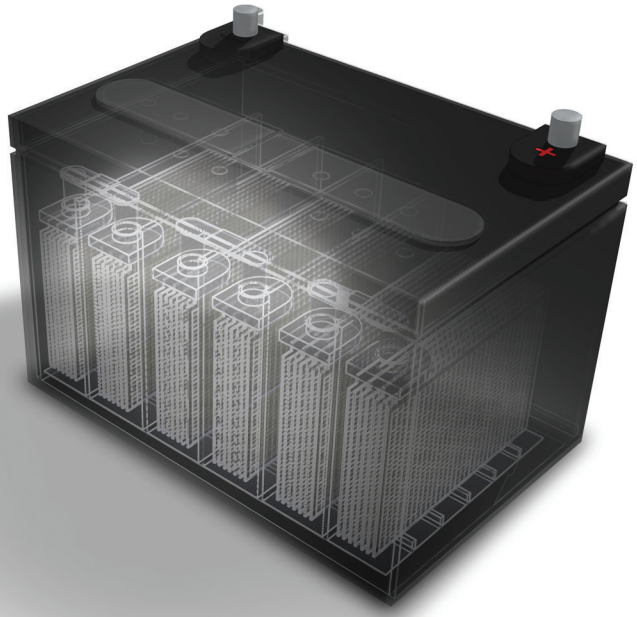
Charging Flooded Lead Acid Batteries for Long Battery Life

How to Prevent Sulfation and Excessive Gassing That Ruin 12V-48V Flooded Lead Acid Batteries



Content Highlights

- **Two leading causes of battery failure are sulfation and excessive gassing.**
- **Good management and correct charging greatly improve battery performance.**
- **Multi-stage charging technology, such as IOTA's IQ4 Charge Controller, is the safest and most effective method of charging flooded lead acid batteries.**
- **How multi-stage charging technology prevents sulfation and excessive gassing.**

Battery owners expect optimal performance from their batteries, but don't always know the best practices to get long life and reliability from them. With some understanding of cause, effect and prevention of leading causes of premature battery failure, owners can expect more years of safe and reliable operation from their batteries.

Two leading causes of capacity loss, failure, and hazards in flooded lead acid batteries are *sulfation* and *excessive gassing*. Both of these can be largely prevented by using smart charging technology to safely store these types of batteries at full charge.

Sulfation, Undercharging, and Battery Failure

The leading cause of battery failure is *sulfation*. Sulfation is a deposit of lead sulfate crystals on the charging plates that resists the battery's ability to accept a charge. Eventually, the deposits will prohibit charging, reducing both the battery's capacity and functional life. The source of the sulfate is the water and sulfuric acid electrolyte solution inside the battery. An ongoing electrochemical reaction between opposite charges occurs in the electrolyte solution that produces electrons. These reactions are at their optimal state while the battery is at the correct full charge, but are diminished when the battery is undercharged or overcharged.

During normal charge and discharge some minor sulfation occurs, but major sulfation can develop when the battery is stored in an uncharged or undercharged condition, which eventually slows and stops the electrochemical reactions. If these reactions stop, sulfation is accelerated as the sulfur leaches out of the electrolyte solution and attaches itself to the lead charging plates. As more crystals deposit on the charging plate, the ability for the battery to accept full charge diminishes, and undercharging worsens. This is a downward spiral to premature battery failure.

Negative and positive battery plates damaged by sulfation.

Two common maintenance practices that contribute to sulfation are storing batteries in an uncharged condition and undercharging. Both of these conditions can be prevented by using smart charging technology to safely maintain stored batteries at full charge.

Gassing, Overcharging and Water Loss

A careful margin exists between maintaining a battery's full charge and overcharging. Like undercharging, overcharging reduces battery life, but it can also lead to a potentially dangerous situation. Preventing overcharging is another important control an owner has over battery life and safety.

One of the hazards of overcharging is *excessive gassing*. Some gassing naturally occurs during normal charging, but when a lead acid battery is overcharged, the electrolyte solution can overheat, causing hydrogen and oxygen gasses to form, increasing pressure inside the battery. Unsealed flooded lead acid batteries use venting technology to relieve the pressure and recirculate gas to the battery. Gassing in excess of venting capacity or malfunctioning vents can 'boil' the water out of the battery and the resulting water loss can destroy the battery. If the electrolyte solution falls below the level required to reach the charge plates, the exposed charge plates will sustain damage. The most hazardous situation is when a lead acid battery is overcharging and overheating, producing more combustible hydrogen and oxygen than can be vented, when finally the pressure is relieved – instantly – by explosion.

Good management practices in battery maintenance can prevent excessive gassing and damage due to water loss. First, the battery should not be overcharged. This can be prevented with smart charging technology that automates multi-stage charging. Second, the water level in the battery should be checked according to the manufacturer's specifications.

Evaporation of water due to excessive overcharging can result in cracked or exploding batteries.

Correct Charging Matters

How a lead acid battery is charged can greatly improve battery performance and lifespan. To support this, battery charging technology has evolved with smart chargers which assist owners by taking the guesswork out of correctly applying the various stages and voltages of charging. Correct application of the charging stages will maintain a battery at full charge, balance undercharging and overcharging, and help prevent sulfation and excessive gassing.

Effective and Safe Multi-Stage Charging

Multi-stage charging is the safest and most effective method of charging flooded lead acid batteries. The electrolyte solution has phases of accepting a full and complete charge – multi-stage charging accommodates those phases and helps to prevent sulfation and excessive gassing. The first three stages are bulk, absorption, and float.

Stage 1 Bulk: Also called the boost stage, this is a period of constant current and increased voltage that provides most of the charge. Charging voltage runs up to the full-rated output of the battery charger for faster charging. If a battery is left at this charge stage it will overcharge.

Stage 2 Absorption: Also called the soak stage or topping stage, the charging voltage drops during this stage and is then held for a controlled period so the electrolyte solution has the opportunity to absorb the charge fully and completely. If a battery is left at this charge stage it will overcharge.

Stage 3 Float: A lower voltage "trickle" charge is delivered to maintain the battery's full charge while not overcharging. In the float stage, the battery is at full charge and ready for discharge with normal operation for motor-start cranking or for running lights, appliances, and electric motors. If a battery is left at this charge it will undercharge as it slowly self-discharges.

The Fourth Phase: Equalization: The fourth phase is called the equalization phase. Since the battery will gradually self-discharge if left in the float stage, multi-stage charging will boost the charge voltage should the voltage drop below a certain level. Additionally, if left in an extended float state, the battery faces the threat of acid sulfate *stratification*. Stratification occurs when electrolytes concentrate at the bottom of the battery, reducing performance. A smart charge controller, such as IOTA's IQ4 Smart Charger, monitors if the battery has remained in the float stage for a specified length of time or if the battery voltage drops below a minimum level. The smart charge technology then enters the equalization phase of automatically initiating a new round of charging through the multi-stage cycle, correcting the undercharge condition and stimulating the mixing of the electrolyte solution. Specifically, the equalization phase of the IQ4 Smart Charger automatically repeats the charge cycle every seven days or when the battery voltage drops below a determined voltage level (see **Table A** for float voltages by battery size). By automatically re-initiating the multi-stage cycle, a balance is achieved between overcharging and undercharging, and stratification is prevented.

Four-Phase Charge Control Help Prevent Sulfation and Excessive Gassing

Multi-stage, charge control technology automatically controls the balance between undercharging and overcharging, and significantly reduces the negative impact of these conditions.

Multi-stage charge technology brings the battery to a full charge safely, effectively and automatically, and then maintains the full charge to avoid sulfation of the battery plates caused by undercharging.

Multi-stage charging also helps prevent excessive gassing caused by overcharging by controlling the duration and amount of charge permitted when charge voltage is highest in the bulk and absorption stages. For example, IOTA's IQ4 Charge Control Technology prevents overcharging by allowing the IOTA battery charger to deliver a charge in the bulk stage until the battery voltage achieves the high value or, if the high value is not achieved, terminates the bulk charge and transitions to absorption after 240 minutes. The second stage, absorption, is prone to overcharging if left unchecked. The IQ4 limits the absorption stage to eight hours, preventing overcharging, and initiates the float stage.

What Battery Owners Need to Know...

- The two leading causes of battery failures, sulfation and excessive gassing, can be prevented.
- Sulfation and excessive gassing are the results of undercharging and overcharging, respectively.
- Maintain proper full charge in flooded lead acid batteries with an automated, multi-stage smart charger recommended by the battery manufacturer.
- Check the water level of your unsealed batteries regularly.

An example of an IOTA DLS charger utilizing an external IQ4 multi-stage charge controller option.

Table A: Typical charging voltages using IOTA IQ4 Charge Control Technology.

BATTERY VOLTAGE:	12V	24V	48V
BULK STAGE	14.8V	29.6V	59.2V
ABSORPTION STAGE	14.2V	28.4V	56.8V
FLOAT STAGE	13.6V	27.2V	54.4V

Using IOTA IQ4 Charge Control Technology

IOTA IQ4 Multi-Stage Charge Control Technology is a four-phase charge controller for IOTA DLS Series Battery Chargers to automate multi-stage charging of 12V-48V flooded lead acid batteries.

The IQ4 uses the four phases – **bulk, absorption, float** and **equalization** – to maintain a proper full charge to extend battery life.

IQ4 is available as an integrated option in IOTA DLS Series Battery Chargers or as a separate module that connects to the DLS charger.

What about using Charge Control Technology with other battery types?

Different battery types (sealed lead acid, AGM, etc.) often require unique charging stages to properly maintain the battery. The charging parameters discussed here are applicable to flooded lead acid batteries. Be aware that some available chargers may not be suitable for other applications. Contact IOTA to find out more about programmable IQ charge controller options for these battery types.

Smart Owners Use Smarter Chargers

Preventing sulfation and excessive gassing extends the lifetime and improves reliability and safety of lead acid batteries. The IOTA IQ4 Charge Control Technology maintains proper battery charge to prevent the damaging effects caused by the storage of batteries in an overcharged or undercharged state. When batteries will not be used for long periods of time, storage in the proper full charge state is crucial to reliable battery performance. IOTA IQ4 charge controllers delivers the necessary four-stage charging process for these flooded lead acid battery applications, and brings battery users the confidence of optimal life and performance of their investment.

About IOTA Engineering

IOTA®, an Acuity Brands® company, has worked continuously in the electronic R & D field, designing and manufacturing innovative products for the lighting and electronics industries since 1968. Initially focused on the development of low voltage solid state ballasts, IOTA has expanded to include emergency battery packs for contemporary lighting designs, DC inverter ballasts, and AC/DC power converters and battery chargers. The company is a leader in developing technology for reliable chargers for specialty battery charging and power conversion applications. IOTA is continually expanding its development of state-of-the-art electronics that keep pace with customer needs and industry demands. From the circuit board design to the completed unit, IOTA designs and develops products that maintain superior performance, and is dedicated to providing the highest levels in customer satisfaction, quality and innovation in the industry.

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P.O. BOX 11846 TUCSON, AZ 85734 • 1361 E. WIEDING ROAD TUCSON, AZ 85706 • 1-800-866-4682 • FAX (520) 741-2837
www.iotaengineering.com