VALVE REGUALATED LEAD-ACID BATTERY

MCA

Website: www.mca-battery.com

GFM SERRIES

TECHNICAL MANUAL

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Contents

Prolegomenon

In order to install and use MCA FC 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

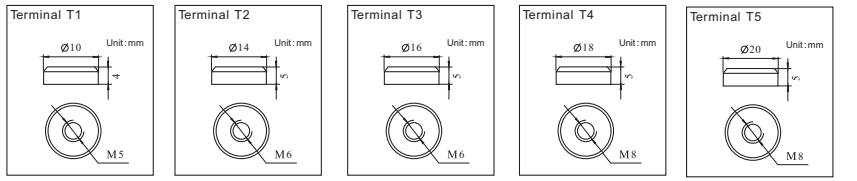
This manual is applied to the following GFM series VRLA battery (hereafter referred to as battery).

GFM Battery Parameters

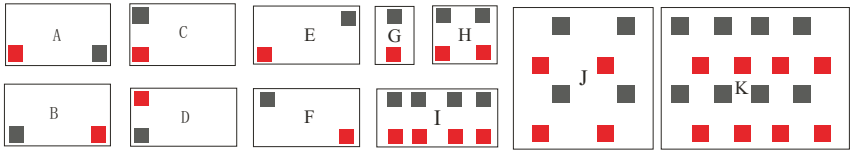
Model	Nominal voltage (V)	Rated capacity (Ah)	Size(mm)				Size(inch)				Weight		Terminal	Layout
			L	W	H	Total H	L	W	H	Total H	(kg)	(lb)		
GFM-200	2	200/10HR	172	110	330	367	6.772	4.331	13.0	14.4	13.0	28.7	T5	G
GFM-300	2	300/10HR	172	150	330	365	6.772	5.906	13.0	14.4	19.0	41.9	T5	G
GFM-400	2	400/10HR	211	175	330	368	8.307	6.89	13.0	14.5	25.5	56.2	T5	H
GFM-500	2	500/10HR	241	172	330	366	9.488	6.772	13.0	14.4	31.0	68.3	T5	H
GFM-600	2	600/10HR	301	175	330	368	11.85	6.89	13.0	14.5	38.0	83.8	T5	H
GFM-800	2	800/10HR	411	175	330	365	16.18	6.89	13.0	14.4	51.0	112.4	T5	I
GFM-1000	2	1000/10HR	474	175	328	366	18.66	6.89	12.9	14.4	62.0	136.7	T5	I
GFM-1500	2	1500/10HR	401	347	342	378	15.79	13.66	13.5	14.9	100.0	220.5	T5	J
GFM-2000	2	2000/10HR	490	349	342	383	19.29	13.74	13.5	15.1	130.0	286.6	T5	K
GFM-3000	2	3000/10HR	711	353	342	383	28.0	13.9	13.5	15.1	200.0	440.9	T5	K

Please contact us for updated information

TERMINALS



POSITION OF TERMINALS



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 for more than 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 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 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. 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 Installation

1. Installthebatteryaccordingto installation drawing.Please leave at least 1,000mm passageway as maintenance space.
2. Install Connectors
   Apply the Vaseline onto the battery terminals to prevent large resistance oxide; then install connectors. After installing all the battery connectors, make sure all positive(+/red) and negative(-/black) terminals are connected properly according to the installation figures; then fix the connecting screws in the moment of 11.3Nm with a insulative moment spanner.
3. Measure Voltage
   After installing the connectors, measure the total voltage of whole string, which should be the total of the cell voltage. If they are inconsistent, please check the battery polarity and recheck the battery connection in a proper moment.
4. Cell Number
   Stick the self-adhesive labels of cell number and system grade sign on the top of relevant cells. The first cell at the positive connecting terminal should be marked as No.1 and the restis marked by analogy.
5. Install Battery Shield
   After checking the voltage and arranging the cell numbers, put the shield at the top of the battery.

6 Battery Features

1. **Nice Appearance**
   European Low Profile style & streamline shape design gives the battery elegant look.
2. **Longer Service Life**
   Unique plate elongating self absorbed technology can effectively prolong the service life.
3. **Maintenance-Free Operation**
   Absorbent Glass Mat (AGM) technology ensures efficient gas recombination up to 99% and freedom from electrolyte maintenance. During the expected float service life of MCA batteries, no need to check the specific gravity of the electrolyte or add water.

4. Longer Float Service Life

A unique corrosion-resistant grid alloy & special lead paste formulations ensures the batteries have excellent recovering ability upon over discharging and longer float service life.

5. Low Self Discharge

Using high purity raw materials ensures MCA batteries have less self-discharge.

6. Environmental & Non-polluting

Gas Recombination technology ensures the battery high seal reacting rate, which can prevent the acid fog from separating out.

7. **Safe & Reliable**

Efficient venting system automatically release excess gas when the pressure rises above the normal level & reseals the valves when it returns to the normal rate, which can protect the battery from bursting.

7 Battery Applications

1. Communication Systems: Switch, Microwave Stations, Mobile Base Stations, Data Centers, Radio and Broadcasting Stations
2. Power Plants & Power Transmission Systems
3. Solar & Wind Power Generation Systems
4. Signal System & Emergency Lighting Systems
5. EPS & UPS Systems

8 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 electro-chemical reactions.

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

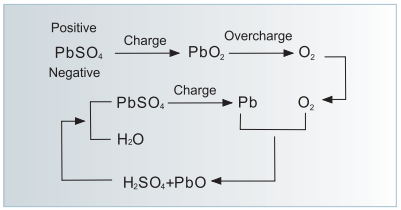
$$\text{Subsidiary Reaction: } H_2O \xrightarrow{\text{Charge}} 1/2O_2 + 2H^+ + 2e$$

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

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

2. Oxygen Combination

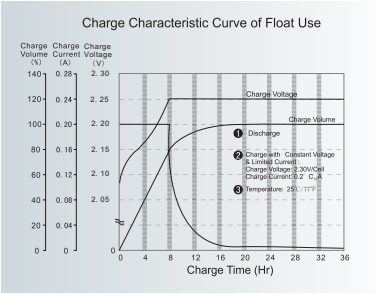
The positive plate generates oxygen gas in the final stage of charging. Under the condition of excessive additives at the negative , oxygen spreads to the negative plates through glass fibre separator and reacts with spongy lead and forms lead oxide and then turns into lead sulfate and water. Keep the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



9 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 higherthan 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

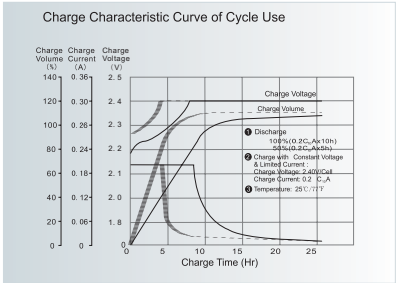
At general temperature （5℃~30℃ ）, float charge voltage is 2.23V~2.27V. The batteries for float charge service adopt the constant voltage but limited current method. The initial current is 0.1 C A and the maximum current is 0.2C A

1) At 25℃, the float charge voltage of 2V battery is 2.25V per cell.

2) When the ambient temperature changes, the float charge voltage should be adjusted. The temperature compensation coefficient is -3Mv/℃ , i.e., Ufloat=「2.25-0.003(t-20)」.

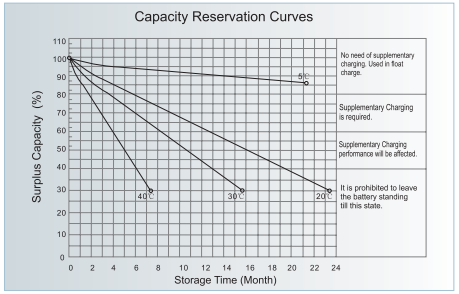
4. Charge Curve of Cycle Use

The batteries for cycle service adopt the constant voltage but limited current method. At 20℃ ~25℃ , the charge voltage of GFM series battery is 2.40V per cell; the initial charge current is not larger than 0.2CA 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.



5. Supplementary Charging

Due to self discharge, battery stocked long time, 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. Initial charging current is 0.05C10- 0.1C10, charging voltage is 2.35- 2.4V/Cell, generally charge for 36 hours. After longtime storage, before use, battery should be makeup charged.



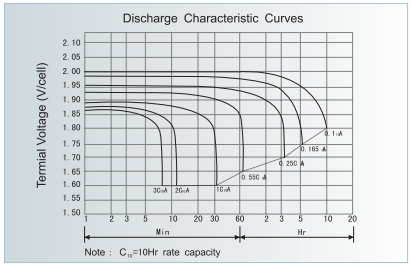
Storage Time vs Charge Voltage and Charge Time

Storage Time (Month)	Charge Voltage (V/Cell)	Maximum Charge Current (A)	Charge Time (Hr)
3 ~ 6	2. 30	0. 2C $_{10}$	36
6 ~ 12	2. 35	0. 2C $_{10}$	48
12 ~ 20	2. 35	0. 2C $_{10}$	60

6. 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 1.8V-1.6V. The discharged capacity is lower with higher discharge current.

Discharge characteristic curves are as right:



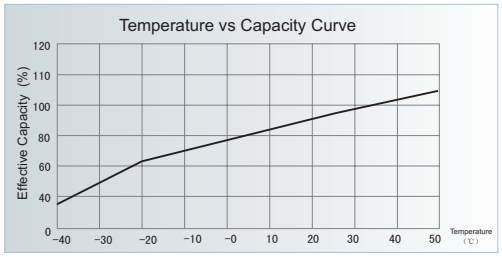
Discharge Capacity vs Temperature

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 life time. 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
	10Hr 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:



7. Float Life Characteristic

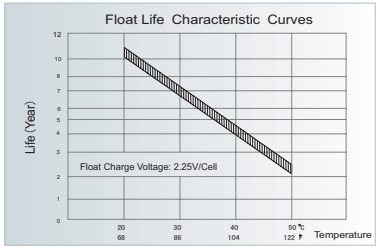
At recommended float charging situation at 25℃, FC series battery design life is over 8 years. Battery's usage lifetime is related with ambient temperature, depth of discharge, discharge rate and float charging voltage. In real usage, depth of discharge, frequent of discharge, incorrect float charging voltage will effect 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 10 degree, 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, 8.3143 J·mole·K-1
T1: environment temperature at during discharge, K
T2: standard temperature 293K



10 Operating 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 2 5℃, 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 instructionmanual . 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.

11 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 clause of above 1.1 as quarterly checking,

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.

1. 3 Yearly checking and initial checking

Apart from checking clause of above 1.1 and 1.2 as yearly checking , please 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 then let batteries rest for 8-24 hours.

12 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	Battery less capacity	After 24-48hrs equalization charger, still low,
5	High temp.round pole	Inspect connect point, charger, ventilation and charging current.
6	Abnormal Appearance	Pls contact the supplier for replacements.
7	Grounding Fault	Check leakage or ground faulty.
8	Abnormal connect & inner resistance	Check good connect or charging method.

13 BATTERY CONSTRUCTION

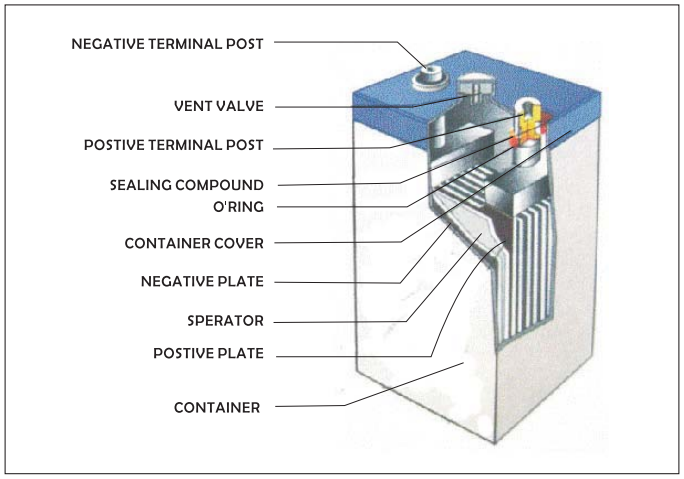
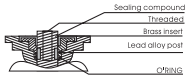


Table: Show the battery parts and special function

Battery Parts	Material used	Special Function
Positive and Negative plates	Heavy duty anti-corrosive Lead-calcum alloy gride pasted with active material	1、Retain high capacity 2、Maintain capacity performance throughout service life 3、Minimize self-discharge
Separator	High density glass fiber	1、Prevents short-circuit betwen (+) and (-) plates 2、Prevents active material from shedding 3、Retains electrolyte
Safety valve	Synthetic rubber cap	Release gas if internal pressure rises too high, Operate at 0.07-0.43Kg/cm^3
Electrolyte	Dilute sulphuric acid fully absorbed by plates & separator	Conduct electro-chemical reaction in (+) and (-) plates
Sealing epoxy	Acud-resistant epoxy resin from Japan	1、Sealed construction allow the gas recombination system which transforms the generated gas into water,thus no topping-up is required throughout battery life and is maintenance free 2、Leak-proof from terminal of case 3、Ensure safety
Case Components: Container,cover and top lid	Injection-moulded made of ABS plastics resin with UL94HB grade and optionally with UL94V0 grade	1、Provides heat-sealed compartment for 2V cell gril groups 2、with stands thermal and mechanical shock 3、Integral handle incorporated into lid for easy lifting
Terminal Construction		1、Threaded insert terminal provides maximum conductivity and enhance high rate of discharge characteristics

14 MATERIAL SAFETY DATA SHEET

Product Identity:Sealed Maintenance Free Lead-Acid Batteries

Hazardous Components

Components	%Weight	TLV	Ld50	Lc50	Lc50
			Oral	Lnhalation	Contact
Lead(Pb,Pb02,PB504)	67-71%	N/A	500mg/kg	N/A	N/A
Sulfuric Acid	16%	1mg/m3	2120mg/kg	N/A	N/A
Fiberglass Separator	1.5%	N/A	N/A	N/A	N/A
ABS	67-71%	N/A	N/A	N/A	N/A
Others(glue,safety valve, Teminal,O-ring---etc.)	3%	N/A	N/A	N/A	N/A

Physical Data

Components	Density	Melting Points	Sollubilit(H2O)	Odor	Appearance
Lead	11.34g/cm3	327.4℃(Boiling)	None	None	Silver-Gray Metal
Lead Sulfate	6.32g/cm3	100+℃(Biling)	40mg/l(15℃)	None	White Power
Lead Dioxide	9.37g/cm3	289℃(Biling)	None	None	Brown Powder
Sulfuric Acid	About 1.3	About114℃(Boiling)	100%	Acidic	Clear Colorless Liquid
Fibergalss SEP.	135-175g/m'.mm	>/=900℃	Slight	Toxic	White Fibrus Glass
ABS	1.05s.g.	20g/10min(22℃/10kg)	None	Almost Odorless	Pellet

Flammability Data

Components			
Lead	None	None	
Sulfuric Acid	None	None	
Hydrogen		4%-72.4%	Sealed batteries can emit hydrogen only if over charged(float volt.>2.4VPC)
Fiberglass Sep.	N/A	N/A	
ABS		1/16"HB	Toxic Vapors may be released.
(Acrylonitrile-styrene)	None	(UL-94.File no.E-6717m)	In case of fire:wear self-contained breathing apparatus. Storage conditions to avoid fire and heating above 60°C Dense smoke from heated material may cause respiratory irritation. In case of inhaling dense smoke, immediately remove a person to fresh air. If necessary,apply artificial respiration and seek medical attention immediately.

First Aid (Sulfuric Acid Precautions)

Skin contact	Flush with water, see physician if contact area is large or if blisters form
Eye Contact	Call physician immediately and flush with water until physical arrives
Lngestion	Call physician,If patient in consciousm,flush mouth with water, have patient drink milk or sodium bicarbonate sollution

Reactivity Data

Component	Sulfuric Acid
Stability	Stable at all temperature
Polymerization	Will not polymerize
Lncompatibility	Reactive metals,strong bases,most organic compounds
Decomposition Products	Sulfuric dioxide,trioxide,hydrogen sulfide,hydrogen
Conditions to Avoid	Prohibit smoking,sparks,eparks,etc.from battery charging area.Avoid mixing acid with other chemicals

Spill or Leak Procedures

Steps to take in case of leak or spill	If sulfuric acid is spilled from a battery, neutralize acid with bicarbonate (baking soda),or calcium oxide (lime).Flush area with eater and discard to the sewage system.Do not allow unneutralized acid into sewage system.
Waste Disposal Method	Neutralized acid may be flushed down the sewer.Spent batteries must be treated as hazardous waste and disposed of according to local,state, and federal guidelines.A copy of this MSDS must be supplied to any scrap dealer or secondary lead smelter with battery.

Protection

Exposure Site	Protection	Comments
Skin	Rubber gloves,Apron	Protective equipment must be worn if the battery is cracked or otherwise damaged.A respirator should be worn during reclaim operations if the TLV exceeede.
Respiratory	Respirator(for lead)	
Eyes	Safety goggles,Face,Shiele	

Electrical Safety

Due to the battery`s low internal resistance and high power desity, high levels of short circuit current can be developed across the battery terminals Do not rest tools or cables on the battery. Use insulated tools only. Follow all installation instructions and diagrams when installing or maintaining battery systems.

Health Hazzard Data

Lead	The toxic effects of lead are accumlative and solw to appear.It affects the kidneys,Reproductive,and central nervous systems. The sym ptoms of lead overexposure are anemia,vomiting,headache, stomach pain(lead colic),dizziness,loss of appetite,and muscle and joint pain .Expo-sure to lead from a battery most often occurs during lead reclaim operations through the breathing or ingestion of lead dust fumes.
Sulfuric Acid	Sulfuric acid is strong corrosive. Contact with acid can cause severe burns on the skin and in eyes. Lngestion of sulfuric acid will cause GI tract burns.Acid can be released if the battery case is damaged or if vents are tampered with.
Fiberglass Separator	Fibrous glass is an irritant of the upper reparatory tract,skin and eyes.For exposure up to 10F/cc use MSA comfoll type type H filter. Above 10F/ CC up to 50F/CC use Ultra-Twin type H filter. This product is not considered. Carcinogenic by NTPor OSHA.