

Advancements In The Battery Management Systems In The Context Of Electric Vehicle Charging

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Abstract- Electric vehicles (EVs) have gained significant traction in recent years, driven by concerns over environmental sustainability and advancements in battery technology. Central to the efficient operation and longevity of EV batteries is the Battery Management System (BMS). This paper describes the batteries used in electric vehicles and the key issues of battery management systems. This paper also addresses the construction of batteries used in electric vehicles and how they are beneficial.

Keywords— Electric Vehicle, battery management system.

1. Introduction

Over the past decade, there has been significant progress in battery technology, leading to the development of numerous high-performance batteries. Electric vehicles now demand powerful batteries equipped with sustainable battery management systems to ensure their safe and dependable operation. These advancements have significantly contributed to making EVs more viable as an environmentally friendly transportation option, offering longer ranges, faster charging times, and increased reliability. There are three primary batteries used in electric vehicle operation. They include lithium-ion batteries, nickel-metal hybrid batteries, and lead-acid batteries. The focus of this paper will be primarily on lithium-ion batteries and lead-acid batteries.

1.1 What Batteries are Being Used in EV Technology?

Most all-electric vehicles and plug-in hybrid electric cars use lithium-ion batteries. Lithium-ion batteries are currently used in most portable consumer electronics, such as cell phones and laptops, because of their high energy per unit mass and volume relative to other electrical energy storage systems. Nickel-metal hydride batteries, used routinely in computer and medical equipment, offer reasonable specific energy and specific power capabilities. These batteries have been widely used in hybrid electric vehicles. Advanced high-power lead-acid batteries are being developed, but these batteries are only used in commercially

available electric-drive vehicles for ancillary loads. They are also used for stop-start functionality in internal combustion engine vehicles to eliminate idling during stops and reduce fuel consumption [1].

2. How do These Batteries Work?

Lithium-Ion Batteries: In a lithium-ion battery, lithium ions (Li+) move between the cathode and anode internally. Electrons move in the opposite direction in the external circuit. This migration is the reason the battery powers the device—because it creates the electrical current. While the battery is discharged, the anode releases lithium ions to the cathode, generating a flow of electrons that helps to power the relevant device. When the battery is charging, the opposite occurs: lithium ions are released by the cathode and received by the anode [2].

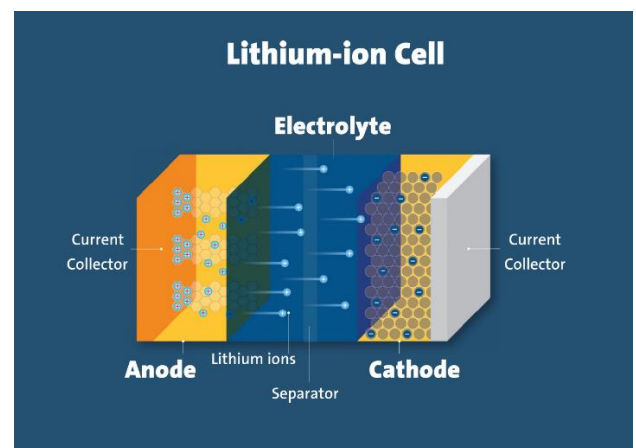


Figure 1. Detailed visual of what a lithium-ion battery looks like.

Reprinted from UL Research Institutes [2].

Lead-Acid Batteries: The battery is made up of cells consisting of spongy lead anodes and lead acid cathodes, submerged in a sulfuric acid electrolyte, and lead as the current collector [3]. A controlled chemical reaction to sulfuric acid causes the battery to produce electricity, then the reaction is reversed to recharge the battery [4].

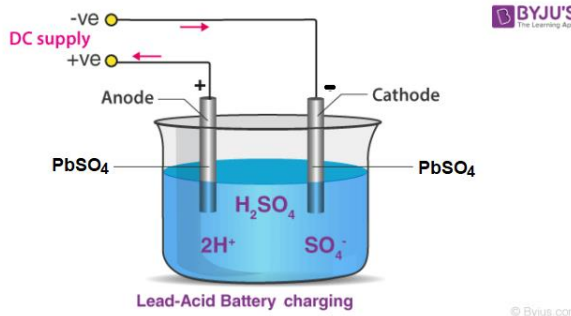


Figure 2. Visual of a lead-acid battery design.

Reprinted from BYJU's Learning [9].

3. What are the Benefits of These Batteries?

Lithium-Ion Batteries: These batteries have high energy density, so they can hold a high amount of energy relative to their size. They are lightweight, have long lifespans, have good long-term performance, are relatively temperature tolerant, and have low self-discharge with only dropping 1-2% of charge per month. In addition, they have a fast-charging time, and they can be customized to who the manufacturers need them [5].

Lead-Acid Batteries: The biggest advantage of lead-acid batteries is their low-cost, long-life cycle, and recyclability. The performance remains consistent and reliable, which makes them a viable choice for those who need reliability in their performance [6].

4. What are the Issues of These Battery Management Systems?

The major concerns about using lithium-ion batteries in electrical vehicles include labor for mining cobalt, the environmental impacts of obtaining lithium, sufficient supply of materials for the batteries, carbon emissions from the manufacture of batteries, and the toxic waste of disposing of the used batteries [7].

Lead-acid batteries are cheap and reliable, but they also have low specific energy, poor cold-temperature performance, and a short life cycle [1]. One can use 30-50% of the energy only before worrying about draining the battery quickly and cutting its lifespan short. If the battery is drained, it takes a long time to recharge it. So, unless the car is recharged overnight, one may not be able to drive it any time soon. Finally, the lead-acid batteries are big and bulky and take up more room than other batteries in an electric vehicle [8].

5. Conclusion

Advancements in EV battery management systems have improved rechargeable batteries' reliability, longevity, and charging times. While the batteries are being improved, there are still disadvantages and issues to working with them in electric vehicles. We can expect to continue to see lithium-ion and lead-acid batteries in EVs, however, with limited resources to create such batteries, there are opportunities for

further research in this field to discover more, and better, alternatives.

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7. Conflicts of Interest:

There are no conflicts of interest in the research.

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