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ВЛИЯНИЕ БЫСТРОЙ ЗАРЯДКИ НА АККУМУЛЯТОРЫ ЭЛЕКТРОМОБИЛЕЙ

EFFECTS OF FAST CHARGING ON ELECTRIC VEHICLE BATTERIES

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Fast charging systems for electric vehicle (EV) batteries are garnering significant attention in the automotive industry, especially as the demand for EVs continues to soar. The imperative for efficient and fast charging solutions is growing more pronounced. This research endeavors to investigate the ramifications of fast charging technology on EV batteries, drawing insights from scientific studies and statistical data. Specifically, our focus lies on examining the adverse effects of fast charging on EV batteries and identifying the circumstances under which such effects are most pronounced. By conducting research on this topic, we aim to provide conclusive findings and actionable recommendations for mitigating these issues and ensuring the optimal performance and longevity of EV batteries.

Системы быстрой зарядки аккумуляторов электромобилей (EV) привлекают значительное внимание в автомобильной промышленности, особенно в связи с тем, что спрос на электромобили продолжает расти. Необходимость в эффективных и быстрых решениях для зарядки становится все более очевидной. Это исследование направлено на изучение последствий технологии быстрой зарядки аккумуляторов электромобилей, опираясь на научные исследования и статистические данные. В частности, наше внимание сосредоточено на изучении негативных последствий быстрой зарядки аккумуляторов электромобилей и выявлении обстоятельств, при которых такие последствия наиболее выражены. Проводя исследования по этой теме, мы стремимся предоставить убедительные выводы

и практические рекомендации для смягчения этих проблем и обеспечения оптимальной производительности и долговечности аккумуляторов электромобилей.

***Keywords**: Electric vehicle, fast charging, battery, temperature Lithium-ion.*

***Ключевые слова**: Электромобиль, быстрая зарядка, аккумулятор, температура, литий-ион.*

INTRODUCTION

In the automotive industry, which has been developing for centuries, the transition to green energy is accelerating along with other industries. Electric vehicles (EVs) are emerging as a key vehicle in this transition and are seen as the most environmentally friendly option in the industry, and so far this view is proving to be correct. Every field faces a large number of problems in its development history, which requires constant improvement over time. One such challenge is fast charging of electric vehicle batteries. Currently, developed countries, famous scientists and electric car manufacturers are cooperating to optimize and improve this charging system. This move is done with two goals: to extend the life of the battery and to improve the charging efficiency, thus delivering more power in a shorter time. Fast charging of electric vehicle batteries provides an opportunity to solve many problems that directly affect the performance of these vehicles. The main focus for consumers is convenience, first of all, saving time. Thus, efforts are focused on addressing these two key factors.

Electric vehicle charging can be divided into several types, mainly consists of alternating current (AC-chargers are generally found in the home, workplace settings, or public locations and will charge an EV at levels from 7,2 kW to 22 kW) charging provided by residential and commercial power sources, and direct current (DC-are generally found in the charging stations, and levels from 50 kW to 350 kW) charging, also known as fast charging. Taking charging conditions as an example, according to the infrastructure of charging via AC (standard household outlets), the charging status is on average 7–12 hours, while via DC (public and home-installed charging stations) it is 20–30 minutes. Another notable difference between the two types is that AC chargers are relatively affordable and can be easily integrated into existing residential and commercial power systems.

They operate at lower power levels and are suitable for overnight charging, and DC fast chargers are more expensive to install and operate due to their higher power requirements and specialized equipment. These chargers also require higher voltages to optimize charging speed, often necessitating dedicated infrastructure upgrades [1].

Nowadays, almost everyone is interested in such a question, whether will fast charging hurt my EV battery or not? is certainly widely discussed by the researchers in front of the public. According to his research, after studying the battery condition of 12,500 Tesla electric cars in the United States for 3 years, and they say "The results show no statistically significant difference in range degradation between Tesla's that fast charge more than 90 % of the time and those that fast charge less than 10 % of the time" [2]. The main reason for this is that the software, management system and safety mechanisms of the battery prevent damage during battery charging. During fast charging, the battery may not maintain its performance in certain cases. Examples include extreme cold, extreme heat, and extreme high and low voltage. If we look at the research, there is no optimal temperature for Lithium-Ion batteries, so this interval lies in the range of 15–35 ^{o}C [3]. According to the properties of Li-ion batteries, which are widely used in EVs, using the battery in extremely hot conditions poses safety problems for human life, and using it in cold conditions will cause negative effects on the performance of the battery. According to the research of Engineering+Infrastructure publication, the range of danger of charging EV batteries at cold temperature is divided into 3 stages, and these are:

Under 10 °C, Li plating and permanent degradation can occur if the battery is fast-charged. Slower charging can help address this concern.

Under 0 °C, Li plating is even more of a concern, particularly if the battery is charged faster than a 1 °C rate.

Under –20 °C, battery performance and its ability to accept a charge are further reduced. Prolonged exposure to these temperatures can destroy the battery [4].

In addition, it should be noted that during fast charging, when the battery capacity exceeds 80 %, not slowing down the charging process will cause it to overheat. Although the safety devices do their job, repeated charging in this condition will drain the battery's capacity. Moreover, the main mechanism of fast charging technology is to fill the battery pack with

a high level of power for a short time, and as a result, the temperature of the battery increases during the receiving process [5].

Taking into account the above, it is noteworthy that charging the battery when the charge indicator exceeds 80 % is a current safety system, because it is almost useless, and it almost means a waste of time. When it comes fast charging modes offered by manufacturers are not always justified due to factors such as battery limitations, aging characteristics, and battery management system.

In our previous discussion, we delved into the potential impact of fast charging on the health of an EV battery. Now let's look at strategies to mitigate potential disappointments. Our research shows that temperature plays an important role in the longevity of an EV battery, so precautions must be taken before charging at high power. To ensure optimal battery performance, the following preparatory steps are necessary:

1. Avoid fast charging in extreme heat. In hot conditions, refrain from quickly charging your electric vehicle battery. Instead, activate the precool mode in the thermal management system before starting the charging process. This preventive measure helps the battery handle the high input voltage without the risk of overheating. Most modern electric vehicles automatically turn on this system when a charging station is selected through the navigation system.

2. Preparing for low temperatures. Likewise, in very cold temperatures, it is important to warm up the EV battery before fast charging. This can be achieved by driving the car for some time to allow the battery temperature to reach the optimal level.

3. Optimal Voltage Range: Regardless of temperature conditions, it is critical to avoid charging your EV battery at too low or too high a voltage. Staying within the recommended voltage range helps maintain battery performance and longevity.

4. Efficient charging strategies. To speed up charging without compromising battery health, consider using AC charging methods. Modern electric vehicle models often demonstrate improved efficiency during AC charging, especially when the battery enters a slow charging mode after reaching 80 % capacity [6].

By following these guidelines, electric vehicle owners can optimize battery performance and minimize the risk of harmful effects associated with fast charging.

Another important point is that during the charging process, some users may try to charge their EVs beyond the battery capacity, ignoring the manufacturer's specifications. For example, each electric vehicle has its own software and battery limits that determine the maximum charging speed. It is not uncommon for electric vehicles to deliver 60 kW of power when connected to a charging station capable of delivering 300 kW. Trying to charge the battery beyond the vehicle's capacity is impractical and may result in inefficiency.

Therefore, it is very important to practice charging etiquette and show respect for other drivers even at charging stations. This includes being mindful of your vehicle's charging capabilities and avoiding behavior that could disrupt the charging experience for others. By following these guidelines, we can create a harmonious charging environment and ensure everyone's needs are met effectively.

CONCLUSION

In conclusion, fast charging, when used judiciously and in accordance with manufacturer specifications and charging protocols, does not inherently have a harmful effect on EV batteries. Taking the right approach and adhering to manufacturer specifications and general charging guidelines ensures optimal condition and longevity of EV batteries.

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ОСНОВНЫЕ НАПРАВЛЕНИЯ ИССЛЕДОВАНИЙ ПО КОМПОНОВКЕ ГОРОДСКИХ ЗАРЯДНЫХ СТАНЦИЙ ЭЛЕКТРОМОБИЛЕЙ

MAIN RESEARCH DIRECTIONS FOR THE LAYOUT OF URBAN ELECTRIC VEHICLE CHARGING STATIONS

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Планирование расположения городских зарядных станций для электромобилей имеет уникальные влияющие факторы. Оно также должно учитывать неопределенности, вызванные характеристиками короткого пробега и длительного времени зарядки электромобилей, а также такие проблемы, как оптимизация непрерывности в долгосрочном строительстве. городских зарядных станций для электромобилей. В данной статье объединены текущие схемы строительства городских зарядных станций и предложены основные направления исследований и направления будущей компоновки городских зарядных станций для электромобилей.

Planning the location of urban electric vehicle charging stations has unique influencing factors. It must also take into account the uncertainties caused by the short range and long charging time characteristics of electric vehicles, as well as issues such as optimizing continuity in long-term