SACRED SUN

GFM-H SERIES
TECHNICAL MANUAL

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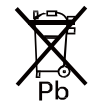
Security Instruction

Please read these instructions carefully in order to make correct, safe, and effective operation. This manual provides you with very important installation and operation guidelines, which will guarantee your equipment an optimal performance and longer service life.

- For your safety,please do not open battery by yourself, only professionals shall be allowed to open and maintain the battery;
- Due to battery be potential harmful to the environment and health,battery shall be replaced by manufacturer's service center.If there is need to replace and maintain,please contact after-sale service center.
- Used battery is recyclable, and improper disposal of battery may be great harmful to the environment and health.So,used battery shall be proper disposed following relative regulations and law or shall be returned to our company for disposal.
- Please choose the batteries of the same model for replacement, and batteries produced by different manufacturers shall be strictly forbidden for connecting in one system.

Notices

				
Warning	Electricity shock	Protecting eyes	With adults custody	No short circuit
				
No flame and spark	Recycled	Proper disposal	Read instructions	CE certificate

Chapter One Product Introduction

Product Characteristics

Basic Characteristics

GFM-H battery is the newest design product with large capacity cell,high performance and long life, adopt super thin glass mat AGM separator, poor electrolyte design, there is gas pass way between positive and negative plate, during charge process, the oxygen generated on positive plate reaches negative plate through the pores of separator recombined into water, gas recombination is achieved. Grid is made of multielement lead-calcium special alloy, separator out of hydrogen is restrained, thus achieve no water loss.So,during the whole battery operation period,there is no need to add water and acid.

Sealing reaction efficiency could be more than 99%,no acid fog escape,no corrosion to equipment, battery could be installed together with equipments.

Low self-discharge rate,optimize alloy formula,adopt high purity raw and subsidiary material, clearn production environment,ensure low self-discharge rate,month average self-discharge ≤1%.

Compact structure,good shock proof performance,high specific energy.

Long service life

Positive grid adopt high-tin-low-ca multielement alloy,crystal nucleus more equal than normal tin-ca alloy, crystal particle connected tightly, preventing crystal boundary corrosion. Meanwhile,super think design for grid,prolong service life of plate.

Patent international advanced primary and secondary grid structure design,current distributing in grid will be more equal and reasonable.

Positive plate solidity adopt high temperature and humidity technic, form long life 4BS structure.

Special assembling equipment,achieve plate sets assembled tightly, ensure the excellent cycle application performance.

GFM-H series batteries positive and negative plate adopt optimize design,the design life is 18 years, normal floating charge application life is 12 years.

Reliable sealing technology

Safety valve adopt Patent labyrinth type,two-layer and explosion-proof acid filter valve design,the valve will open automatically for decompression when battery inner pressure reach a certain value, and the valve will close when battery inner pressure come back to normal level, acid filter

in valve preventing acid fog escape and preventing out flame in when depression.

GFM-H series batteries terminal sealing adopt patent multi-layer design, resist mechanism impact, resist high temperature aging, improving acid corrosion endurance performance, prolong acid leakage track,ensure sealing reliability during battery service life.

Batteries could endure 80kPa inner pressure without any abnormity.

- **Good consistency**

  GFM-H series battery is large capacity cell design,for suring battery capacity and floating charge voltage consistency,during plate production,cell assembling and finished products test,one homogenization procedure added in each process,open circuit voltage variance is ≤±10mV. Thus ensuring battery quality consistency.

- **Good large current discharge performance**

  GFM-H series battery with radial grid structure and special active material formula improving large current discharge performance and charge acceptance ability,be suitable for large current discharge application demand.

  Copper insert terminal structure design with low resistance is good for large current discharge application.

- **Large capacity cell design**

  GFM-H series battery is large capacity cell design,cell capacity could reach 2000Ah,ensuring good consistency effectively,meanwhile,GFM-H battery could be composed to large capacity power supply system of 800~4000Ah.

- **Convenient installation**

  Batteries are connected by tinning copper core multistrand soft cable or short circuit proof tinning red copper bar.Connecting is convenient and the voltage loss is small.

- **Applicable for wide temperature range**

  Special electrolyte formula and special active substance formula,enhance good high and low temperature performance,battery could be used in a wide temperature range as -15℃~+45℃,and the recommended application temperature range is 25±5℃.

Main Applications

- Cable communication station and exchange station
- Wireless communication station and distribution base station
- Electricity power,army and other special network telecommunication base station
- Data and TV signal transmission system
- Power generation station power transmission and substation
- Power direct current system
- EPS/UPS

Battery Structure

24V1000Ah system composed by 3GFM-1000H battery

Type and Dimensions

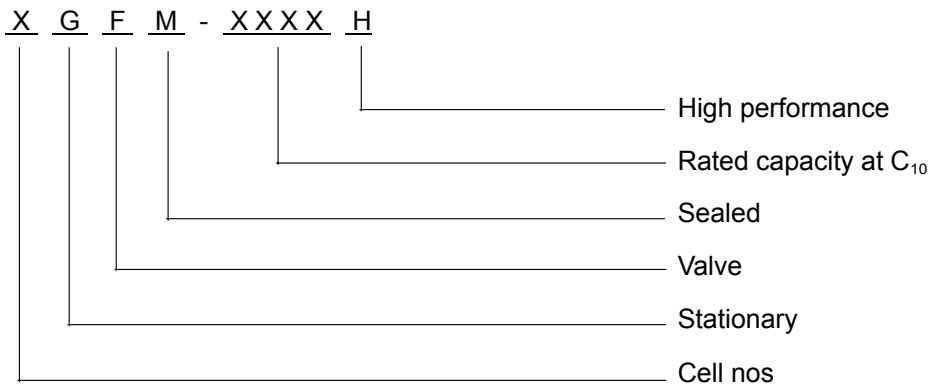


Table 1-1 GFM-H series battery type and dimensions

Battery Type	Module Rated Voltage (V)	Battery Nos in Module (pcs/module)	Rated Capacity (Ah)			Module Dimensions (mm)			Battery Weight/pc (kg)	Module Weight (kg)
			C_{10} End voltage 1.80V/cell	C_3 End voltage 1.80V/cell	C_1 End voltage 1.75V/cell	Depth	Width	Height		
4GFM-800H	8	4	800	600	440	615	780	295.5	49.5	238.3
3GFM-1000H	6	3	1000	750	550	615	835	258	60.5	218.1
3GFM-1200H	6	3	1200	900	660	615	835	294.5	72.5	256.9
2GFM-1500H	4	2	1500	1125	825	615	705	295.5	91.5	215.1
2GFM-2000H	4	2	2000	1500	1100	615	855	299	116.5	270.6

Working Principle

The electrochemical reaction of batteries in charge and discharge process as follows:

$$PbO_2 + 2H_2SO_4 + Pb \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} PbSO_4 + 2H_2O + PbSO_4$$

In the final stage of charge process, active substance in positive plate transformed to lead dioxide,negative plate has not reached fully charged stage,the process of active substance in negative plate transformed to spongy lead has not finished, oxygen gas generated in positive plate reaches the negative palte through separator pores and reacts active substance in negative plate,resulting depolarized state in negative plate, and restraining the generation of hydrogen.

The working principle of electrochemical reaction to realize sealing as follows:

- The reaction in positive plate (oxygen generated)

① $2H_2O \longrightarrow O_2+4H^++4e$

Move to the surface of negative plate through the separator

- The reaction in negative plate (oxygen absorbed)

② $2Pb+O_2 \longrightarrow 2PbO$ (oxygen reacts with spongy lead)

③ $2PbO+2H_2SO_4 \longrightarrow 2PbSO_4+2H_2O$ (PbO reacts with electrolyte)

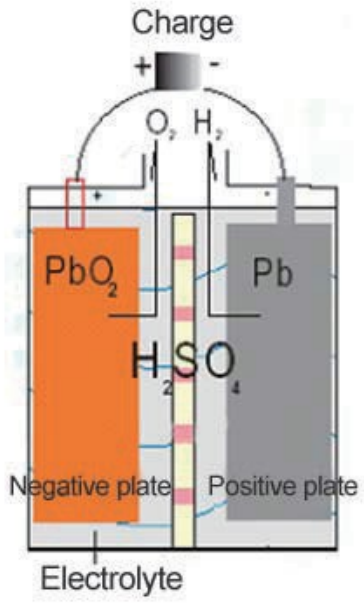
④ $2PbSO_4+4H^++4e \longrightarrow 2Pb+2H_2SO_4$ ($PbSO_4$ reduction)

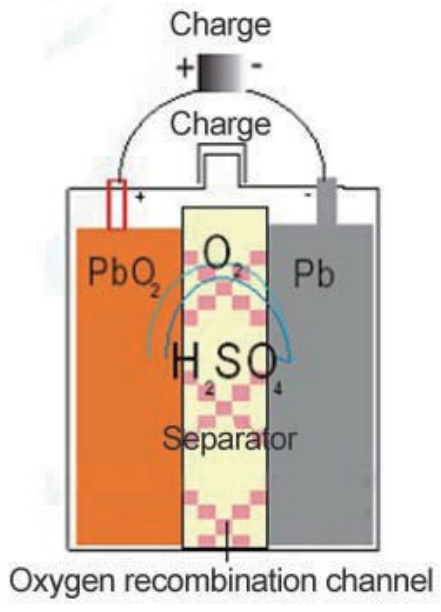
- The whole reaction in the negative plate is: ② +③+④ : $O_2+4H^++4e=2H_2O$

The final production returns to ①, and recycles like this.

In general, in charging process oxygen gas generated in positive plate could quickly reach the negative plate and recombine into water through react with active substance in negative plate, no gas escape and water loss, achieving the sealing.

Gas recombination illustration



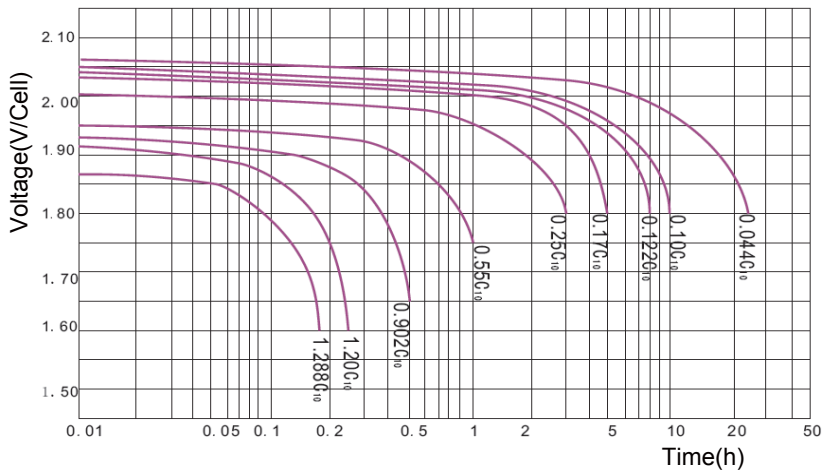


Chapter Two Technical Characteristics

Discharge Characteristic Curve and Discharge Data

The battery capacity is directly related to the discharge current, end voltage and discharge temperature. In general,the smaller discharge current, the lower cut-off voltage, the higher temperature will cause larger discharge capacity.Figure 2-1 is the discharge curves of GFM-H Series at different discharge rate at ambient temperature 25℃.Table 2-2 and 2-3 is constant current discharge data, customers could choose battery accordingly.

- Figure 2-1 Discharge characteristic curve under different discharge rates(25℃)



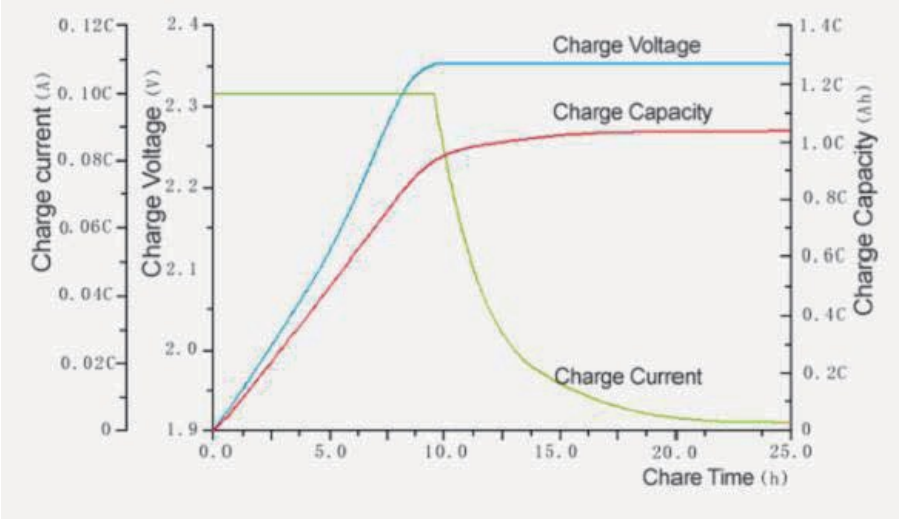
- Table 2-1 GFM-H series battery end voltage at different discharge rate(25℃)

Discharge Rate (A)	End Voltage (V/cell)
$I \le 0.01C_{10}$	1.95
$0.01C_{10} < I \le 0.05\ C_{10}$	1.90
$0.05C_{10} < I \le 0.09\ C_{10}$	1.85
$0.09C_{10} < I \le 0.25\ C_{10}$	1.80
$0.25C_{10} < I \le 0.55\ C_{10}$	1.75
$0.55\ C_{10} < I \le 0.65C_{10}$	1.65

Charge Characteristic Curve

Figure 2-2 is the battery charge characteristic curves with constant voltage of 2.35V / cell, limited current of 0.1C_{10} A,Charge the battery for 25 hours after fully discharged battery and the charged capacity can be as high as the 104% of the discharged capacity.

- Figure 2-2 Charge characteristic curve



Internal Resistance and Short Circuit Current

The internal resistance is dynamic nonlinear parameter, it continuously varies with the temperature, charge state and service duration. The internal resistance is the lowest when the battery is fully charged.Table 2-4 present the internal resistance and short circuit current of the battery which the internal resistance is measured by HIOKI 3551 BATTERY HITESTER resistance tester at an ambient temperature of 25±5℃, in the fully charged state.

■ Table 2-4 The internal resistance and short-circuit current (25 ℃)

Battery Type	Reference Internal Resistance/battery(mΩ/cell)	Short Circuit Current(A)
4GFM-800H	0.36	6000
3GFM-1000H	0.31	7500
3GFM-1200H	0.22	8700
2GFM-1500H	0.20	11000
2GFM-2000H	0.28	13000

Chapter Three Operation and maintenance

Parameters

GFM-H series batteries could be used in ambient temperature of -15℃~+45℃,and the recommended operation temperature is 25±5℃,higher or lower temperature will shorten battery service life.

Table 3-1 Switching power supply parameters recommended setting table (48V system)

NO.	Parameter type		I type power supply	II type power supply	III type power supply	IV type power supply
1	Floating charge voltage (V)		54.0	54.0	54.0	54.0
2	Equalizing charge voltage (V)		56.4	56.4	56.4	56.4
3	Charge current limitation (A/group)		$0.10C_{10}$	$0.15C_{10}$	$0.15C_{10}$	$0.15C_{10}$
4	High voltage alarm voltage(V)		57	57	57	57
5	Low voltage alarm voltage(V)		47	47	47	47
6	Low voltage load disconnect-LVLD (V)		45	45	45	46
7	Low voltage battery disconnect-LVBD (V)		44	44	45	45
8	The battery protection voltage(V)		43.2	43.2	43.2	43.2
9	Reset voltage(V)		50	50	50	50
10	condition of starting equalizing charge (fulfill one of the conditions)	Discharging voltage as the conditions(V)	48.5	48.5	49.2	49.2
		Discharging time as the conditions(h)	0.5	1.0	1.0	0.5
		Discharging capacity as the conditions(Ah)	$15\%C_{10}$	$15\%C_{10}$	$10\%C_{10}$	$5\%C_{10}$
		Initial charging current as the conditions(A)	$\geq 0.05C_{10}$	$\geq 0.05C_{10}$	$\geq 0.05C_{10}$	$\geq 0.05C_{10}$
11	Equalizing charging period(day)		180	90	60	30
12	Condition of ending equalizing charge(fulfill one of the conditions)	Equalizing charge time as the conditions(h)	10	15	15	20
		The charge coefficient as the condition	1.03	1.05	1.05	1.07
		The equalizing charge tail current as the condition(A)	$0.01C_{10}$	$0.01C_{10}$	$0.005C_{10}$	$0.005C_{10}$
13	Temperature compensation	Temperature compensation coefficient(mV/℃/cell) (Reference temperature:25℃)	-3.5	-3.5	-3.5	-3.5
		High limited voltage of floating charging temperature compensation(V)	56.16	56.16	56.16	56.16
		Low limited voltage of floating charging temperature compensation(V)	52.32	52.32	52.32	52.32

■ The floating charge voltage,equalizing charge voltage showing in Table 3-1 is the setting data under ambient temperature of 25℃ ,for parameter at other temperature please refer to Table 3-2.

■ According the communication state power supply condition, line introduction and operation sate, the city power supply can be divided into four types; divided conditions shall meet the following requirements:

I Type power supply: Introduction of each supply line from two independent power supply, the power supply is stable and reliable. The two lines should not appear at the same time the outage, the monthly average interruption frequency should not be more than 1 times, the average of each fault time should not be grater than 0.5h. The two supply lines should be automatically input device of standby power supply.

II Type power supply: supply line allows the planned maintenance outage, the monthly average interruption frequency should not be more than 3.5 times, the average of each fault time should not be more than 6h. The power supply shall meet the one of the following conditions requirements:

① Introduction one supply line from stable ring network, the ring network formed by two or more independent power supply.

② Introduction one supply line from one stable and reliable independent power supply or one stable and reliable transmission line.

III Type power supply: Introduction one supply line from one power supply, power supply line long, many users, the monthly average interruption frequency should not be more than 4.5 times, the average of each fault time should not be more than 8h.

IV Type power supply: The power supply shall meet the one of the following conditions requirements:

① Introduction one supply line from one power supply, the supply line regular power failure, the power supply not ensure, not up to requirements of III type power supply.

② A long time seasonal power failure or no power available.

■ The voltage in table 3-1 is the setting data under 48V system switching power supply, other voltage system please refer to the above table corresponding adjustment.

Factors Influencing capacity

Quantity of electricity battery discharge under certain condition is called battery capacity,symbol is C ,normal unit is Ampere Hour,in short is Ah.Usually discharge rate is indicated through the suffix of C ,such as C_{10} means capacity at 10 hours discharge rate. C_3 means capacity at 3 hours discharge rate.

Battery capacity contains rated capacity and actual capacity,for GFM-H series battery rated capacity please refer to Table 1-1.Actual capacity is fact quantity of electricity battery discharge under certain condition,it equal to discharge current multiply discharge time,unit is Ah.

The battery capacity is directly related to the discharge current, end voltage and discharge temperature. In general,the smaller discharge current, the lower cut-off voltage, the higher temperature will cause larger discharge capacity.

Temperature VS battery capacity

Temperature affect battery capacity.Figure 3-1 is capacity(C_{10}) and temperature curve,for example, temperature fall from 25℃ to 0℃, capacity will be 80% of rated capacity, meanwhile, low temperature will cause long term charge shortage,negative plate will be vitriolization,finally,there will be not any capacity.If discharge temperature is not 25℃,you could convert the capacity to $C_{25℃}$ according to following formula.

$$C_{25℃} = \frac{C_T}{1 + k\ (T - 25)}$$

In formula:T-Discharge temperature

CT Capacity at temperature of T

k Temperature coefficient

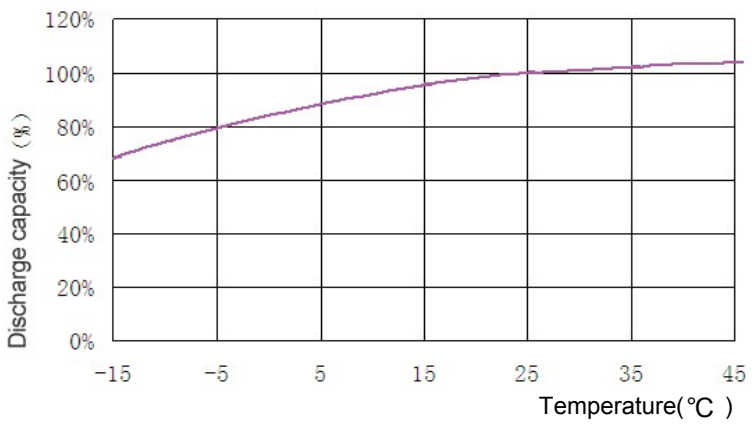
k=0.006/℃ at C_{10} discharge

k=0.008/℃ at C_3 discharge

k=0.01/℃ at C_1 discharge

Along with temperature rise,battery capacity will be larger among certain range,for example,temperature rise from 25℃to 35℃,capacity will be about 105% of rated capacity,but temperature continue rise, capacity rise will be slow,finally, capacity will maintain no change.

- Figure 3-1 GFM-H series battery discharge capacity and temperature curve



Temperature and Floating Charge Voltage/Equalizing Charge Voltage

Choose suitable floating charge voltage is for reaching perfect service life and rated capacity,if loating charge voltage is over high,loating current will be large accordingly,that will enhance plate corrosion speed and battery water loss,then shorten battery service life;if floating charge voltage is over low,battery can not maintain fully charged state,irreversible vitriolization will be caused easy,capacity reduced accordingly,then shorten battery service life as well.

Floating charge application,charge voltage could be adjusted according to ambient temperature,temperature compensation coefficient is -3.5mV/℃/cell.The same way to adjust equalizing charge voltage.Please refer to Table 3-2.The floating voltage, equalizing voltage at different temperature are calculated as following formula:

$$V_T = V_{25℃} + \frac{K \times (T - 25)}{1000}$$

In formula: VT—Floating/Equalizing voltage at temperature of T,V/cell;

$V_{25℃}$ —Floating/Equalizing voltage at 25℃,V/cell;

K—Temperature coefficient,mV/℃/cell;

T—Environment temperature, ℃ .

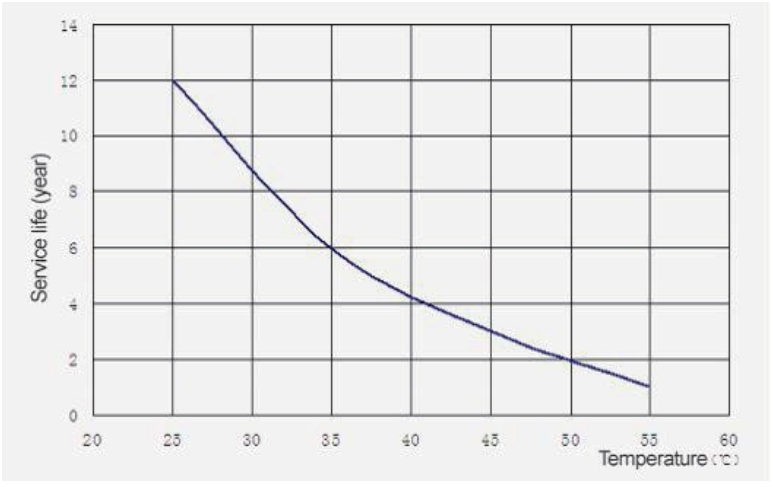
■ Table 3-2 Voltage Setting at Different Temperature

Temperature(℃)	GFM-H Series	
	Floating Charge Voltage (V/cell)	Equalizing Charge Voltage (V/cell)
≤ 0	2.34	2.44
10	2.30	2.40
20	2.27	2.37
25	2.25	2.35
30	2.23	2.33
35	2.22	2.32
40	2.20	2.30
≥45	2.18	2.28

Temperature and Battery Service Life

Higher temperature will speed up the battery grid corrosion and water loss, thus greatly shorten the battery life, when the temperature is over 25℃, the service life of the battery will be shortened by half as the temperature increasing by 10℃, shown in Figure 3-2 .

■ Figure 3-2 GFM-H series battery service life and temperature curve



Charge Requirement

Equalizing Charge and Supplementary Charge

Equalizing charge or supplementary charge is needed in the following cases:

■ After finish installation,before the battery system is put into operation, the battery bank should be supplementary charged.

- Running in full-floating operation for three months, or when there are more than two batteries with voltage of lower than 2.18V.
- The battery is out of work beyond 3 months.

Recommended charge method as follows:

- Using the constant current $0.1C_{10}A$~$0.15C_{10}A$ charging the battery group to the battery average voltage reach to equalizing voltage, then switch to using the constant equalizing voltage charging the battery, the equalizing charging time is generally 10-20h.
- After equalizing charging, for still lower than 2.18V/cell battery, should be using $0.1C_{10}A$ discharge 3-4h,and then equalizing charge.

Recharge

Recharge the battery immediately after complete or partial discharge according to the below method:

Using the constant current $0.1C_{10}A$~$0.15C_{10}A$ charging the battery group to the battery average voltage reach to equalizing voltage, then switch to using the constant equalizing voltage charging the battery until the end of battery fully charged. Using the above method charging, the fully charged marks can use any of the following two conditions as the basis of adjustment:

- Different depth of discharge, the battery fully charged time refer to table 3-3.
- At the constant voltage condition, the charging current valve is invariable in continuous three hours at the end of charging.

Under special conditions, the battery should be fully charged asap, may be appropriate to increase the charging current,limited current ≤ $0.18C_{10}A$.

- Table 3-3 Required charge time in different depth of discharge

Depth of dischrge(%)	Charge current of constant current charge(A)	Time for changing constant current charge to constant voltage charge(h)	Charge voltage of constant voltage charge(V)	Charge time(h)
20	$0.10C_{10}$	1.6	2.35	12
	$0.15C_{10}$	1.2	2.35	10
50	$0.10C_{10}$	4.3	2.35	18
	$0.15C_{10}$	3.3	2.35	16
80	$0.10C_{10}$	6.8	2.35	20
	$0.15C_{10}$	5.5	2.35	18
100	$0.10C_{10}$	8.7	2.35	24
	$0.15C_{10}$	6.8	2.35	22

Floating charge

Floating operation is the best operation condition for battery. In floating operation, the battery keep fully charged state,under this condition,battery could reach the longest service life. For floating operation, the charge voltage should be suitable adjusted according to ambient temperature as shown in Table 3-2.

Storage

- The battery can be stored at -10~45℃ before installation; the storage time shall not exceed 6 moths and 3moths at -10~30℃ and 31~45℃ respectively. Battery that has been stored for a long time shall be charged and the longest storage time should not exceed 18 months.
- The battery should be stored in clean, ventilate, and dry environment with dustproof, moisture proof, anti-collision and other protective measures. To place the battery in closed containers is strictly prohibited.
- The used battery shall be charged fully before storage, then store the battery following the storage requirements.

Maintenance

To ensure the performance of battery, the battery should be correctly inspected and maintained. The maintenance methods are recommended as follows.

Monthly Maintenance:

- Keep the battery space clean.
- Measure and record the ambient temperature of the battery-room and battery container temperature.
- Check battery and battery rack connection,spring mat and bolts connected tight or not,input terminal heating or not,connected terminal between layer heating or not.

- Check the container sealing,leakage/potential leakage or not in terminal,valve and container position
- Check charger temperature compensation function in normal or not,parameters setting correct or not,equalizing charge voltage,floating charge voltage period and other parameters reasonable setting or not
- Check battery cleanliness,terminal damage and heating track,container and lid damage and over heating track.
- Measure and record the total voltage and floating current of the battery system.

Quarterly Maintenance:

- Repeat every item of monthly inspection.
- Measure and record the floating voltage of each on-line battery. After temperature emendation,if more two batteries with a voltage of lower than 2.18V, the battery system needs equalizing charge.If the problem is not solved,go on annually maintenance even three yearly maintenance items.All the above methods fail,please contact our after-sale service center .

Annually Maintenance:

- Repeat every item of quarterly maintenance and inspection.
- Check weather the battery beyond service expiry or not.
- Perform a discharge test to check the exact load every year, discharge 30%_40% of the rated capacity.

Maintenance notes

- Please use insulated tools when operation and maintenance,any metal objects to be put on top of the battery shall be strictly prohibited;
- Please do not use any organic solvent to clean batteries ;
- Please do not take down safety valve or add any substance into battery
- Please do not smoke or set out fire near batteries.
- Please keep battery fully charged within 24 hours after discharge,avoid capacity affected
- Check whether safety valve twisted tightly or not,but please do not take down it.
- Stored battery performance could be in degeneration,please put the battery in operation early.
- Only professionals shall be allowed to maintain the battery

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