White Paper

TYPES OF BATTERY TECHNOLOGIES IN MARKET

Introduction

Most of the perceived confusion among battery users of all types is largely due to the wide variety of construction methods used in making batteries. Although electrochemical workings of these differently constructed batteries are very similar for the most part, manufacturers recommend that these batteries can be used for different applications and charged by slightly different methods.

What is the battery?

(Electromechanical & Electrochemical Energy)

The battery is a device to store energy. It stores energy by holding electrochemically active materials together in such a fashion so that they can generate and store free electrons (electrical potential energy) for a longer period and only deliver that energy when the battery user demands it.

The inherent properties of the electro-chemically active materials allow them to store energy chemically and then release that energy electrically as a byproduct of a chemical reaction. If we skip the explanation of how a battery is "brought to life" and jump to the point where the battery has already experienced several discharges and recharges, then we can say that the battery stores electrical charge. The production of the electrical charge came as a byproduct of a chemical reaction.

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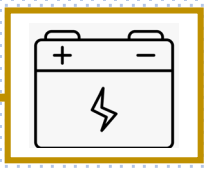
Types Of Battery Available In The Market



1) Lead-acid Batteries
2) Lithium-Ion Batteries
3) Sodium Sulphur Batteries

Lead-acid Batteries

A lead-acid battery is one of the most widely used battery type in the market. They remain the technology of choice for automotive SLI (Starting, Lighting, and Ignition) & Power Backup applications because they are robust, tolerant to abuse, tried, and tested, and because of their low cost. The lead-acid battery comprises of two chemically dissimilar lead-based plates in the electrolyte (H_2SO_4). The positive plate contains lead dioxide PbO_2, and the negative plate contains pure lead in a spongy form. When immersed in dilute sulphuric acid, the nominal electric potential is 2 volts.

This voltage is universal for all lead-acid batteries. During discharge, the sulphate ions in the electrolyte interact with the negative and positive plates, forming lead sulphate on both the plates. The loss of sulphate ions in the electrolyte reduces its specific gravity in proportion to the energy delivered. During recharge, the electric current converts the plates back to their charged state, and the sulphate back to sulphuric acid. The specific gravity of the electrolyte likewise rises again as a result.

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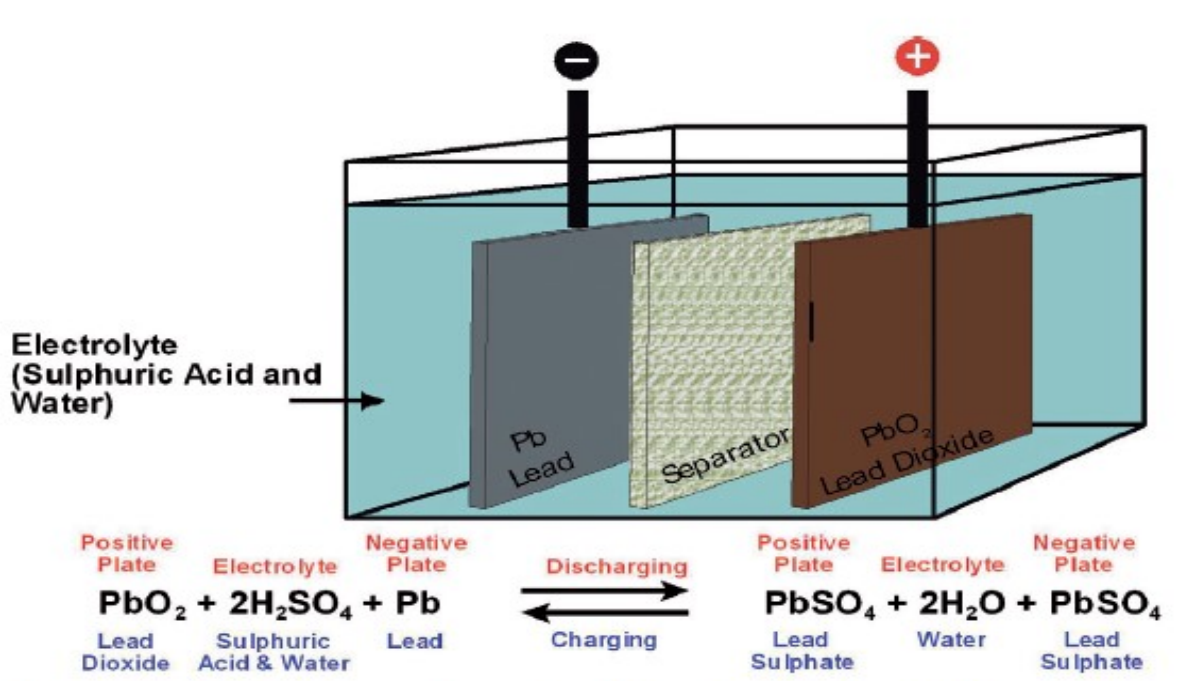

Figure 1. Basic operating principle of a lead acid battery

Lithium-Ion (Li-ion) Battery

A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium ions as a key component for its electrochemistry. During a discharge cycle, lithium atoms in the anode are ionized and separated from their electrons. The lithium ions move from the anode and pass through the electrolyte until they reach the cathode, where they recombine with their electrons and electrically neutralize. The lithium ions are small enough to be able to move through a micro-permeable separator between the anode and cathode in part because of lithium's small size (third only to hydrogen and helium). Li-ion batteries are capable of having a very high voltage and charge storage per unit mass and unit volume. Li-ion batteries can use several different materials as electrodes. The most common combination is lithium cobalt oxide (cathode) and graphite (anode), which is most commonly found in portable electronic devices such as cellphones and laptops. Other cathode materials include lithium manganese oxide (used in hybrid electric and electric automobiles) and lithium iron phosphate. Li-ion batteries typically use ether (a class of organic compounds) as an electrolyte.

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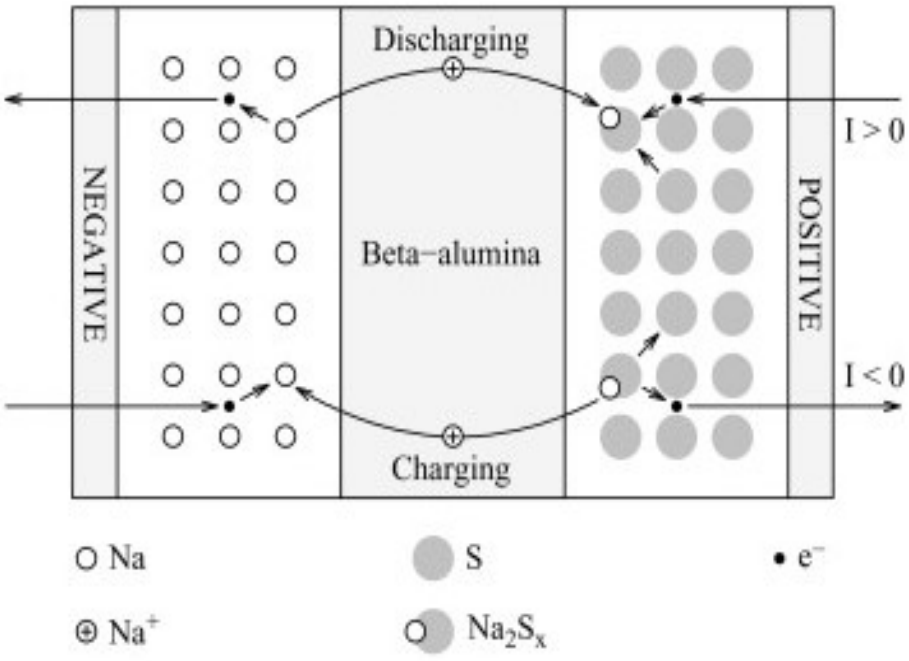
Sodium Sulphur Batteries

Sodium Sulphur battery is a high-temperature battery. It operates at 300°C and utilizes a solid electrolyte, making it unique among the common secondary cells. One electrode is molten sodium and the other is molten sulphur, the reaction between these two is the basis for the cell reaction. The cross-section of a sodium sulphur battery is shown in the figure below. Although the reactants particularly sodium can behave explosively but modern cells are generally reliable.

Sodium sulphur battery operates on the principle of a reversible redox reaction between sodium and sulphur. The operating temperature of this battery is ~ 300 °C and the sodium and sulfur electrodes are molten during operation. The electrolyte is a solid beta-alumina of sodium-ion conductive ceramic. The chemical reaction governing the operation of the battery is:$2Na+xS \rightleftharpoons Na2Sx$

The figure illustrates the flow of the ions and electrons during the charging and discharging processes.



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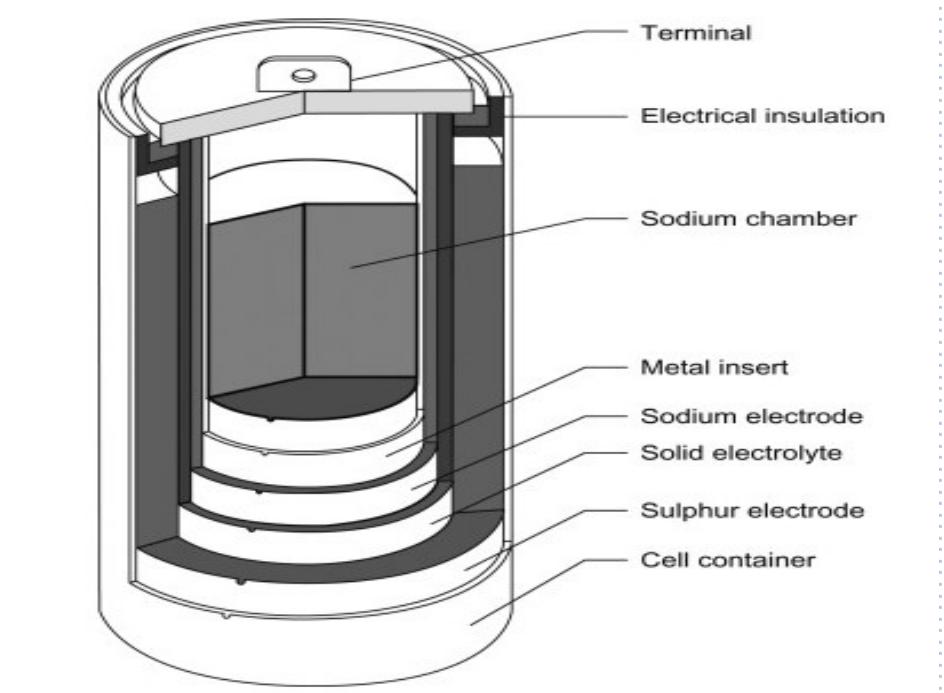

While the cost is enticing, the energy density is low and the cells need to operate at more than 350 °C which is a distinct disadvantage when attempting to use in automotive and consumer applications.

Battery Failure

The Storage Battery is a most faithful help even if given a fighting chance, it will respond instantly to the demands made upon it. Given reasonable care and consideration, it performs its duties faithfully for many months. When such care is lacking, however, it is soon discovered that the battery is subject to many problems, most of which are "preventable," and all of which, if they do not kill the battery, at least, greatly impair its efficiency. We may consider the various parts through which a battery is composed and describe the troubles which they are subject to. Most battery problems are contagious, and if one part fails, some of the other parts get affected. These problems may best be considered in the order in which the parts are given in the list.

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Battery Storage Challenges

It is critical to consequences and, therefore, among the most critical challenges is how to recycle the batteries and enable them to have a second-hand use and the other is the self-discharge of the battery. All batteries are affected by self-discharge. Self-discharge is not a manufacturing defect but a battery characteristic; although poor fabrication practices and improper handling can increase the problem. Self-discharge is permanent and cannot be reversed. Self-discharge increases with age, cycling, and elevated temperature. Discard a battery if the self-discharge reaches 30 percent in 24 hours. The amount of electrical self-discharge varies with battery type and chemistry. Primary cells such as lithium-metal and alkaline retain the stored energy best and can be kept in storage for several years. Among rechargeable batteries, lead-acid has one of the lowest self-discharge rates and loses only about 3 percent per month.

Regular Maintenance Testing

It is extremely important to have regular maintenance testing. Regular testing will allow you to track your battery's performance and assess remaining life. With this information, you can compare the actual performance as per the manufacturer's specifications. Most importantly having this information lays the foundation for future energy storage installations.

Maintenance Testing provides the following data:

- A better understanding of how the battery degrades with different provided ancillary services
- Ability to value future storage systems as a function of life
- Allows you to compare the life and performance of different battery chemistries

Minimal maintenance testing:

- Standard battery charge-discharge cycling
- Electrical impedance spectroscopy Capacity and efficiency can both be measured via cycling, and impedance testing infers any material changes within the cells. These tests will allow you to track the rate at which capacity is degrading.

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Battery Installations

The installation of all battery systems shall be in accordance with proper instructions. The installation of all battery systems shall be in accordance with the safety data sheet applicable to the battery chemistry and battery system. Restricted access shall be provided to battery systems to prevent access by unauthorized persons. Restricted access may be achieved by the following:

- A dedicated battery room
- A dedicated enclosure
- A fenced off, and secure, a section of a larger room.

The battery system shall have an IP rating appropriate for the environment in which they are installed. Battery systems shall be able to operate safely and function properly in the conditions in which they are likely to be exposed and batteries and battery modules should meet relevant product standards. Particular situations include:

- Solar radiation (direct sunlight)
- Ambient temperature
- External heat sources
- Presence of water or high humidity
- Presence of solid foreign bodies
- Presence of corrosive or polluting substances
- Impact
- Vibration
- Other mechanical stresses
- Presence of flora and fauna

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Summary & Conclusion

Installing a battery energy storage system is a big project and a big investment. There is no historical data to gauge the success or failure of these projects and that makes it more important to understand how these technologies work and how they differ to maximize the value of your system.

Eastman Battery is one of the best battery brands currently catering to growing consumer demands in different parts of the world.

With over 37 years of experience, Eastman has emerged as a strong player in energy solutions space providing unlimited energy to people who want more out of life. We have a battery for every need ranging from traditional to rechargeable and solutions that are sustainable and energy-efficient. Not only are our batteries recyclable, but we also ensure that we keep our carbon footprint to a minimum. We are revolutionizing the battery industry by incorporating the latest technological advances and testing our energy solutions on various industry parameters.

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