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UNDERSTANDING DEGRADATION IN STORED SLA AND LFP BATTERIES: A COMPARATIVE ANALYSIS

Batteries are integral components of various devices, ranging from small electronics to backup power systems. Two widely used battery types are Sealed Lead Acid (SLA) and Lithium Iron Phosphate (LiFePO4 or LFP). While these batteries offer distinct advantages, both are susceptible to degradation when left unused for extended periods. This article explores the degradation phenomena in SLA and LFP batteries that sit on the shelf for 6, 9, and 12+ months.

Sealed Lead Acid (SLA) batteries, also called the VRLA batteries, which is short for Valve Regulated Lead Acid batteries, consist of lead dioxide and sponge lead plates submerged in a sulfuric acid solution inside a sealed case. When stored, SLA batteries undergo two main degradation processes: self-discharge and sulfation. Self-discharge occurs due to internal chemical reactions, leading to gradual loss of charge over time. Sulfation, a more pronounced issue, arises from the accumulation of lead sulfate crystals on the battery plates. This reduces the available surface area for chemical reactions, impairing battery capacity and performance.

Lithium Iron Phosphate (LFP) batteries, known for their high energy density and cycle life, are more resilient to degradation compared to SLA batteries. However, even LFP batteries experience degradation when stored for prolonged periods. One primary concern is the phenomenon known as “lithium plating,” which occurs when low charge levels cause lithium ions to plate onto the anode instead of being absorbed. This can lead to capacity loss, faster aging, and increased internal resistance that will cause longer charging time.

After long months of storage, SLA batteries may experience a noticeable drop in capacity due to self-discharge and sulfation. It is best to charge SLA at least every 6-9 months. Regular charging and maintenance are recommended to mitigate these effects. LFP batteries tend to retain a higher percentage of their charge after the same duration, but precautions should still be taken to prevent excessive discharge.

SLA batteries left on the shelf for a year or more may suffer from severe sulfation, leading to reduced capacity and increased internal resistance. They often lose charge when sitting on a shelf, usually five times a lithium batteries’ self-discharge rate. LFP batteries, though still more resilient, can experience some capacity loss due to the accumulation of lithium plating but these batteries can be stored up to 3 years if taken proper storage measures. Ensuring proper storage conditions and regular charge maintenance becomes critical for preserving battery health.

For Sealed Lead Acid (SLA) batteries, there are several key practices to ensure their optimal performance and longevity:

1) Periodic Charging: It is advisable to perform periodic charging every 6 to 9 months. This practice helps prevent sulfation, a common issue in SLA batteries during extended periods of inactivity. Regular charging prevents this buildup and ensures the battery remains ready for use.

2) Charge Level Maintenance: When storing SLA batteries, it is recommended to keep their charge level as close to 100% as possible. Batteries stored with a low charge level are more susceptible to degradation as sulfation will occur over time. Maintaining a high charge level minimizes the risk of self-discharge and helps preserve the battery's overall capacity.

3) Good Quality Chargers: High and good quality chargers are designed to provide the correct charging voltage and current to SLA batteries. Charging with the wrong voltage or current levels can lead to overcharging, undercharging, or overheating, which can significantly reduce the battery's lifespan. Good quality chargers incorporate safety features such as overcharge protection, short-circuit protection, and temperature monitoring. These features reduce the risk of damage to the battery and ensure safe charging operations.

Proper care and maintenance of Lithium Iron Phosphate (LFP) batteries are also crucial for maximizing their efficiency and lifespan. Here are some key practices to consider:

1) Optimal Storage Conditions: When storing LFP batteries, it's advisable to maintain their charge level within the range of 40% to 60%. Additionally, storing them at a moderate temperature, ideally between 32°F and 77°F (0°C and 25°C), is recommended. These conditions help preserve the battery's capacity and performance over time. Extreme temperatures should be avoided as they can lead to accelerated degradation and reduced overall lifespan.

In extremely low temperatures, LFP batteries may experience adverse effects such as reduced energy and performance. Cold temperatures can cause the chemical reactions within the battery to slow down. An increase in internal resistance and longer charging time may occur as electrons can't separate quickly from their lithium atoms, making it less efficient in delivering power.

When LFP batteries are stored in a very high temperature, there is a risk of thermal runaway. This is a dangerous condition where the battery will overheat and may lead to serious fire and explosion.

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2) Battery Management Systems (BMS): Employing battery management systems (BMS) is highly recommended for LFP batteries. These systems help prevent over-discharge and overcharging, which can be detrimental to the battery's health. BMS ensures that the battery operates within safe voltage and temperature ranges, prolonging its lifespan and enhancing safety.

In conclusion, both SLA and LFP batteries are vulnerable to degradation during extended periods of inactivity. SLA batteries are particularly impacted by self-discharge and the formation of sulfation, whereas LFP batteries demonstrate greater durability but are not entirely exempted from degradation effects. By applying suitable mitigation approaches, users can optimize the longevity and operational capabilities of these batteries, guaranteeing their readiness for utilization as required.

AUTHORS

John Paul P. Caña
President/Chief Engineering Officer, Gintuga Technologies LLC, www.gintuga.com
MSC Computer Engineering, Mapua University
BSC Electronics and Communications Engineering, Mapua University

Candy Rose S. Nisol
Director of Engineering, Gintuga Technologies LLC, www.gintuga.com
BSC Electronics and Communications Engineering, University of St. La Salle

Christina Mae Y. Hachero
MSS – Hardware Engineer, Gintuga Technologies LLC, www.gintuga.com
BSC Electronics and Communications Engineering, University of St. La Salle

191 Covington Dr. • Bloomingdale, IL 60108 zeusbatteryproducts.com 877.469.4255 sales@zeusbatteryproducts.com