Electric Vehicle Safety Issues and the Solutions

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Abstract. Due to the need for environmental protection and technological progress, the number of electric vehicles has increased year by year, and at the same time, with the frequent occurrence of safety accidents, the safety of electric vehicles has become the focus of common attention inside and outside the industry. This article starts from the two aspects of electric vehicle operation safety and information security. First, based on the incomplete statistics of domestic electric vehicle operation safety accidents, it analyzes the characteristics of the accident and the causes of power battery thermal runaway. Based on the current information security issues, and combined with the current situation of my country's electric vehicle safety management, put forward some suggestions to ensure the safety of electric vehicles.

Keywords: Electric vehicle; safety problem; solution.

1. Introduction

The "New Energy Automobile Industry Development Plan (2021-2035)" from the Industry and Information Technology department recently pointed out that the development and direction of the automotive sector are increasingly being driven by electrification, networking, intelligence, and sharing. However, in the new round of industrial transformation, electric vehicles are the best carrier for intelligent networking, and their operation safety and information security accidents occur frequently, seriously affecting the popularization and promotion of electric vehicles and their intelligence. In the lives of individuals, automobiles play a significant role in transportation. More and more people are beginning to purchase cars as people's living levels rise. However, the widespread usage of cars has led to several issues, including resource scarcity, environmental degradation, and energy consumption. Due to these issues, major automakers are now competing to create a variety of new ecologically friendly vehicles that emit no pollution [1]. Starting from the two aspects of operation and information security, this paper analyzes the causes of domestic electric vehicle fire accidents in recent years, the characteristics of vehicle models, battery types, and the causes of battery thermal runaway, and expounds the new challenges brought about by the intelligent networking of electric vehicles [2]. Finally, suggestions are put forward on how to ensure the operation and information security of electric vehicles.

2. Classification of Electric Vehicle Safety Issues

Most of the existing fault diagnosis research is aimed at the "0/1" diagnosis of a single fault, but in actual situations, the type of battery fault is unknown and uncertain, and even multiple faults may occur concurrently, and their characteristics are coupled with each other. Applicability is difficult to guarantee. On the other hand, thermal runaway is the main source of power battery fires, but not all battery fires must be caused by thermal runaway. When a vehicle collides, the violent impact may directly cause severe damage to the battery. A large amount of electrolyte leaks, and escapes flammable gas, which will catch fire or even explode immediately if it encounters an open flame [3]. Therefore, only from a single point of view such as "heat" or "electricity", it is impossible to accurately describe the safety of batteries. In future research, it is necessary to combine multidisciplinary fields such as "thermal electricity fluid chemistry mechanics" to explore the coupling mechanism of battery multi-domain characteristics including extreme faults and multiple faults concurrently, and to establish a comprehensive, effective, and practical battery. Safety

management system [4]. This leads to the problem that the SOC calculation accuracy is not high. The system includes a battery pack management device, a storage battery and a BMU module. The battery pack management device is connected to the BMU module. The battery pack management device includes a microprocessor control circuit and is connected to each single battery. The corresponding multi-channel data acquisition chip, voltage sensor and temperature sensor are shown in Fig. 1.

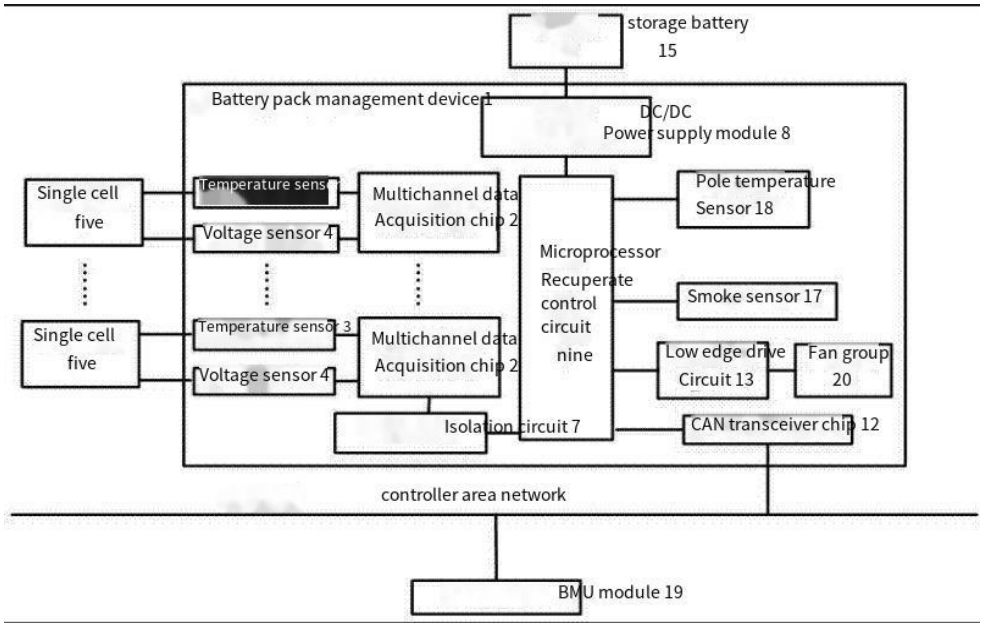

Fig 1. Electric vehicle power battery management system.

The charging and distribution system of electric vehicles is responsible for the management of battery charging and discharging. Ensuring its collision safety is not only to reduce the damage to the vehicle when it encounters a collision, reducing the economic loss suffered by the owner, but also to eliminate the risk of high-voltage electricity endangering personal safety caused by the collision. However, because of the effectiveness of this part of the crash safety design is not as easy to perceive and understand as the crash test results and active safety configuration, people often have little understanding of the technical level and investment of different car companies in this area and their impact on car safety. Intuitive understanding. Excellent collision safety protection for the charging and distribution system should be like the BYD e platform. On the one hand, the cross-section design, material selection, process selection, and even connection methods of the doors, floor longitudinal beams and beams should ensure the safety of the charging and distribution system [5]. Considering the protection, and carrying out targeted optimization, to provide the most reliable structural protection for the charging and distribution system; on the other hand, using airbags, etc., to send signals to the charging and distribution management system in the event of a collision, so that the high-voltage circuit is immediately cut off. The active safety discharge activates immediately, thus ensuring personal safety. At present, people know relatively little about the collision safety design of electric vehicle charging and distribution systems, which is directly related to the fact that the industry is still on the rise and the technical level of various enterprises is different. BYD's e platform's demonstration of the excellent collision safety design of the charging and distribution system will help consumers raise their awareness of its importance and buy more cost-effective and safer cars [6]. The anti-collision safety design of electric vehicle power batteries, like the charging and distribution system, involves two aspects: its own safety and the safety of drivers and passengers. Although people pay more attention to the collision safety of batteries because they store a large amount of energy; however, it is still difficult to understand the complex structure of different types of power batteries from single cells, battery modules, battery packs to complete systems. Discern the safety of the products of different car companies, and don't know whether they can leave enough escape time for themselves in case their car suffers a serious collision. Taking the shape parameters of the bottom of a pure electric vehicle as an example (the battery pack is shown in red), the common bottoming

collision scenarios on the road are as follows (Fig. 2): When the vehicle is driving on a flat road, the vertical height of the obstacle is higher than The ground clearance of the battery pack; when the vehicle passes the curb, the wheel on one side falls into the curb with a height difference; it is caused by the height difference of the road surface when the vehicle goes uphill or reverses downhill [7].

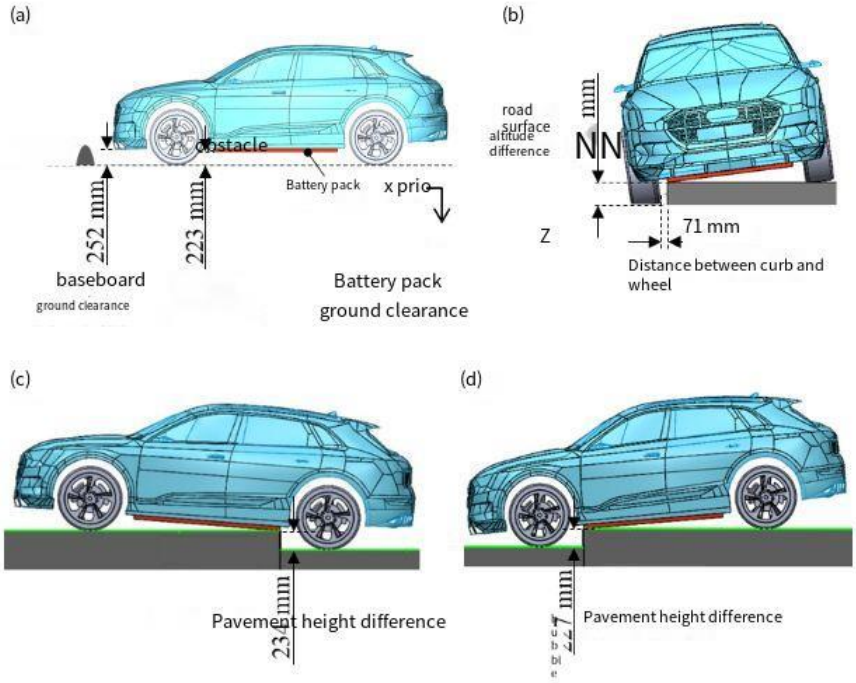

Fig 2. Electric vehicle crash test system.

3. Research Progress and Existing Problems

3.1. Collision Safety

According to the analysis data of electric vehicle accidents recently released by the British Transport Research Laboratory (TRL), it can be found that there is not much problem with electric vehicles themselves. Electric vehicles have different types of acceleration and driving modes, which may lead to collision accidents during mode switching, but there are no cases of related causes in the actual accident analysis report. It can be said that no car is safe in severe collision situations. But for pure electric vehicles, if the battery compartment is damaged after a collision, the vehicle is likely to burn or even explode [8]. Therefore, the burning that occurs within a certain period after the collision will still make ordinary consumers nervous. However, research by that cham research revealed that none of the EVs it tested under Euro NCAP suffered damage, with battery compartments well protected from all sides. During NCAP testing, no battery damage or fire was encountered, even in extreme crashes that put extreme stress on the vehicle's structure. Crash test engineers at the UK's Center for Automotive Research pointed to advances in the design of early EVs. How to incorporate the battery in the automobile while maintaining the high-voltage line's safety is one of the issues that must be solved today. Batteries, motors, inverters, etc. are typically incorporated into the structure of BEVs on a specific platform from the beginning [9]. In fact, we don’t have to worry about the safety of electric vehicles. Electric vehicles have gone from spontaneous combustion without warning in the past to fires after collisions. Battery safety is improving, especially these two incidents of fires after electric vehicle accidents that once sparked heated discussions, have not yet involved the power battery, how to ensure the safety of pure electric vehicles in these two fire accidents. According to the design experience and structure of fuel vehicles in the past, pure electric vehicles not only need reinforcement and protection of active safety, but more importantly, we should pay more attention to the passive safety performance of vehicles and batteries. Only in this way can we ensure that pure

electric vehicles have reserved sufficient buffer space for extreme situations such as collisions; further increasing the strength and safety of the vehicle [10].

3.2. Battery Safety

When a car is parked, spontaneous combustion challenges people preconceived notions of vehicle safety and raises the bar for battery safety management. Not only during operation, but also in the power-off state to effectively monitor and protect the battery [11]. The root cause of battery spontaneous combustion is internal short circuit, metal impurities mixed in during processing and electrode burrs, etc., electrical abuse, uneven electrolyte infiltration, etc., may cause partial lithium precipitation, which may scratch the battery diaphragm and cause tiny Such tiny internal short circuits are not easy to detect. They will continue to generate heat inside the battery. When the heat generated by the internal short circuit accumulates to a certain extent, it will cause thermal runaway of the battery and cause the power battery to catch fire. Fire accidents during the charging process ranked second, accounting for 20%, 14% of which occurred during routine charging, 5% of which were due to malfunctioning charging equipment, and 1% of which were due to batteries being overcharged directly [12]. It is clear that more battery fire mishaps are being brought on by regular charging every year; in fact, battery charging was to blame for 25% of fire events that took place in the first half of 2019. Even for small mobile devices such as mobile phone charging treasures, charging safety has always been a worrying issue. , How to carry out more standardized management of charging methods and charging facilities, and conduct feasible and effective safety status monitoring of rechargeable battery packs are very important issues. In addition to charging, battery fire accidents caused by car collisions accounted for a high proportion, ranking third. When a vehicle collides, it will bring a violent impact to the battery, which can easily cause damage to the structure of the battery pack and cause a short circuit. The design of the battery box of an electric vehicle must meet complex functions such as ventilation and heat dissipation, insulation and waterproofing [13]. The traditional view that "high temperature and hot summer are more likely to cause battery fire" is not correct for electric vehicles. The role of a single incentive, and the thermal management system commonly used in modern electric vehicles makes it less likely for power batteries to trigger thermal runaway due to a single thermal abuse. Solving the battery safety problem requires in-depth thinking and comprehensive analysis of its incentives from a more complex perspective [14].

4. Solutions and Rresearch Trends of Electric Vehicle Safety Issues

4.1. Collision Safety

Electric vehicles rely on electric drive systems, which are different from traditional motor vehicles, and the two should be inspected differently. Special inspections suitable for electric vehicles should be added to the traditional annual inspection items, such as charging function, waterproof performance inspection, power battery, drive motor and its controller and other parts inspection. Enterprises should improve the quality and safety level of electric vehicles. The government should strengthen the interim and ex-post supervision of enterprises and products, and build a new energy vehicle enterprise, local and national monitoring platform to detect potential safety hazards in a timely manner [15]. Because of its convenience and good mobility, electric vehicles have become an important means of transportation for people's daily short-distance travel. However, the road safety awareness of electric vehicle drivers is relatively weak, and dangerous behaviors such as running red lights and rushing to drive with motor vehicles often occur, resulting in frequent collisions between cars and electric vehicles. Whether the performance of electrical insulation is good or not can be measured by measuring parameters such as insulation resistance, withstand voltage strength, leakage current and dielectric loss [16]. Obvious, accurate and uniform signs are important factors to ensure the safety of electricity use. Signs generally include color signs, nameplate signs, and model signs. The color indicates the wires of different properties and purposes; the nameplate mark is generally

used as a sign of a dangerous place; the model mark is used as a sign of the special structure of the equipment.

4.2. Battery Safety

Traditional automotive information security technology cannot meet higher protection requirements. At present, it is urgent to carry out research on key information security technologies based on the characteristics and usage scenarios of intelligent networked vehicles, such as strengthening innovations in key chips, software, communication protocols, and system applications. The development of traditional automotive safety technology has gone through a lot of experimental research, even including a large number of costly crash safety tests, before it is gradually perfected. Battery safety research is no exception. Only by establishing a sufficient and complete battery safety test database, through the discovery, observation and exploration of test phenomena, can a breakthrough be made from the root cause. Nowadays, regardless of research institutes or automobile companies, the test in the field of battery safety is only in its infancy. The test conditions are single and the test data is scarce, which is far from being able to support the needs of the current battery safety technology research. In the follow-up work, for a variety of batteries Electrode materials, various battery types, consideration of multiple complex fault states, and the establishment of rich battery safety test data in the full SOC range, full temperature range, and full life cycle are the top priorities of battery safety research. However, most of the existing battery safety research relies on traditional electrochemical models or equivalent circuit models. The reliability and applicability of these models under fault conditions need to be investigated. When the battery fails, its internal electrochemical characteristics are very different from those in normal operation. Some "side reactions" of the battery under normal conditions may instead become the "main reaction" that plays a dominant role. The characteristics of the effective circuit have also changed greatly, so the traditional battery model cannot accurately describe the battery mechanism under the fault state. According to various failure forms of the battery, it is necessary to analyze and establish a high-precision and high-reliability battery model. The nature of safety problems, the only way to establish an effective diagnosis mechanism and safety management methods.

5. Conclusion

This article analyzes the characteristics of electric vehicle accidents and the causes of thermal runaway, and expounds the new challenges brought about by the intelligent networking of electric vehicles. Based on the above research, it is suggested that enterprises should pay more attention to the design and management of product safety in terms of electric vehicle operation safety, and the government should further formulate appropriate regular safety inspection items for electric vehicles and establish a sound safety supervision platform. In terms of information security, it is necessary to speed up the research of key technologies, and improve the technical requirements and evaluation standard system of intelligent networked vehicle information security. The statistics of the serious electric vehicle battery fire incidents in the past five years were analyzed, the distribution of fire incidents was analyzed, the correlation between the real accident cause and the underlying battery failure was clarified, and the internal short circuit and external short circuit of the battery were discussed. The failure principle of main battery failure types such as overcharging and overcharging and its triggering mechanism for thermal runaway; the status quo of battery safety research is reviewed, the research directions and research results of major technical teams are listed, and finally the current research The lack of work and future technical routes are given several points of discussion. The content of this paper provides factual support and evaluation of the necessity and criticality of battery safety research, and provides certain basis and ideas for future research work.

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