Technical Manual

GL SERIES VALVE REGULATED LEAD-ACID BATTERY

UPSEN EXPERT POWER SUPPLIER

Shenzhen UPSEN Electric CO., Ltd.

Contents

Prolegomenon

In order to use UPSEN GEL series battery correctly and safely, please read this technical manual and other data together with battery carefully for a comprehensive understanding.

★Pay attention to safety during installation to avoid accident.
★It is required for users to read this manual carefully and keep it well.
★If you have any questions about the Technical Manual or any technical problems, please contact us or our local agent.

Dangerous!				
				
High Voltage..... Don't touch any terminals or connectors without insulation to avoid electric shock.	Eyes Protection: Gas from explosion may harm eyes or even cause blindness.	Prohibition: Sparks, fire and smoking.	Vitriol: May cause blindness or severe burns.	Wash eyes with clean water immediately and go to see a doctor.
Do not loosen the safety vales.		Keep the battery in a well ventilated environment when in operation.		
Please read carefully the installing and using instructions in this manual.		Battery maintenance and repair should be conducted by experienced technicians.		

1 Application Range

This manual is applied to UPSEN Nano Silicon GEL Deep Cycle series battery (hereafter referred to as battery).

2 Check

1. After receiving the batteries, please check the packing and make sure the batteries are intact. Avoid bumping during carrying, and be careful when open the cartons.
2. Please open the cartons near the installation place and check appearance and quantity of the battery accessories after opening.
3. It's difficult to detect leakage if there are slight damages on the battery shell. Please check carefully and make sure there is no damage or leakage on the battery shell.
4. If the battery falls to the ground or its shell is bumped abnormally, please report the details to our company for confirmation and aftermath arrangement.

3 Storage before Installation

1. Storage Environment
   If the battery is not installed immediately after being received, please store it in a clean, ventilated and dark place at around 5~30℃.
2. Storage Time
   Due to self-discharge, the battery capacity will lose gradually in storage. Do not store the battery over 12 months or it will affect the battery performance eternally. After being stored for 6 months, the battery should be charged in voltage of 2.40 ± 0.1V for 24 hours and hereafter should be recharged at regular intervals (at least once every 6 months). A relatively high temperature will accelerate the battery self-discharge; from 20℃ when the temperature increases every 10℃, recharging interval should be reduced half. For example, when the battery is stored at 35℃, its initial charging or recharging interval should be 3 months.
   If the battery is not charged properly, its performance and life will be affected and cause the normal guarantee invalid.

4 Installation Cautions

1 . Before touching the battery, please wear a rubber apron, rubber gloves, safety goggles or other eyes protection equipments; do not wear metal objects, such as jewelry etc.
2 . The battery is very heavy. Be careful and do not pump the battery when moving it.
3 . Smoking or lighting fires are strictly forbidden. Keep the battery away from electric arc.
4 . Avoid short circuit. The battery has been charged and please prevent battery from short circuit to avoid equipment damage or personal injury.
5 . Put the battery in a cool and well ventilated place. Do not install the battery in a place that is possible to be immersed by water.
6 . Fix the bolts and nuts on the connection terminals to the specified torque; otherwise it may cause sparks or damages to the terminals.
7 . Please clean the battery shell and cover with a wet cloth; to prevent static and spark, do not use a duster or a dry cloth to clean the battery. It's prohibited to use organic solvent such as rubber solution or naphtha, which will cause the battery shell cracking.
8 . In normal operation, there will be no dissociative electrolyte attached on the shell after battery gets fully sealed. However, if the battery shell is damaged, dissociative vitriol is possible to leak. In case electrolyte splashes onto eyes, skin or clothes, flush it with a large quantity of water. If it splashes into eyes, after rinsing with water, please go to see a doctor promptly.
9 . Make sure the positive (+/red) and negative (-/black) terminals are connected properly, otherwise it will cause fire or damages to the battery or charger.
10. Please use the following protection equipments when you carry, install and maintain the battery.
1) Safety goggles or protective face-shield;
2) Acid-resistant gloves;
3) Acid-resistant apron, safety shoes;
4) Proper carrying instruments;
5) Insulation instruments.

11 . Battery posts, terminals and fittings contain lead or lead compound; and other chemical compositions in the battery are harmful to personal health.

Wash your hands after touching the battery!

5 Battery Features

1. Long Service Life
Heavy duty lead-calcium grids ensure mild corrosion and enable a long designed service life over 10 years standby use under optimal float charge conditions and below optimal operating temperature of 25°C.

2.Patent Designed Construction
UPSEN batteries are equipped with PE compound separator construction, which ensures that gel electrolyte is distributed evenly through-out the inner battery and ensures the best evenness of all parts of the battery.

3.Triplex Sealed Construction

Valve regulated sealed construction and triplex strengthened sealing on terminals and posts prevent electrolyte leakage, and guarantee the air tight and liquid tight state of batteries in normal operation and prevent external air from entering battery inner.

4.Low Self Discharge

Because of the use of lead-calcium grids alloy, UPSEN batteries have low self discharge and reliable performance. In room temperature, self discharge ratio per month of UPSEN battery is about 3% of the battery capacity.

5.High Security

UPSEN batteries are equipped with explosion-proof safety valves to prevent production of redundant gas. And the construction is designed to prevent setting fire to the internal battery in case sparkles approach.

6.High Efficiency of Recovery

Unique formulas are used in lead paste of positive post and ensure the battery can be recharged easily to a normal level.

7.No Electrolyte Stratification

Special additives are use in electrolyte to give it a gelatinous consistency without flowing, leaking or stratification, and make all parts of plates react evenly.

6 Operating Principle

1.Electrochemistry

A lead-acid battery is an electrical storage device that converts electrical energy into potential chemical energy; when needed the stored chemical energy can be converted back into electrical energy again to be supplied to external systems. In the discharge state, part of PbO_2 at the positive turns into $PbSO_4$, and part of Pb at the negative also turns into $PbSO_4$. In this electro-chemical reaction, both positive and negative electrodes generate $PbSO_4$. In the charging state, the lead sulfate ($PbSO_4$) at the positive and negative turns into PbO_2 and Pb, respectively. When in discharging, the concentration and density of electrolyte H_2SO_4 decreases gradually; while in charging, it increases. Battery charging and discharging are realized by electrochemical reactions.

$$\text{Positive: } PbSO_4 + 2H_2O \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} PbO_2 + H_2SO_4 + 2H^+ + 2e^+$$

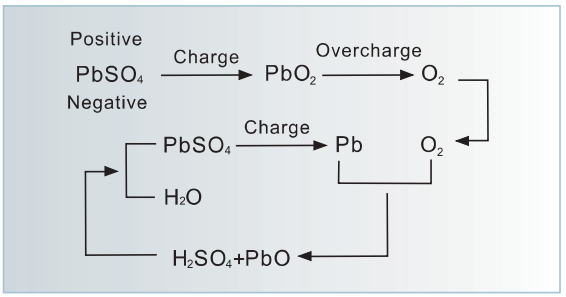
$$\text{Subsidiary Reaction: } H_2O \xrightarrow{\text{Charge}} 1/2O_2 + 2H^+ + 2e$$

$$\text{Negative: } PbSO_4 + 2H^+ + 2e \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} Pb + H_2SO_4$$

$$\text{Subsidiary Reaction: } 2H^+ + 2e \xrightarrow{\text{Charge}} H_2$$

2.Oxygen Combination

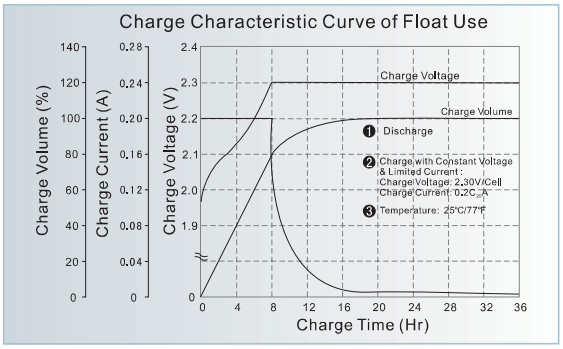
The positive plate generates oxygen gas in the final stage of charging. Under the condition of excessive additives at the negative, oxygen spreads to the negative plates through PE compound separator and reacts with spongy lead and forms lead oxide and then turns into lead sulfate and water. Keep the negative plates in depolarization or undercharge state so that the battery cannot reach the overpotential of oxygen gassing. Thus the battery avoids oxygen gassing and water loss and is made a maintenance free sealed storage battery.



7 Battery Charge, Discharge & Life

1. Charge Characteristics

Charge condition is one of the important factors in battery use. The battery performance and service life are directly related to its charging methods and charging parameters in using. The battery is recommended to be charged at the temperature range of 5-30℃ . At any temperature lower than 5℃ or higher than 35℃ it will cause undercharge or overheating and then decrease the battery life.



2. Charge Curve of Float Use

3. Relationship between Float Charge Voltage and Environment Temperature

At general temperature （5℃~30℃ ）, float charge voltage is 2.25V~2.30V. The batteries for float charge service adopt the constant voltage but limited current method. The initial current is $0.1C_{20}A$ and the maximum current is $0.2C_{20}A$.

1) At 25℃, the float charge voltage of battery is 2.27V per cell.
2) When the ambient temperature changes, the float charge voltage should be adjusted. The temperature compensation coefficient is -3Mv/, i.e., Ufloat=「2.27 – 0.003(t-25)」* n.

4. Equalize Charge

Equalize charge is required for float Service as long time float charge will make some batteries drop behind in the battery bank. An equalize charge can prevent battery stratification and reduce sulfation and bring all cells to similar levels, which is the leading cause of battery failure.
Equalize charge requirements for UPSEN battery as follows:

※ Equalize charge 1 time every three months or every 20 discharge cycles.

※ Equalize charge method: with equalize charge voltage 2.35~2.45Vpc @25℃ and max. charge current 0.3CA, and equalize charge time is 12~24h(when the charge current at the end stable about 2~3 hours ,stopped equalize and switch to float).

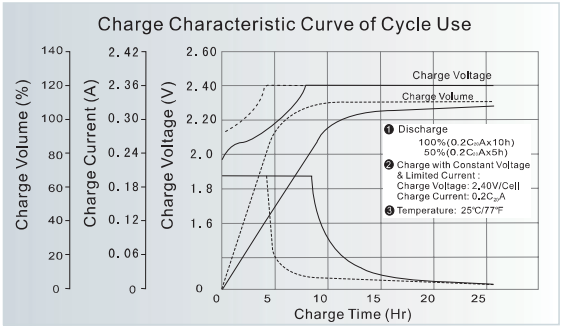
※ Before equalize charge please let the battery 100% discharged.

5. Charge Curve of Cycle Use

The batteries for cycle service adopt the constant voltage but limited current method. At 20℃ ~25℃ , the charge voltage of GEL series battery is 2.40V per cell; the initial charge current is not larger than $0.2C_{20}A$ and the battery fully charges in approximately 24 hours.

In the final stage of charging, if the charge current value remains unchanged for 3 hours, it indicates that the battery is fully charged.

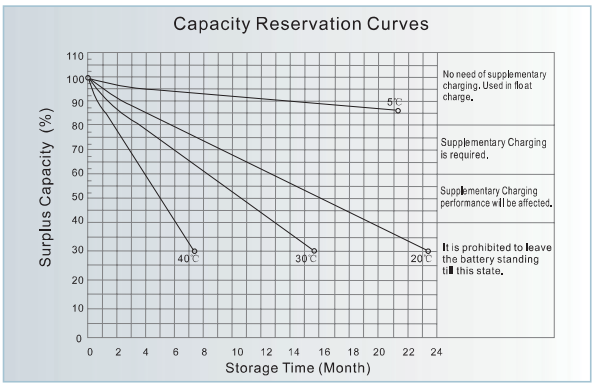
Charge curves are as right.



6. Supplementary Charging

Due to self discharge, battery stocked longtime, the capacity reduce slowly, the relationship between capacity reservation, temperature and stock time as right curves.

Supplementary Charging adopts the constant voltage but limited current method. Generally charging current is 0.05 C_{20}- 0.2C_{20}, charging voltage is 2.35 ± 0.05V/Cell, generally charge for 24~36 hours. After longtime storage, before use, battery should be makeup charged.



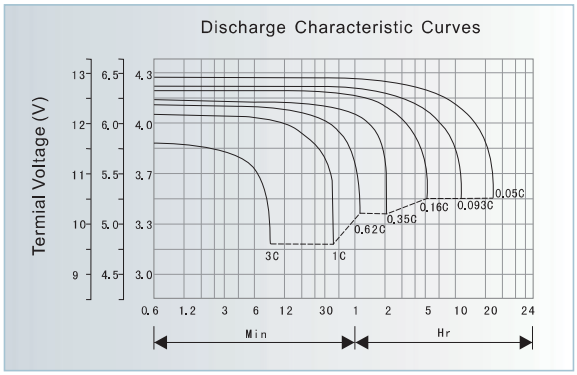
Storage Time vs Charge Voltage and Charge Time

Storage Time (Month)	Charge Voltage (V/Cell)	Maximum Charge Current (A)	Charge Time (Hr)
3~6	2.40	0.2C_{20}	24
6~12	2.40	0.2C_{20}	36

7. Discharge Characteristic

Discharge rate is different, the cutoff voltage also different. Higher discharge current, lower cutoff voltage; reversely, lower discharge current, higher cutoff voltage. Normally the battery cutoff voltage set at 1.80 – 1.60V. The discharged capacity is lower with higher discharge current.

Discharge characteristic curves are as right:



Discharge Capacity vs Temperature

Battery discharge capacity is related with temperature. Lower temperature, lower capacity discharged; higher temperature, higher capacity discharged. But the too high temperature will seriously damage the battery lifetime. The best working temperature for battery is 20- 25℃. The discharged capacity at different temperature Ct vs Discharged capacity at 25℃ C25 have below relationship:

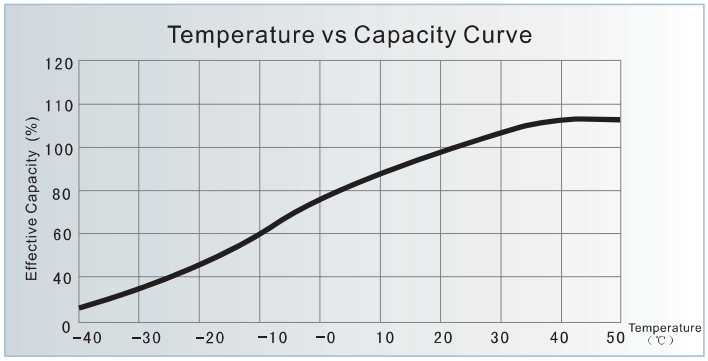
$$C_{25} = \frac{Ct}{1 + K\ (t - 25)}$$

C25 Discharged capacity at 25℃ (AH)
Ct Discharged capacity at t℃ (AH)
t Environment temperature during discharge (℃)
K Temperature compensation coefficient

20Hr rate discharge：K=0.006/℃；5Hr rate discharge：K=0.007/℃

3Hr rate discharge：K=0.008/℃；1Hr rate discharge：K=0.010/℃

Temperature vs Capacity Curves as below:



8. Float Life Characteristic

At recommended float charging situation at 25℃, GEL battery design life is over 10 years. Battery's usage lifetime is related with ambient temperature, depth of discharge, discharge rate and float charging voltage. In real usage, deep discharge, frequent discharge, and incorrect float charging voltage will affect the battery lifetime directly.

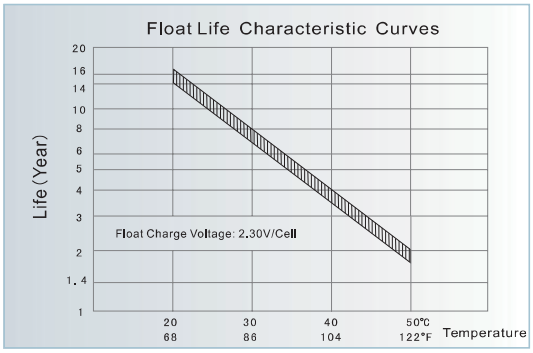
Float Life characteristic curves are as below:

Float Lifetime vs Temperature

According to Arrhenius equation, battery design life fluctuated with temperature, temperature increased every 10degree, the float lifetime cut half.

$$\ln \frac{K1}{K2} = \frac{Ea}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

K1： Equal constant at T1 temperature
K2： 1 (Equal constant at T2 temperature)
Ea: activation energy
R: air constant, 8.3143J·mole^{-1}· K^{-1}
T1: environment temperature at during discharge, K
T2: standard temperature 293K



Float Charge Voltage (V)	Battery Actual Float Life at Different Temperature (Year)				
	20℃	25℃	30℃	40℃	50℃
2.30	15.0	10.6	7.5	3.7	1.9

8 Record

The operating record of fixed batteries is very important for battery maintenance and protection. This information is useful for user to confirm battery life and adjust the longevity.

Battery is allowed to operate at a temperature lower than 25℃, however, the charging time will be relatively long. After installing batteries and a week of float charge, it's required to record the following information:

1）Battery terminal voltage
2）Charger voltage
3) Float charging voltage of each battery
4）Internal resistance of each battery. Within the same battery, put the meter that tests internal resistance at the two terminals that is in farthest diagonal position.
5）Environment temperature
6) Check if all the connecting points have been fixed to the proper torque （11.3N.M）.
Use a milliohmmeter to test internal resistance of each connecting strip. Conduct the test according to the probe potion on the instruction manual. If the data range is 20% bigger than that during installation, fix screws again to the torque of 11.3N.M. If the data remains high, please wipe terminals and the interface between terminals and connecting strips.

9 Maintenance

Put mask or protective glass when approach battery, make sure not put battery next to fire/ smoking place.

It can prolong battery life and easy to judge when battery need replacement by proper maintenance. If the maintenance way differs from this manual, users can only make the maintenance method according to battery usage and using reliability. All maintenance needs the professionals to execute.

1. Checking

Try to make all checking under float charging conditions. Measurements should be made according to specification from suppliers and keep the records for future collation.

1. 1 Monthly checking

Record for monthly checking:

1. 1. 1 All batteries float charging voltage
1. 1. 2 Current and voltage from charger
1. 1. 3 Temperature, ventilation and monitor equipments situation.
1. 1. 4 Eye check record for battery string:

1) Battery appearance: terminal, connector, any corrosive phenomena with battery rack.

2) The clearance region between batteries and rack

3) Any phenomena of crack or leakage for battery

4) Any phenomena of deformation for battery and rack

1. 2 Quarterly checking

Apart from checking items of above 1.1 as quarterly checking , plz also check following issues and keep record. (Need to collate with previous records.）

1） Resistance per block
2） Temperature of negative terminal for each battery
3） Check connect resistance at random (at least check 10% or not less than 6 connectors), if resistance is higher than initial resistance, then need to check all connectors' resistance and dig out reason. （Plz check different connectors each time）

1. 3 Yearly checking and initial checking
   Apart from checking items of above 1.1 and 1.2 as yearly checking, plz also checking following issues and keep record (Need to collate with previous records.)
   1) Check all connector resistance;
   2) Try to check AC current and voltage from rectifier.
1. 4 Special checking
   Batteries need inspection to check if they were get damaged in special situation (like over-discharge, abuse charging machine or charging machine can not work properly ect). The inspection includes all yearly checking clause and make records.

2. Ripple Voltage of rectifier
   We recommend ripple Voltage of rectifier should not be bigger than 0.5% of charging voltage, and librating ripple time should be shorter than 8 millisecond.
3. Battery cleaning
   Use water or carbonic acid water to clear battery and cover.
4. Capacity test
   If batteries can work properly, no need to check capacity. Only to check capacity when doubt battery capacity. Battery cut voltage after discharge should not be lower than suppliers specification.
   Before capacity testing, make sure battery get fully charged for more than 48 hours under float charge, if not, make a equalization charge for 24 hours. Let batteries rest and cool down for 8-24 hours and then conduct capacity test.

10 Common Faults & Solutions

No.	Common Fault	Solution
1	Leakage	Pls contact the supplier for replacements.
2	Crack	Pls contact the supplier for replacements.
3	Low floating V.	After 24-48hrs equalization charger, still low,
4	High temp.round pole	Inspect connect point, charger, ventilation and charging current.
5	Abnormal Appearance	Pls contact the supplier for replacements.
6	Grounding Fault	Check leakage or ground faulty.
7	Abnormal connect & inner resistance	Check good connect or charging method.