

Types of Batteries for New Energy Electric Vehicles

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Abstract:

This article aims to study and explore the different types of batteries used in new energy electric vehicles, and classify them. As environmental preservation and sustainable development gain greater prominence, the adoption of new energy electric vehicles as a viable alternative to conventional fuel-based vehicles has surged. Concurrently, there have been remarkable advancements in battery technologies supporting these electric vehicles. Understanding the classification and characteristics of electric vehicle batteries is of great significance for promoting the development of the electric vehicle industry. This article will provide a detailed introduction to several major battery technologies, including lithium-ion batteries, sodium ion batteries, and solid-state-state batteries, and analyze their advantages and disadvantages; Application fields and future development trends.

Keywords: New energy electric vehicles; Battery classification; Lithium-ion batteries; Sodium-ion batteries; solid-state-state battery

1. Introduction

In recent years, the global focus on environmental issues has significantly increased, driving the rapid development of new energy electric vehicles. As a crucial component of electric vehicles, batteries of different types possess distinct characteristics and applicability. Therefore, it is essential to classify the batteries used in new energy electric vehicles and understand their specific features to select appropriate battery technologies and promote the sustainable development of the electric vehicle industry.

By examining the classification and characteristics of different battery types, such as lithium-ion batteries, sodium-ion batteries, and solid-state batteries, we can gain insights into their diverse applications in electric vehicles. This understanding enables informed decision-making regarding battery technology selection for various types of electric vehicles, including passenger cars, buses, and electric bikes.

Considering the advantages, disadvantages, and specific use cases of these battery technologies, we can make informed decisions about their application in electric vehicles. Furthermore, staying informed about future development trends and potential breakthroughs in battery technology allows us to anticipate advancements that could further enhance the sustainability and viability of new energy electric vehicles.

In conclusion, the classification and understanding of battery types used in new energy electric vehicles are crucial for promoting the adoption of electric vehicles and supporting the sustainable development of the automotive

industry. By selecting the most suitable battery technology for specific applications, we contribute to a cleaner and greener future.

2. Lithium-ion batteries

A lithium-ion battery is a type of battery that achieves charge transfer by transferring lithium-ions between the positive and negative electrodes. It consists of a positive electrode material (usually lithium cobalt oxide or lithium iron phosphate), a negative electrode material (usually graphite), an electrolyte, and a diaphragm [1]. It is one of the most commonly used battery types in electric vehicles today.

2.1 Advantages of lithium-ion batteries

Lithium ion batteries are a widely adopted preferred battery technology in the field of electric vehicles, and their unique characteristics make them highly favored. Firstly, Lithium-ion battery has high energy density, it can provide longer service life and larger battery capacity. This means that electric vehicles can travel longer distances to meet the needs of users. Secondly, compared to other battery types, lithium-ion batteries have a lower self discharge rate, which means less charge loss when not in use, increasing the storage time and reliability of the battery. In addition, lithium-ion batteries also have a longer cycle life and can withstand more charging and discharging cycles, thus having a longer service life [1]. Finally, lithium-ion batteries are relatively lightweight and suitable for mobile devices and weight sensitive applications, providing better energy solutions for electric

vehicles. In conclusion, the advantageous characteristics of lithium-ion batteries, including their high energy density, minimal self-discharge rate, extended cycle life, and portability, have solid-stateified their position as the favored battery technology for electric vehicles.[2].

2.2 Disadvantages and existing problems of lithium-ion batteries

Although lithium-ion batteries have significant advantages in fields such as electric vehicles, there are also some noteworthy drawbacks. Firstly, safety is one of the main challenges for lithium-ion batteries. Due to the presence of flammable organic solvents and high energy density materials inside, lithium-ion batteries may face the risk of overheating, short circuit, and even explosion under incorrect use or extreme conditions. These safety hazards require strict management and control to ensure the reliability and safety of the battery system[2]. Secondly, the limited availability of lithium resources is also a key issue. Lithium is a scarce resource with limited reserves and is not renewable. With the increasing demand for electric vehicles and other products, lithium supply may face supply and demand pressure, which may lead to price increases and instability in resource supply. Therefore, developing alternative materials or adopting more effective recycling and recycling technologies is an important way to solve this problem. In addition, the long charging time of lithium-ion batteries is also a limiting factor. Compared to traditional fuel vehicles, charging the battery requires more time. The construction of charging infrastructure and the improvement of charging speed are the key to solving this problem, in order to increase users' acceptance and convenience of electric vehicles. Finally, although lithium-ion batteries perform well in terms of cycle life, their capacity and performance will gradually decrease with increasing usage time. This may require regular replacement of battery components, which increases overall cost and environmental impact.

In summary, the safety issues, limited lithium resources, long charging time, and attenuation of cycle life of lithium-ion batteries are the drawbacks that need to be carefully considered in applications such as electric vehicles. However, with the continuous progress and innovation of technology, I hope these problems can be solved or alleviated, promoting the further development and application of lithium-ion batteries.

3. Sodium-ion batteries

The sodium-ion battery employs sodium-ions as a charge carrier, making it a promising charging battery technology. The positive electrode material of sodium-ion batteries is usually metal sodium oxide, such as nickel oxides and

cobalt oxide, which can embed and release the sodium-ion structure. Negative electrode usually uses carbon -based materials (such as graphite) to embed and release sodium-ions. Sodium-ion battery is an emerging rechargeable battery technology that can be used as an energy solution for alternative lithium -ion batteries [3].

3.1 Advantages of sodium-ion batteries

Firstly, the resource advantage of sodium-ion batteries is one of their key characteristics. Compared to rare minerals such as lithium, cobalt, and nickel required for lithium-ion batteries, sodium is more abundant in the Earth's crust, with ample reserves and widespread distribution. This provides sodium-ion batteries with better resource protection, unaffected by insufficient supply of rare minerals. Secondly, sodium-ion batteries offer cost advantages. With an energy density that can exceed 100Wh/kg, sodium-ion batteries are comparable to lithium iron phosphate batteries but at a lower cost. This positions sodium-ion batteries as potential replacements for traditional lead-acid batteries in large-scale energy storage applications, helping to reduce the overall cost of energy storage systems.

The research on sodium-ion batteries began in the 1980s and has made significant progress after years of development. Recent advancements have improved both the positive and negative electrode materials of sodium-ion batteries, resulting in increased capacity and extended cycle life. Sodium-ion batteries can achieve cycle lives exceeding 3000 cycles, surpassing those of lead-acid and lithium-ion batteries. This indicates the potential for sodium-ion batteries to replace traditional battery technologies and find commercial applications in areas such as start-stop systems, low-speed electric vehicles, and energy storage.

Additionally, sodium-ion batteries exhibit advantages such as excellent performance after fast charging and stable operation across different temperature environments. They can maintain good performance even under extreme test conditions, including puncture, short circuit, overcharge, and overdischarge. The safety, durability, power density, and temperature operating range of sodium-ion batteries are comparable to those of lithium-ion batteries.

In summary, sodium-ion batteries possess resource advantages, cost advantages, and performance advantages, and their development is driven by the growing demand for energy storage solutions.

3.2 Disadvantages of sodium-ion batteries

The main drawbacks of sodium-ion batteries include low energy density and slow ion mobility. Compared to lithium-ion batteries, sodium-ion batteries have a lower

energy density, which means that they store less energy at the same capacity. In addition, the ion mobility of sodium-ion batteries is also slow, resulting in slower charging and discharging speeds, which affects the efficiency and charging time of the battery.

In addition, sodium-ion batteries can refer to the design and production process technology of lithium-ion batteries, which has certain feasibility. Although the negative electrode of sodium-ion batteries uses hard carbon, with a relatively high discharge voltage and slightly lower capacity, the energy density and performance of sodium-ion batteries can still be improved by searching for positive and negative electrode materials with higher specific capacity and voltage.

In summary, although sodium-ion batteries have some obvious drawbacks, their advantages in resource abundance and cost, as well as the process technology of lithium-ion batteries, make them a highly regarded and recommended battery technology. Future research and technological improvements are expected to further enhance the performance and application fields of sodium-ion batteries.

4. Solid-state batteries

Solid-state batteries are a new type of battery technology that operates similarly to liquid lithium-ion batteries, achieving charging and discharging processes through the movement of lithium-ions between the positive and negative electrodes.

4.1 Safety of Solid-state batteries

Solid-state state batteries have significant advantages in terms of safety compared to traditional lithium-ion batteries. Solid-state batteries use solid-state-state electrolytes instead of liquid electrolytes, so there is no risk of liquid electrolyte leakage, avoiding the possibility of fire and explosion caused by electrolyte combustion or volatilize. The solid-state-state electrolyte of solid-state-state batteries also has a high melting point and thermal stability, which can maintain stability in high-temperature environments and reduce the risk of thermal runaway [4]. In addition, the solid-state-state electrolyte of solid-state-state batteries can also prevent the migration of harmful substances such as oxygen or polysulfide, improving the stability and durability of the battery.

The safety of solid-state-state batteries is also reflected in their matching with positive and negative electrode materials. Solid-state batteries can be paired with high energy density positive and negative electrode materials, improving the energy density of the battery while reducing its weight. This matching makes solid-state-state batteries more stable during operation, reducing the possibility

of short circuits and internal reactions. solid-state-state batteries also have a long cycle life and a wide operating temperature range, allowing them to operate safely and reliably in various environments.

Overall, solid-state batteries have significant advantages in terms of safety and can effectively solve the safety hazards caused by liquid electrolytes. However, solid-state batteries are still in the research and development stage, and there may still be certain safety risks for some special situations and abnormal operations. Therefore, further research and improvement are needed to promote and commercialize solid-state battery technology to ensure its safety performance in practical applications.

4.2 Voltage and energy density of solid-state batteries

The voltage and energy density of solid-state batteries are important indicators of solid-state battery technology. The voltage of solid-state batteries mainly depends on the material selection and structural design of electrodes and electrolytes. The conductivity of solid-state electrolytes is generally low, so the voltage of solid-state batteries is relatively low, generally between 2-4V [4]. However, with the development and optimization of solid-state electrolyte materials, the voltage of solid-state batteries is expected to further increase in the future.

Solid-state batteries can achieve higher energy density due to the use of solid-state electrolytes. At present, the energy density of solid-state batteries can reach 300-400Wh/kg. In comparison to conventional liquid batteries, solid-state batteries offer an extended range and enhanced energy storage capacity within the same size and weight constraints. In addition, solid-state batteries also have a high cycle life, which can ideally reach around 45000 cycles [4].

However, solid-state batteries still face some challenges and limitations. One of the main issues is the excessive interface impedance, which means that the effective contact between the electrode and electrolyte is weak, limiting the transport kinetics of ions in solid-state materials, thereby affecting the performance of the battery. In addition, the research and production costs of solid-state batteries are still relatively high, and further cost reduction is needed to achieve commercial applications.

In summary, the high safety, small size, light weight, and long cycle life of solid-state batteries make them ideal power batteries for electric vehicles and other fields. With the continuous improvement and breakthrough of solid-state battery technology, it is believed that the voltage and energy density of solid-state batteries will further increase in the future.

5. Other emerging battery technologies

In addition to traditional lithium-ion batteries, there are also some emerging battery technologies that are constantly developing. Although these new technologies face some problems in their development process, they have enormous potential.

5.1 Aluminum air battery

Aluminum air battery is a new battery technology that utilizes the reaction between aluminum and air to generate electricity. Compared to traditional lithium-ion batteries, aluminum air batteries have higher energy density and lower cost. Aluminum air batteries release electrical energy by reacting the aluminum anode with oxygen in the air. However, aluminum air batteries still face challenges such as slow anodic reaction rate and corrosion of anode materials, and further research and improvement are needed to improve their performance and stability.

5.2 Zinc air battery

Zinc air battery is a battery technology that utilizes the chemical reaction between zinc and air to generate electrical energy. Zinc air batteries have advantages such as high energy density, low cost, and good rechargeability. It releases electrical energy by reacting the zinc anode with oxygen in the air. However, zinc air batteries are affected by issues such as zinc dendrite growth and electrode dendrite blockage during use, which limits their cycling life and stability. Therefore, further improvements are needed in the design and materials of zinc air batteries to improve their performance and reliability.

5.3 Sulfur lithium batteries

Sulfur lithium battery is a new battery technology that uses sulfur as the positive electrode material. Compared to traditional lithium-ion batteries, sulfur lithium batteries have higher energy density and lower cost. Sulfur materials as positive electrodes have abundant resources and high reactivity, which can achieve higher energy storage. However, the low conductivity and volume expansion of sulfur materials limit the cycle life and charge discharge efficiency of sulfur lithium batteries. Therefore, it is necessary to enhance the performance of sulfur-lithium batteries through means such as controlling the structure of sulfur materials and implementing interface engineering, in order to facilitate their commercialization[5].

6. Future Development Trends

With the continuous rapid development and technological progress of the electric vehicle industry, battery technology is also undergoing major changes. Here are

some of the potential developments and trends in battery technology for new energy electric vehicles.

6.1 Improving Energy Density

Improving Energy Density One of the main focuses of battery research and development is to improve the energy density of batteries. By optimizing materials, exploring advanced interface engineering techniques, and enhancing battery structures, researchers aim to increase the amount of energy that can be stored in a given volume or weight of the battery. This improvement in energy density will not only help enhance the range of electric vehicles but also improve user experience by reducing the need for frequent charging.

6.2 Extending Cycle Life

Extending Cycle Life The cycle life of batteries, which refers to the number of charge and discharge cycles a battery can undergo before its performance starts to degrade, is a crucial factor in ensuring the reliability and longevity of electric vehicles. To meet the demands of users, future battery technologies need to improve the stability, durability, and cycle life of batteries. This can be achieved through advancements in materials, electrode design, and innovative manufacturing processes that minimize degradation and extend the overall lifespan of the battery.

6.3 Cost Reduction

Cost Reduction Lowering the cost of batteries is a key factor in driving the widespread adoption of electric vehicles. Currently, the high cost of battery production contributes significantly to the overall price of electric vehicles. However, as technology continues to advance, and economies of scale are realized through increased production, the cost of batteries is expected to gradually decrease. Innovations in manufacturing processes, materials sourcing, and recycling methods will contribute to cost reduction and play a vital role in making electric vehicles more affordable for consumers.

6.4 Achieving Sustainable Development

Achieving Sustainable Development In addition to technological advancements, the future of battery technology in new energy electric vehicles will need to prioritize sustainability and environmental friendliness. As the industry progresses, there should be a stronger emphasis on selecting battery materials and production processes that reduce dependence on limited resources and minimize environmental impacts. This includes exploring alternative materials with abundant availability, optimizing recycling methods to recover valuable materials from used batteries, and implementing

environmentally conscious manufacturing practices. By addressing these sustainability challenges, the new energy electric vehicle industry can move towards a more sustainable and environmentally friendly future[2].

7. Conclusion

This paper reviews the battery classification of new energy electric vehicles, and details major battery technologies such as lithium-ion batteries, sodium-ion batteries, and solid-state batteries, as well as other emerging battery technologies such as aluminum-air batteries, zinc-air batteries, and sulfur-lithium batteries. Each battery technology has unique advantages and limitations and is suitable for different application scenarios. In the future, with the continuous progress and innovation of technology, battery technology is expected to further improve its energy density, cycle life and safety, and promote the sustainable development of the new energy

electric vehicle industry.

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