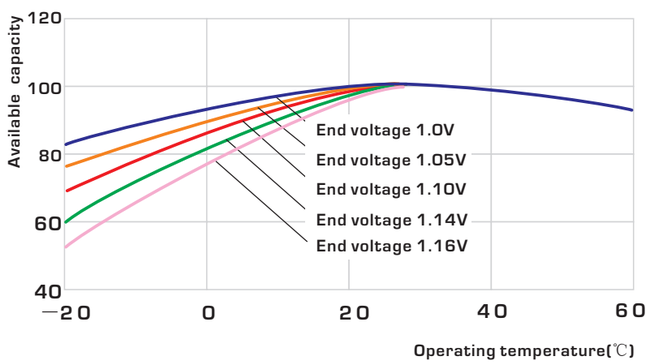
1.6.3 Internal Resistance

The internal resistance of a cell varies with the type of service and the state of charge, thus it is difficult to define and measure it accurately. The most practical value for normal applications is the discharge voltage response to a change in discharge current.

After fully charged at normal temperature, the NiFe cells are 50% discharged, the internal resistance is about 20% higher. When 90% discharged,it is about 80% higher. In addition, reducing the ambient temperature can also increase the internal resistance. E.g. the internal resistance is about 40% higher at 0℃.

1.6.4 Effect of temperature on performance

Variations in ambient temperature affect the performance of a battery. The capacity de-rating factors which are required in sizing cell to compensate for temperature variations are given in the following graphical form .



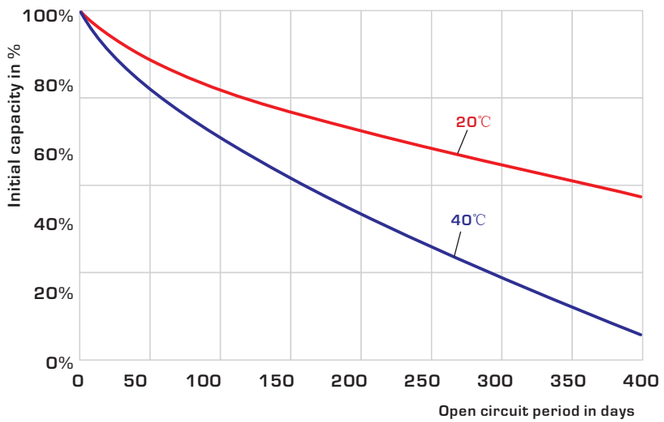
Typical Capacity De-rating Factors Versus Temperature

1.6.5 Short Circuit Current

The short circuit Current of Changhong NF-S series NiFe cell is approximately 10 times of the ampere-hour capacity.

1.6.6 Open Circuit Loss

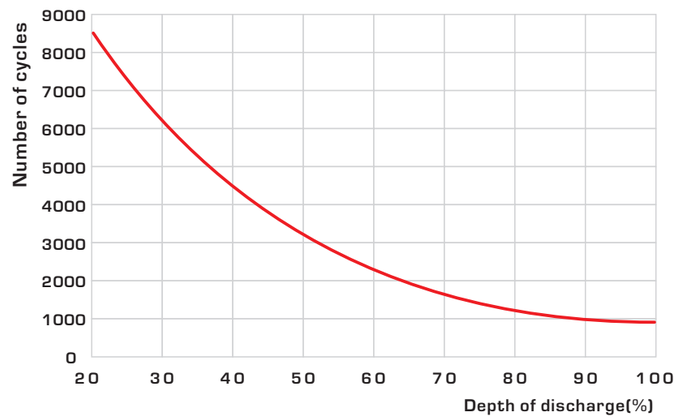
Because of the self-discharge,the state of charge in the open circuit state will decrease slowly with time. The open circuit loss value at different temperatures which may be experienced in photovoltaic application is shown in the following figure.



Open circuit loss at 20℃and 40℃

1.6.7 Cycling

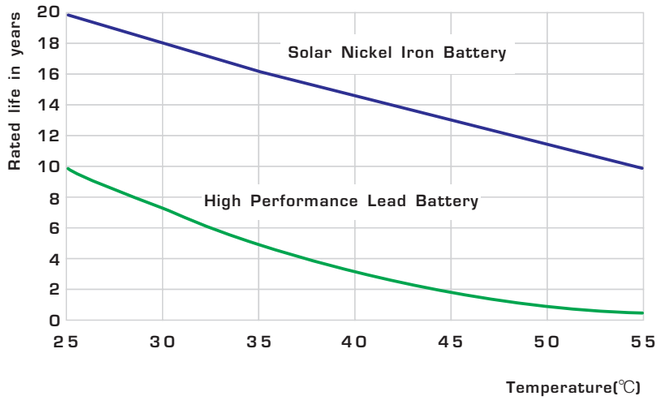
The Changhong NF-S series NiFe cell is adaptable to a wide range of depth of discharge (DOD). The number of cycles vary with DOD required. The lower DOD is, the more numbers of cycles are. The number of cycles reach thousands during shallow discharge, while it can only reach hundreds of cycles during deep discharge. The following figure gives the effect of DOD on the available cycle life.



Typical cycle life versus DOD(20℃)

1.6.8 Effect of Temperature on Lifetime

Changhong NF-S series NiFe cell is designed for 20- year service life, but the increase in the temperature of electrolyte will reduce the expected life. In general, every 9℃ increase in temperature over the normal ambient temperature of 25℃ reduces the service life of Changhong NF-S series NiFe cell by 20%. For lead-acid batteries,it will be 50%. The following figure shows the comparison graph of life expected at high temperature for both Ni-Fe and lead-acid batteries.

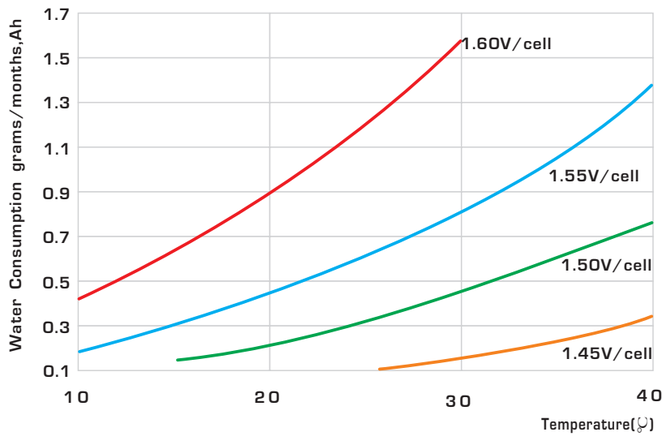


Typical battery life expected at high temperature

1.6.9 Water Consumption and Gas Evolution

Surplus charge or overcharge will break down the water of the electrolyte into oxygen and hydrogen, so pure distilled water should be added to compensate for water loss. In theory, the quantity of water consumed can be calculated according to the Faradic equation that each Ah of overcharge breaks down 0.366CC of water. However, due to the recombination separator used in Changhong NF-S series NiFe cell, the water usage will be considerably less than this. The following graph gives typical water consumption values over different ranges of voltages and various temperatures.

The battery gives off no gas during discharge. The electrolysis of 1CC water generates 2000CC of mixture gas in the proportion of 2/3 hydrogen and 1/3 oxygen.



Typical Water Consumption

1.7 Charging

1.7.1 Charge Method

First charge method — — The charge current depends on the capacity of solar panels. When charge voltage of battery reaches the limited values set, the charge current will diminish gradually. The upper charge voltage limit of Changhong NF-S series NiFe cell battery is usually controlled at the range of 1.65V/cell~1.75V/cell.

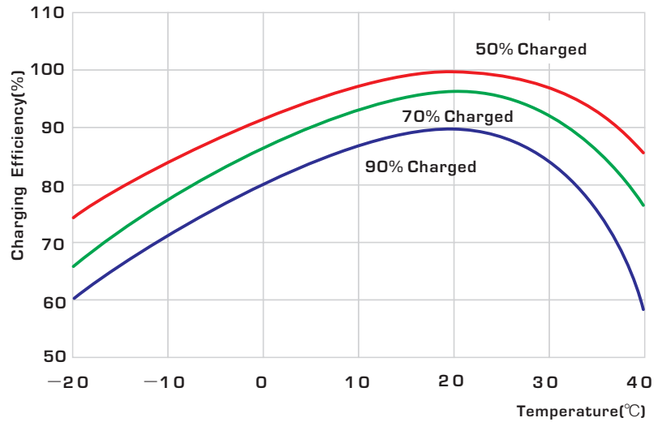
Second charge method— Firstly, charge the battery up to a high voltage fixed and then drop it to a lower level voltage , so as to reduce the water consumption inside. In the first state, the recommended charge voltage is

1.65V/cell~1.75V/cell. In the second state, it should be controlled at the range of 1.42V/cell~1.45V/cell.

If deep discharge cycling is frequently carried out, it is recommended that you turn up the charge voltage. When the battery is operated outdoors or beyond the temperature range of 10℃ ~ 30℃ , the charge voltage compensation coefficient of -3mV/℃ should be taken into account.

1.7.2 Charge Efficiency

Charge efficiency depends on the state of charge and ambient temperature. The graph below shows the charge efficiency for a 50%, 70% and 90% charge under various ranges of temperature.



Charging Efficiency As A Function Of Temperature

1.8 Battery Sizing Principle

The "Autonomy sizing principle" is the most popular batterysizing method for photovoltaic system application. This type of sizing method takes the number of autonomy working days (based on the maximum number of low insolation days expected) into consideration. On assumption that the cell is fully charged every day, the battery can be sized according to the following formula.

Capacity required = R × A × KT × KDOD × KA

R=Autonomy working times required (Hours)

A = Average daily Load （Amps）

KT =Temperature compensation factor

KDOD=Allowable Max. DOD compensation factor

KA=Ageing compensation factor

All parameters can be found from this manual according to its respective working conditions.

Let's take an example to understand this better. Assuming battery is required for autonomy work for 7 Days (168 hours), discharge it to end-off voltage of 1.14V/cell at ambient temperature of 40℃ and the average daily load is 90W/48V, that is Autonomy working time R=168hours

Average daily load =90W/48V

A =1.875A

Temperature compensation factor

KT =1/0.98=1.02

The Max. DOD allowable calculated from the 20-year life requirement （52times/year）=1040

so,the DOD allowable=85%

The Max. compensation factor of DOD allowable

KDOD =1/0.85=1.176

Ageing compensation factor at 40℃

KA =20/14.2=1.408

Thus, the capacity required =168 × 1.875 × 1.02 × 1.176 × 1.408=532.01Ah

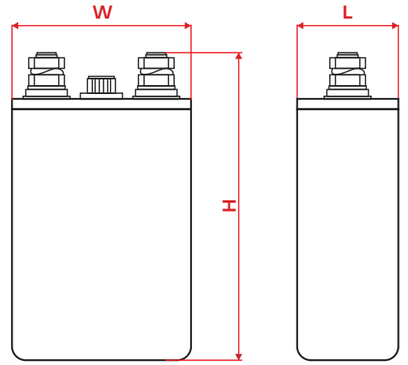
The numbers of cells required =48V/1.2V (nominal voltage) =40

Conclusion: We chose 40 cells of NF600-S batteries for this application.

Trouble Shooting

Trouble	Cause	Solution
Drop in the cell capacity	The electrolyte has been used for a long time and the carbonate content inside is too much.	Replace the electrolyte.
	The electrolyte is exhausted.	Replace the electrolyte.
	No enough electrolyte,and the level of electrolyte is below the minimum level line.	Add distilled water,adjust the electrolyte density then overcharge the cell
	Harmful impurities contained in the electrolyte are too much.	Replace the electrolyte after cleaning. overcharge the cell. If other causes,repair the cell accordingly.
	The charge/discharge parameters are not correct.	Charge or discharge the cell in strict accordance with the supplier's requirements.
	Short-circuit or slight short-circuit inside the cell.	Replace the electrolyte or repair the cell after cleaning.
	Short-circuit or slight short-circuit occurs from outside the cell.	Keep the cells in a clean and dry environment and check wiring.
	The instruments are out of calibration.	Check and rectify the galvanometer and voltmeter.
Voltage is abnormal	Short or open circuit in a cell or no electrolyte inside cell.	Clean the cell,or change the electrolyte.
	Short or open circuit outside the battery.	Keep the cells dry,and check for wiring errors.
	Poor wire connection or disconnection.	Check and repair.
The cell Container swells	The positive plate swells.	If necessary,change the cell.
	The vent is blocked up.	Clean with hot water or replace it.
	There is short-circuit inside the cell. or there are too many impurities in the electrolyte.	Check and replace the electrolyte.
Bubbles appear in the inside of the cell	The electrolyte contains organic impurities.	Replace the electrolyte.
Alkaline corrosion caused by electrolyte leakage	The level of electrolyte is too high.	Drain out the superfluous electrolyte.
	The vent of terminal is unsealed.	Replace the sealing parts and screw tightly.
	Electrolyte overflows.	Clean the area of corrosive electrolyte fluid.

Selection Table



Model	Rated Voltage V	Rated Capacity I_t Ah	Max. External Dimension mm			Max. Weight kg	Volume of Electrolyte L	Terminal Thread	Container Material
			Length	Width	Height				
NF10-S	1.2	10	38	84	138	0.80	0.2	M6	MBS or PP
NF20-S	1.2	20	32	113	220	1.2	0.3	M6	MBS or PP
NF30-S	1.2	30	68	134	245	2.8	0.8	M10×1	MBS or PP
NF40-S	1.2	40	68	134	245	3.0	0.8	M10×1	MBS or PP
NF50-S	1.2	50	68	134	245	3	0.7	M10×1	MBS or PP
NF60-S	1.2	60	70	134	285	4.2	0.9	M16	MBS or PP
NF80-S	1.2	80	80	141	365	5.8	1.7	M10×1	MBS or PP
NF100-S	1.2	100	80	141	365	6.2	1.6	M10×1	MBS or PP
NF120-S	1.2	120	80	141	365	6.4	1.4	M10×1	MBS or PP
NF150-S	1.2	150	106	164	345	9	2.5	M20	MBS or PP
NF200-S	1.2	200	106	164	345	10	1.8	M20	MBS or PP
NF250-S	1.2	250	138	276	425	18.5	4.6	2×M16	PP
NF300-S	1.2	300	138	276	450	21	5.9	2×M16	MBS or PP
NF400-S	1.2	400	138	276	490	17	5.9	2×M16	PP
NF500-S	1.2	500	138	276	490	27	6.1	2×M16	PP
NF600-S	1.2	600	176	291	510	38	9.2	2×M20	MBS
NF700-S	1.2	700	176	291	510	39	8.4	2×M20	MBS
NF800-S	1.2	800	186	398	570	59	17.2	3×M20	MBS
NF900-S	1.2	900	186	398	570	60	15.6	3×M20	MBS
NF1000-S	1.2	1000	186	398	570	61	15.0	3×M20	MBS

Remarks: 1）We can manufacture other models according to the clients' requirements.
2）We can process battery crates according to the clients' requirements.

Discharge Data Table

Discharge currents and duration when battery is fully charged at 20℃ ± 5℃

Final voltage =1.16V/C

Cell Type	18h	20h	1d 24h	2d 48h	3d 72h	4d 96h	5d 120h	6d 144h	7d 168h	8d 192h	9d 216h	10d 240h
NF10-S	0.50	0.46	0.39	0.20	0.14	0.10	0.08	0.07	0.06	0.06	0.05	0.05
NF20-S	1.00	0.92	0.78	0.40	0.27	0.21	0.17	0.14	0.12	0.11	0.10	0.09
NF30-S	1.50	1.38	1.16	0.61	0.41	0.31	0.25	0.21	0.19	0.17	0.15	0.14
NF40-S	2.00	1.84	1.55	0.81	0.54	0.41	0.33	0.28	0.25	0.22	0.20	0.18
NF50-S	2.50	2.30	1.94	1.01	0.68	0.52	0.42	0.35	0.31	0.28	0.25	0.23
NF60-S	3.00	2.76	2.33	1.21	0.82	0.62	0.50	0.43	0.37	0.33	0.30	0.28
NF70-S	3.50	3.22	2.71	1.41	0.95	0.72	0.58	0.50	0.43	0.39	0.35	0.32
NF80-S	4.00	3.68	3.10	1.62	1.09	0.83	0.67	0.57	0.50	0.44	0.40	0.37
NF90-S	4.50	4.14	3.49	1.82	1.23	0.93	0.75	0.64	0.56	0.50	0.45	0.41
NF100-S	5.00	4.60	3.88	2.02	1.36	1.03	0.83	0.71	0.62	0.55	0.50	0.46
NF120-S	6.00	5.52	4.65	2.43	1.63	1.24	1.00	0.85	0.74	0.66	0.60	0.55
NF150-S	7.50	6.90	5.81	3.03	2.04	1.55	1.25	1.06	0.93	0.83	0.75	0.69
NF200-S	10.0	9.20	7.75	4.04	2.72	2.06	1.67	1.42	1.24	1.10	1.00	0.92
NF250-S	12.5	11.5	9.7	5.05	3.40	2.58	2.08	1.77	1.55	1.38	1.25	1.15
NF300-S	15.0	13.8	11.6	6.06	4.08	3.09	2.50	2.13	1.86	1.66	1.50	1.38
NF350-S	17.5	16.1	13.6	7.07	4.76	3.61	2.92	2.48	2.17	1.93	1.75	1.60
NF400-S	20.0	18.4	15.5	8.08	5.44	4.13	3.33	2.83	2.48	2.21	2.00	1.83
NF500-S	25.0	23.0	19.4	10.1	6.81	5.16	4.17	3.54	3.10	2.76	2.50	2.29
NF600-S	30.0	27.6	23.3	12.1	8.17	6.19	5.00	4.25	3.71	3.31	3.00	2.75
NF700-S	35.0	32.2	27.1	14.1	9.53	7.22	5.83	4.96	4.33	3.86	3.50	3.21
NF800-S	40.0	36.8	31.0	16.2	10.9	8.25	6.67	5.67	4.95	4.42	4.00	3.67
NF900-S	45.0	41.4	34.9	18.2	12.3	9.28	7.50	6.38	5.57	4.97	4.50	4.13
NF1000-S	50.0	46.0	38.8	20.2	13.6	10.3	8.33	7.08	6.19	5.52	5.00	4.58

Discharge currents and duration when battery is fully charged at 20℃ ± 5℃

Final voltage =1.14V/C

Cell Type	18h	20h	1d 24h	2d 48h	3d 72h	4d 96h	5d 120h	6d 144h	7d 168h	8d 192h	9d 216h	10d 240h
NF10-S	0.52	0.48	0.40	0.21	0.14	0.11	0.09	0.07	0.06	0.06	0.05	0.05
NF20-S	1.04	0.96	0.81	0.42	0.28	0.21	0.17	0.15	0.13	0.11	0.10	0.10
NF30-S	1.57	1.44	1.21	0.63	0.43	0.32	0.26	0.22	0.19	0.17	0.16	0.14
NF40-S	2.09	1.92	1.62	0.84	0.57	0.43	0.35	0.29	0.26	0.23	0.21	0.19
NF50-S	2.61	2.40	2.02	1.05	0.71	0.54	0.43	0.37	0.32	0.29	0.26	0.24
NF60-S	3.13	2.88	2.43	1.26	0.85	0.64	0.52	0.44	0.39	0.34	0.31	0.29
NF70-S	3.66	3.36	2.83	1.47	0.99	0.75	0.61	0.52	0.45	0.40	0.36	0.33
NF80-S	4.18	3.84	3.23	1.68	1.13	0.86	0.69	0.59	0.51	0.46	0.41	0.38
NF90-S	4.70	4.32	3.64	1.89	1.28	0.97	0.78	0.66	0.58	0.52	0.47	0.43
NF100-S	5.22	4.80	4.04	2.10	1.42	1.07	0.87	0.74	0.64	0.57	0.52	0.48
NF120-S	6.27	5.76	4.85	2.53	1.70	1.29	1.04	0.88	0.77	0.69	0.62	0.57
NF150-S	7.83	7.20	6.06	3.16	2.13	1.61	1.30	1.10	0.96	0.86	0.78	0.71
NF200-S	10.4	9.60	8.08	4.21	2.83	2.15	1.73	1.47	1.29	1.15	1.04	0.95
NF250-S	13.1	12.0	10.1	5.26	3.54	2.68	2.17	1.84	1.61	1.43	1.30	1.19
NF300-S	15.7	14.4	12.1	6.31	4.25	3.22	2.60	2.21	1.93	1.72	1.56	1.43
NF350-S	18.3	16.8	14.1	7.36	4.96	3.76	3.03	2.58	2.25	2.01	1.81	1.66
NF400-S	20.9	19.2	16.2	8.42	5.67	4.29	3.47	2.94	2.57	2.29	2.07	1.90
NF500-S	26.1	24.0	20.2	10.5	7.08	5.36	4.33	3.68	3.21	2.86	2.59	2.38
NF600-S	31.3	28.8	24.3	12.6	8.50	6.44	5.20	4.42	3.86	3.44	3.11	2.85
NF700-S	36.6	33.6	28.3	14.7	9.92	7.51	6.07	5.15	4.50	4.01	3.63	3.33
NF800-S	41.8	38.4	32.3	16.8	11.3	8.58	6.93	5.89	5.14	4.58	4.15	3.80
NF900-S	47.0	43.2	36.4	18.9	12.8	9.66	7.80	6.63	5.79	5.16	4.67	4.28
NF1000-S	52.2	48.0	40.4	21.0	14.2	10.7	8.67	7.36	6.43	5.73	5.19	4.75

Discharge currents and duration when battery is fully charged at 20℃ ± 5℃

Final voltage =1.10V/C

Cell Type	18h	20h	1d 24h	2d 48h	3d 72h	4d 96h	5d 120h	6d 144h	7d 168h	8d 192h	9d 216h	10d 240h
NF10-S	0.53	0.50	0.43	0.21	0.14	0.11	0.09	0.08	0.07	0.06	0.05	0.05
NF20-S	1.07	0.99	0.85	0.43	0.29	0.22	0.18	0.15	0.13	0.12	0.11	0.10
NF30-S	1.60	1.49	1.28	0.64	0.43	0.33	0.27	0.23	0.20	0.18	0.16	0.15
NF40-S	2.13	1.98	1.70	0.86	0.58	0.44	0.35	0.30	0.26	0.23	0.21	0.19
NF50-S	2.67	2.48	2.13	1.07	0.72	0.55	0.44	0.38	0.33	0.29	0.26	0.24
NF60-S	3.20	2.97	2.55	1.29	0.87	0.66	0.53	0.45	0.39	0.35	0.32	0.29
NF70-S	3.73	3.47	2.98	1.50	1.01	0.77	0.62	0.53	0.46	0.41	0.37	0.34
NF80-S	4.27	3.96	3.40	1.72	1.16	0.88	0.71	0.60	0.52	0.47	0.42	0.39
NF90-S	4.80	4.46	3.83	1.93	1.30	0.98	0.80	0.68	0.59	0.53	0.48	0.44
NF100-S	5.33	4.95	4.25	2.15	1.44	1.09	0.88	0.75	0.65	0.58	0.53	0.48
NF120-S	6.40	5.94	5.10	2.58	1.73	1.31	1.06	0.90	0.79	0.70	0.63	0.58
NF150-S	8.00	7.43	6.38	3.22	2.17	1.64	1.33	1.13	0.98	0.88	0.79	0.73
NF200-S	10.7	9.90	8.50	4.29	2.89	2.19	1.77	1.50	1.31	1.17	1.06	0.97
NF250-S	13.3	12.4	10.6	5.36	3.61	2.73	2.21	1.88	1.64	1.46	1.32	1.21
NF300-S	16.0	14.9	12.8	6.44	4.33	3.28	2.65	2.25	1.96	1.75	1.58	1.45
NF350-S	18.7	17.3	14.9	7.51	5.06	3.83	3.09	2.63	2.29	2.04	1.85	1.69
NF400-S	21.3	19.8	17.0	8.58	5.78	4.38	3.53	3.00	2.62	2.33	2.11	1.93
NF500-S	26.7	24.8	21.3	10.7	7.22	5.47	4.42	3.75	3.27	2.92	2.64	2.42
NF600-S	32.0	29.7	25.5	12.9	8.67	6.56	5.30	4.50	3.93	3.50	3.17	2.90
NF700-S	37.3	34.7	29.8	15.0	10.1	7.66	6.18	5.25	4.58	4.08	3.69	3.38
NF800-S	42.7	39.6	34.0	17.2	11.6	8.75	7.07	6.00	5.24	4.67	4.22	3.87
NF900-S	48.0	44.6	38.3	19.3	13.0	9.84	7.95	6.75	5.89	5.25	4.75	4.35
NF1000-S	53.3	49.5	42.5	21.5	14.4	10.9	8.83	7.50	6.55	5.83	5.28	4.83

Discharge currents and duration when battery is fully charged at 20℃ ± 5℃

Final voltage =1.05V/C

Cell Type	18h	20h	1d 24h	2d 48h	3d 72h	4d 96h	5d 120h	6d 144h	7d 168h	8d 192h	9d 216h	10d 240h
NF10-S	0.54	0.51	0.43	0.22	0.15	0.11	0.09	0.08	0.07	0.06	0.05	0.05
NF20-S	1.09	1.01	0.86	0.43	0.29	0.22	0.18	0.15	0.13	0.12	0.11	0.10
NF30-S	1.63	1.52	1.29	0.65	0.44	0.33	0.27	0.23	0.20	0.18	0.16	0.15
NF40-S	2.18	2.02	1.72	0.87	0.58	0.44	0.36	0.31	0.27	0.24	0.21	0.20
NF50-S	2.72	2.53	2.15	1.08	0.73	0.55	0.45	0.38	0.33	0.30	0.27	0.25
NF60-S	3.27	3.03	2.58	1.30	0.88	0.66	0.54	0.46	0.40	0.36	0.32	0.30
NF70-S	3.81	3.54	3.00	1.52	1.02	0.77	0.63	0.53	0.47	0.42	0.38	0.34
NF80-S	4.36	4.04	3.43	1.73	1.17	0.88	0.72	0.61	0.53	0.48	0.43	0.39
NF90-S	4.90	4.55	3.86	1.95	1.31	0.99	0.81	0.69	0.60	0.53	0.48	0.44
NF100-S	5.44	5.05	4.29	2.17	1.46	1.10	0.90	0.76	0.67	0.59	0.54	0.49
NF120-S	6.53	6.06	5.15	2.60	1.75	1.33	1.08	0.92	0.80	0.71	0.64	0.59
NF150-S	8.17	7.58	6.44	3.25	2.19	1.66	1.35	1.15	1.00	0.89	0.81	0.74
NF200-S	10.9	10.1	8.58	4.33	2.92	2.21	1.80	1.53	1.33	1.19	1.07	0.98
NF250-S	13.6	12.6	10.7	5.42	3.65	2.76	2.25	1.91	1.67	1.48	1.34	1.23
NF300-S	16.3	15.2	12.9	6.50	4.38	3.31	2.70	2.29	2.00	1.78	1.61	1.48
NF350-S	19.1	17.7	15.0	7.58	5.10	3.86	3.15	2.67	2.33	2.08	1.88	1.72
NF400-S	21.8	20.2	17.2	8.67	5.83	4.42	3.60	3.06	2.67	2.38	2.15	1.97
NF500-S	27.2	25.3	21.5	10.8	7.29	5.52	4.50	3.82	3.33	2.97	2.69	2.46
NF600-S	32.7	30.3	25.8	13.0	8.75	6.63	5.40	4.58	4.00	3.56	3.22	2.95
NF700-S	38.1	35.4	30.0	15.2	10.2	7.73	6.30	5.35	4.67	4.16	3.76	3.44
NF800-S	43.6	40.4	34.3	17.3	11.7	8.83	7.20	6.11	5.33	4.75	4.30	3.93
NF900-S	49.0	45.5	38.6	19.5	13.1	9.9	8.10	6.88	6.00	5.34	4.83	4.43
NF1000-S	54.4	50.5	42.9	21.7	14.6	11.0	9.00	7.64	6.67	5.94	5.37	4.92

Discharge currents and duration when battery is fully charged at 20℃ ± 5℃

Final voltage=1.00V/C

Cell Type	18h	20h	1d 24h	2d 48h	3d 72h	4d 96h	5d 120h	6d 144h	7d 168h	8d 192h	9d 216h	10d 240h
NF10-S	0.56	0.52	0.43	0.22	0.15	0.11	0.09	0.08	0.07	0.06	0.05	0.05
NF20-S	1.13	1.03	0.87	0.44	0.30	0.23	0.18	0.16	0.14	0.12	0.11	0.10
NF30-S	1.69	1.55	1.30	0.66	0.45	0.34	0.28	0.23	0.20	0.18	0.16	0.15
NF40-S	2.26	2.06	1.73	0.88	0.59	0.45	0.37	0.31	0.27	0.24	0.22	0.20
NF50-S	2.82	2.58	2.17	1.09	0.74	0.56	0.46	0.39	0.34	0.30	0.27	0.25
NF60-S	3.38	3.09	2.60	1.31	0.89	0.68	0.55	0.47	0.41	0.36	0.33	0.30
NF70-S	3.95	3.61	3.03	1.53	1.04	0.79	0.64	0.54	0.48	0.42	0.38	0.35
NF80-S	4.51	4.12	3.47	1.75	1.19	0.90	0.73	0.62	0.54	0.48	0.44	0.40
NF90-S	5.08	4.64	3.90	1.97	1.34	1.01	0.83	0.70	0.61	0.54	0.49	0.45
NF100-S	5.64	5.15	4.33	2.19	1.49	1.13	0.92	0.78	0.68	0.60	0.55	0.50
NF120-S	6.77	6.18	5.20	2.63	1.78	1.35	1.10	0.93	0.81	0.73	0.66	0.60
NF150-S	8.46	7.73	6.50	3.28	2.23	1.69	1.38	1.17	1.02	0.91	0.82	0.75
NF200-S	11.3	10.3	8.67	4.38	2.97	2.25	1.83	1.56	1.36	1.21	1.09	1.00
NF250-S	14.1	12.9	10.8	5.47	3.72	2.81	2.29	1.94	1.70	1.51	1.37	1.25
NF300-S	16.9	15.5	13.0	6.56	4.46	3.38	2.75	2.33	2.04	1.81	1.64	1.50
NF350-S	19.7	18.0	15.2	7.66	5.20	3.94	3.21	2.72	2.38	2.11	1.91	1.75
NF400-S	22.6	20.6	17.3	8.75	5.94	4.50	3.67	3.11	2.71	2.42	2.19	2.00
NF500-S	28.2	25.8	21.7	10.9	7.43	5.63	4.58	3.89	3.39	3.02	2.73	2.50
NF600-S	33.8	30.9	26.0	13.1	8.92	6.75	5.50	4.67	4.07	3.63	3.28	3.00
NF700-S	39.5	36.1	30.3	15.3	10.4	7.88	6.42	5.44	4.75	4.23	3.82	3.50
NF800-S	45.1	41.2	34.7	17.5	11.9	9.00	7.33	6.22	5.43	4.83	4.37	4.00
NF900-S	50.8	46.4	39.0	19.7	13.4	10.1	8.25	7.00	6.11	5.44	4.92	4.50
NF1000-S	56.4	51.5	43.3	21.9	14.9	11.3	9.17	7.78	6.79	6.04	5.46	5.00