Zeus Battery Products

SEALED LEAD ACID (SLA) BATTERIES COMPARED TO LITHIUM IRON PHOSPHATE (LFP) BATTERIES

Energy storage is an important part of the global economy since it allows the release of electric energy upon demand.

Batteries had become available in the early 19th century when they provided the main source of electricity before the development of electric generators and the electric grid system. Improvements in battery technology allowed advances, such as the use of telegraphs and telephones eventually leading to portable computers, mobile phones, electric cars, and many other electrical devices.

Over the last couple of centuries, and dominantly in the last several decades, batteries have undergone enormous advancement with respect to storage capacity, efficiency, and their available sizes.

Beside mobility devices and material movers, energy storage in residential, commercial, and industrial applications is one of the key drivers behind ever growing demand for batteries.

Today, two most common battery types are being utilized for household and commercial energy storage, lead acid and lithium iron phosphate batteries.

COMPARING SLA AND LFP BATTERIES

Lithium is an element in the periodic table with great electrochemical properties. Besides being one of the lightest metals, one of its properties is the capability of generating relatively high voltages while occupying small volume. Lithium based batteries are capable of being charged and discharged at faster rates than lead-acid batteries.

Sealed Lead Acid (SLA) batteries have ruled the market because of their low cost. In the last decade, Lithium Iron Phosphate (LFP) batteries have grown in popularity which has made lead-acid and lithium-iron the leading batteries used in residential and commercial energy storage applications.

Besides using different chemistry, the SLA and LFP batteries vary in terms of the cost of ownership and performance.

SLA (SEALED LEAD ACID) BATTERY

Lead acid batteries have been around for more than 100 years. They are one of the lowest cost batteries per unit of energy unit or per Wh (Watt-hour). Two main types of lead acid batteries are being produced, FLA (Flooded Lead Acid) and SLA (Sealed Lead Acid). SLA batteries are often referenced as VRLA (Valve Regulated Lead Acid) or AGM (Absorbed Glass Matt) batteries.

SLA batteries come in two basic configurations, AGM (Absorbent Glass Mat) and Gel. Gel batteries have lower charge and discharge rates than AGM thus needing longer times to charge and cannot provide as high output power as comparable AGM batteries. Either of the two SLA types require very little to no maintenance and are spill-proof. Unlike FLA (flooded) batteries that need to be installed upright, SLA batteries will operate in just about any position.

https://www.zeusbatteryproducts.com/product-tag/sealed-lead-acid-sla/

LFP (LITHIUM IRON PHOSPHATE) BATTERY

LiFePO4 is a naturally occurring mineral. The lithium iron phosphate battery (LFP) is part of the lithium ion family of batteries that came to light in the 1990's when John B. Goodenough's research group at the University of Texas used it as a cathode material while utilizing migration of Li-ion from one electrode to another.

Because of its low cost, non-toxicity, the natural abundance of iron, its excellent thermal stability, safety characteristics and its electrochemical performance, this type of battery since its inception has gained considerable market acceptance. This type of battery had been available commercially since the late 1990's.

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BATTERY FEATURES AND PERFORMANCE FACTORS

Energy Efficiency

A battery's efficiency is an important metric when selecting batteries. A rechargeable battery absorbs energy during charge and provides energy during discharge while incurring some losses. Some of the energy gets lost due to the electro-chemical conversion and some due to the batteries internal impedance.

The overall energy efficiency of a battery is the ratio of the energy that enters the battery during charging compared to the energy that can be extracted from the battery during discharging.

SLA battery charge efficiency is 85% to 90% and comparable LFP battery provides 92% to 100% charge efficiency depending on the rate of charge. The faster the rate of charge is, the less efficient the battery becomes regardless of its chemistry.

SLA battery discharge efficiency is 50% to 99% whereas a comparable LFP battery provides 92% to

100% discharge efficiency depending on the rate of discharge. The faster the rate of discharge, the less efficient the battery becomes regardless of its chemistry.

Typical overall energy efficiency (charge and discharge efficiency combined) of an SLA battery is around 70% whereas LFP battery is in the 95% range.

More efficient batteries also charge faster. With respect to the solar panel system you have set up, it may also mean you can use fewer solar panels, a relatively smaller backup generator, and lower battery capacity.

Depth of Discharge (DoD)

A battery's Depth of Discharge is a measure of the percentage of energy that can be safely consumed, in other words it refers to the percentage of total battery capacity that can be safely drained before the battery needs to be charged. Both SLA and LFP batteries can be discharged up to 100%. The higher the DoD is, the shorter the lifespan of the battery will be regardless of its chemistry. As an example, in typical 50% DoD application, an SLA battery can reach about 500 charge/discharge cycles and LFP battery will achieve close to 3500 cycles.

Rate of Charge and Discharge

Charge and Discharge Rates of a battery are governed by C-rates. The capacity of a battery is commonly rated at 1C, meaning that a fully charged battery rated at 1Ah should provide 1A for one hour. The same battery discharging at C/2 (0.5C) should provide 0.5A for two hours, and at 2C it delivers 2A for half an hour. The same battery using a 0.5C or (C/2) charge rate would theoretically take two hours to fully charge using 0.5A charging current. SLA batteries can safely accommodate up to 0.3C charge rate yet their regular charge rate is 0.1C. A regular LFP battery charge rate is 1C with peak charging rates of 10C. Due to its ability to charge at high C-rates and its charging efficiency, LFP batteries can be fully charged in less than one hour whereas a typical SLA battery will take more than 10 hours to get fully charged.

Capacity, Energy Density, and Specific Energy

Capacity or Nominal Capacity (Ah for a specific C-rate) is the total Amp-hours available when the battery is discharged at a certain discharge current (specified as a C-rate) from 100 percent state-of-charge to the cut-off voltage. Capacity is calculated by multiplying the discharge current (in Amps) by the discharge time (in hours) and decreases with increasing C-rate.

Energy Density (Wh/L) is the nominal battery energy per unit volume, sometimes referred to as the volumetric energy density. Specific energy is a characteristic of the battery chemistry and packaging. A high energy density battery will occupy less volume than a battery with lower energy density. A battery with high energy density will weigh less than a battery with low energy density thus comparable LFP battery can occupy up to 70% less volume than comparable SLA battery. Average SLA energy density is 80Wh/L whereas LFP is 250Wh/L.

Specific Energy (Wh/kg) is the e nominal battery energy per unit mass, sometimes referred to as the gravimetric energy density. Specific energy is a characteristic of the battery chemistry and packaging. A battery with high specific energy will weigh less than a battery with lower specific energy thus comparable LFP battery weighs 55% less than similar SLA battery. Average SLA specific energy is 45Wh/kg and LFP is 140Wh/kg.

Cost of Ownership

SLA batteries have lower upfront cost than comparable SLA batteries yet provide much shorter useable life and thus have to be replaced more often than LFP batteries. Every type of rechargeable battery will age and lose its original capacity over time. A rechargeable battery life is measured by the number of charge/discharge cycles. Generally, the cycle life is the number of complete charge/discharge cycles that the battery can support before its original capacity falls under 80% charge/recharge. By this time, the battery has visibly reduced performance.

SLA and LFP batteries have widely ranging cycle lives. For comparison, typical SLA batteries will achieve less than 300 cycles in 80% DoD (Depth of Discharge) before its original capacity falls below 80%, LFP batteries will achieve over 2000 cycles in the same 80% DoD usage.

Lithium Iron Phosphate (LFP) batteries provide lower long-term cost of ownership over SLA batteries. The average upfront cost of LFP batteries today is about 3.5X of comparable SLA it has 7X longer cycle life.

Safety

Both SLA and LFP batteries are designed to be safe to use and are safe for the environment. However, both types of batteries are capable of internal overheating that can lead to electrolyte leakage.

LFP batteries can undergo internal cell overheating. Significant steps are taken using built-in protection that cuts the battery from the charging system or from the load when any overheating occurs. LFP batteries have built-in safety feature, such as overcharge, overcurrent and short circuit protection that makes them inherently safer than the SLA batteries.

Protecting the Environment

SLA batteries are less environmentally friendly than LFP batteries since they contain large amounts of lead that is extremely hazardous to both environment and humans. SLA batteries also contain more raw material than comparable LFP batteries resulting in greater impact on the environment during the raw material processing. The lead material processing uses larger amounts of energy than comparable materials used in LFP batteries.

The LFP batteries thus have smaller carbon footprint and the materials contained within them can be recycled and/or recovered without hurting the environment.

Today, SLA battery recycling programs makes this type of battery more eco-friendly than in the past.

WHEN TO USE SLA AND WHEN TO USE LFP BATTERIES?

Commercial and home battery backup systems are a cost-efficient alternative to a traditional electric gas or gasoline backup generators.

SLA batteries are well suited for a scenario where they provide infrequent backup such as in fire and safety alarm systems, off-grid solar, UPS, etc. SLAs work great as backup power for RVs, boats, sump pumps, etc. where they spent most of their life in a standby mode.

LFP (Lithium Iron Phosphate) batteries on the other hand provide many advantages over the SLA (Sealed Lead Acid) batteries. LFP batteries provide 7x longer lifespan than comparable SLA batteries and are more efficient and environmentally friendly. LFP batteries can be also charged very quickly and discharged at more depth of discharge than SLA. LFP batteries weigh in at about 45% of comparable SLA batteries.

LFP batteries quick charge capability, light weight and long life span makes them excellent choice for moveable applications such as warehouse robots, AVGs/UVGs, material movers, floor cleaners, scrubbers, wheelchairs, scooters, etc.

FINAL COMMENTS

Sealed Lead Acid (SLA) batteries are a mature technology and have been in play for long time. They are an affordable option with a low up-front cost offering benefits in a standby, light-duty application. Lithium Iron Phosphate (LFP) batteries provide long term lower cost of ownership over SLA batteries. The upfront cost is about 3.5X of comparable SLA yet they have 7x longer cycle life. LFP technology provides close to 100% charge/discharge energy efficiency whereas SLA is less than 70% efficient.

> ZEUS Battery Products manufactures both the SLA and LFP batteries in an off the shelf or in a application specific configuration. The ZEUS team provide expert recommendations based on the user application during the design review process.

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