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New energy vehicle technology research - Charging technology

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Abstract. In recent years, China's economic development is becoming more and more rapid, leading to the increasingly serious pollution emission problem of traditional fuel vehicles. In order to solve the environmental problems, the transformation of automobiles has become an urgent problem. At the present stage, electric vehicles are also widely concerned by all sectors of society because of their low carbon emissions, energy saving and low use cost. With the rapid growth of electric vehicle sales, the demand for charging piles is rising, and the mainstream charging facilities for new energy vehicles are still in short supply. Therefore, we need to focus on efficient wireless charging to solve the major problems in the current electric vehicle industry. This paper analyzes the wireless dynamic energy transmission technology, extending the service life of the battery, how to reduce the cost, the optimization of coil parameters design, the offset of transmission coil and receiving coil, foreign body detection and overheating problems.

Keywords: new energy vehicle; dynamic; charging technology

1. Introduction

Due to the large-scale development of the global economy, energy shortage and environmental pollution are becoming more and more serious. Therefore, countries around the world are vigorously developing clean energy to achieve low-carbon travel. As an indispensable tool of travel in modern society, the automobile has greatly improved the travel efficiency, but also led to a lot of air pollution. A current focus is how to ensure the sustainability of efficient travel (that is, using transportation vehicles such as cars) under the premise of a green earth. In recent years, many studies have focused on wired charging modes, which require a fixed range of charging facilities and is inefficient. Therefore, in order to make the rapid promotion of new energy vehicles and reduce the corresponding pollution emissions, in this paper, we propose a more efficient method - wireless charging technology.

In the current research, we aim to understand the electric vehicle technology involved in the key points of electrical engineering knowledge, and the specific circuit module, in-depth analysis and discussion, establish the electric vehicle related electrical research complete knowledge framework, to improve the new energy vehicle charging efficiency to lay a solid foundation. Thereafter, in-depth research on these basic knowledges, conducted in-depth research, raised questions, and solved related problems.

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2. Principle, technology and improvement of vehicle charging technology

2.1. Research background

As an efficient charging method, wireless charging technology also has some problems, such as the design and optimization of coil parameters, and the offset of transmission coil and receiving coil. At present, there are practical problems of how to reduce the cost of wireless charging equipment and improve the user experience to be solved urgently. Therefore, wireless charging technology is a topic worthy of in-depth research, and the research on this problem has certain practical significance.

2.2. Research status, both at home and abroad:

Developed countries such as the United States, Germany for wireless charging research is relatively perfect and comprehensive, many scholars on how to optimize the coil parameters and coil displacement research, content extended to the coil field, scholars Amjad Muhammed, Farooq-i-Azam Muhammed compared the two main wireless charging way - capacitor power transmission and inductive power transmission, and classify the wireless charging system, the fixed and dynamic wireless charging efficiency, the necessity of wireless charging system in the field of new energy vehicles [1].

Scholars Palani and Geetha studied the necessity of charging MR-coupled wireless electric vehicles, and he believed that the charging system can maintain the power efficiency at the highest level after developing a strategy [2].

Domestic scholars have carried out various research on wireless charging. In terms of the definition and research of dynamic wireless charging, scholar Zhang Zhenli defined it in 2021 [3].

For the rationality of constant current and constant voltage wireless charging topology and control technology, Wu Miaobin elaborated from many aspects in 2022, and elaborated and explained the difference and connection between its single resonance network and multi-resonance network [4]

From the perspective of China's current development, the development of wireless charging technology is slow, and the relevant theoretical research is still limited to the static wireless centralized power supply guide rail mode currently being implemented. There are few studies and experiments on the dynamic segmented power supply guide rail mode. According to the data collected from this topic at present, although many scholars have carried out various studies on wireless charging, there are also deficiencies and shortcomings in these studies.

3. Main body

3.1. Operational principle:

Charging when parking: The power outage charging technology is to charge the electric vehicle when parking, which is roughly the same as the traditional charging method. Electric cars can be charged at a specific location, such as parking and a parking lot. Running charging: using the power supply rail laid under the ground in the form of high frequency alternating magnetic field will power transmission to run on the ground within the vehicle receiving energy receiving equipment, then to the car battery power, which can reduce the battery capacity and volume, effectively increase the battery range, prolong its service life.

Structural mode: It mainly consists of two parts, one part on the road and the second part on the vehicle. On the road, this fixed part is called the transmitter. And the transmission coil is laid on the power supply guide rail. According to the different coil circuit structure, the power supply guide rail is divided into two modes, namely centralized guide rail and segmented guide rail. The second part is placed beneath the vehicle and is the moving receiver. Vacuum separates the two elements, with each part having its electronic system. The ejector blocks generate high frequency alternating magnetic flux. This magnetic flux is coupled to the receiver coil and then converted to electricity used to charge EV batteries.

Specifically, to the structural, the most core structure of the wireless charging of electric vehicles is the magnetic coupling mechanism. To optimize the coil parameters, select the appropriate magnetic

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material, improve the coupling coefficient, improve the transmission power and efficiency of the system, and improve the resistance to offset and electromagnetic shielding. Further, the four resonant circuit topologies can be used. Their exponentiate was performed after the insertion of the capacitors on both sides. Assuming that connections can be connected in parallel (P) and / or series (S); the topology is series (SS), series and parallel (SP), parallel (PS), and parallel (PP) [5].

Also, for dynamic wireless charging system, electric vehicles in the process of operation, due to the relative position of the magnetic coupling mechanism will change, the magnetic field between the uneven distribution of the influence of various factors, so the energy transmission belongs to the nonlinear change, how to improve the stability of the power supply system and transmission rate will be studied as the focus of the energy transmission control. Finally, electric car wireless charging is the use of electromagnetic induction principle of power transmission, in the process of charging, electromagnetic radiation, electromagnetic radiation assembly damage to human health, will reduce the efficiency of energy transmission, interference to the charging system at the same time, only solve these problems, the system can be safe, reliable and stable operation, make the electric car wireless charging apply. Therefore, it is the maximum power to ensure the electromagnetic compatibility of the system in the future research.

3.2. Technology: Battery charging technology

The storage battery is the main energy storage device of electric vehicles. A battery is a device that can convert chemical energy into electric energy, and its basic composition is usually a positive and negative electrode and an electrolyte solution. Electrical energy is generated through the chemical reactions between the two electrode plates and the electrolyte. In some secondary cells, the chemical reaction is reversible, and the electricity is stored in the secondary cell in the form of chemical energy. The energy density, power density and other characteristics of the battery are usually determined by the battery type. In the design of the electric vehicle battery, the battery type needs to be determined to ensure that the basic parameters of the battery meet the requirements of the vehicle operation. In some cases, considering that the battery power does not meet the requirements of the acceleration and braking characteristics of the car, new energy storage devices such as ultracapacitors are used.

In the process of battery charging, the current and voltage need to meet certain conditions. The charging process can be divided into the following four charging modes according to the different current and voltage changes: constant current charging (Constant-Current, CC) mode, constant current charging (Constant-Voltage, CV) mode, constant current-constant pressure charging (Constant-Current-Constant-Voltage, CC-CV) mode and multi-segment constant current charging (Multi-stage Constant-Current, MCC) mode.

(1) Constant-current charging mode the battery current is constant throughout the charging process. To extend the battery life, the constant current is usually set to a lower value. The disadvantage of this charging mode is that the charging completion time is longer, which can be used for nickel metal hydride batteries and lithium batteries.

(2) Constant voltage charging mode the charging voltage is kept constant to avoid damage to the overvoltage battery. In this charging mode, the current gradually decreases until the set threshold, when the charging process is over.

(3) Constant current-constant voltage charging mode This charging mode consists of two stages. In the first stage, the battery is charged with a constant current, and the current meets the set electricity The maximum charging current stipulates that the battery voltage rises at this stage. When the voltage reaches the maximum value, the charging turns to the second stage constant voltage mode, during which the battery current gradually drops. When the preset lowest current value is reached, the charging ends. This charging mode is mostly used for the charging of electric vehicles.

(4) Multi-segment constant-current charging mode: In this charging mode, the battery is multi-stage constant current charging. When the voltage reaches the preset threshold, the stage is switched, and the constant current value set in each stage is different. The main advantage of this mode is that the charging time is short, so it is mostly used for fast charging.

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3.3. Improvement: Wireless transmission of electricity

Static wireless charging refers to the charging method carried out after the car is parked in the centralized charging area. It is mainly applicable to parking lots, residential areas, shopping malls, etc. It has the disadvantages of frequent charging, short range, large battery consumption, perfect charging facilities and high cost. Dynamic wireless charging refers to the charging mode in the operation process of cars, which can effectively increase the battery range, prolong the battery life, and improve the user experience, which will become the focus direction of the future development and research of electric vehicles.

Radio energy transmission mode can be through the following electromagnetic induction type, magnetic coupling resonance type (Magnetically Coupled Resonant, MCR) and electric field coupling type, far field radiation type radio energy transmission is mostly microwave type or photoelectric type. Strong magnetic coupling resonance type (Strongly Coupled Magnetic Resonance, SCMR) is between the near field and the far field. The following radio energy transmission modes are as follows [6]:

Electromagnetic induction type WPT:

Advantages: 1), small power occasions easy to apply 2) easy to control 3) electrical isolation

Disadvantages: 1) transmission efficiency is very low (20%) 2) transmission gap is small 3) need to control electromagnetic radiation 4) need to consider the device gap or surrounding metal objects interference.

Magnetic coupling resonant WPT:

Advantages: 1) can provide kW level high power transmission 2) mature technology has been commercialized 3) has a certain coil resistance to offset ability 4) electrical isolation

Disadvantages: 1) Energy transmission efficiency greatly depends on the size of the gap

Electric field coupled WPT:

Advantages: 1), can achieve medium power transmission 2) not by the device gap and surrounding metal objects interference 3) energy transmission using metal plate low cost 4) suitable for close (less than 10cm) transmission 5) do not need to control electromagnetic interference EMI

Disadvantages: 1) efficiency is only 50% 2) complex control 3) the size of the transmitting end and receiving end devices is large

Microwave WPT:

Advantages: 1) suitable for very long distance (km) energy transmission 2) microwave beam can be dynamically adjusted with mobile load 3) kW level energy transmission can be realized in the future

Disadvantages: 1) Low efficiency in long-power transmission (less than 10%) 2) implementation complex 3) microwave radiation

Photoelectric WPT:

Advantages: 1) suitable for long distance (km) energy transmission 2) can be dynamically adjusted with the moving load beam 3) the transmitting end size is small. Disadvantages: 1) low efficiency (20%); 2) There can be no barrier between the occurrence end and the receiving end.

Among the more important are the magnetic coupling mode, and the microwave formula Induction coupling type: induction coupling type technology belongs to a kind of wireless charging technology, based on the principle of loose coupling transformer, send and receive both ends have a coil, and on the primary coil through a certain frequency of ac, this time the secondary coil will produce the corresponding current, and the transmission end can produce Quantity delivery to the receiving end, thus realizing the energy transfer. However, due to the lack of a magnetic core, in the process of energy transfer, there will be a large part of the magnetic momentum cannot be transmitted to the receiving end, but scattered over the air magnetic path. Therefore, in the process of energy transfer, the coupling system is within 0.5, and the magnetic core magnetic resistance is lower than the air magnetic resistance, so the way of wireless charging is not very efficient [7].

Microwave type: microwave energy type wireless charging technology, the main working principle is the car running when electricity is converted into microwave signal, and then with the aid of the corresponding transmission device signal transmission, using conversion device into microwave signal, finally the electricity generated during the conversion are stored in the car battery. In this way of

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charging, the charging part and the receiving part use 2.45GHz microwave signal, although the output power is only 1 kilowatt, but the transmission distance can reach 100 cm. Compared with the two wireless charging technologies mentioned above, this wireless charging technology has very obvious advantages. Moreover, the microwave wavelength is relatively short, so this charging method can be used for long-distance directional transmission. But this way of charging also has certain disadvantages, that is the output power is low, and the speed of the microwave energy is slow, band is narrow, so the microwave energy type charging efficiency is less than 40%, and the other two wireless charging technology efficiency is much lower, so the wireless charging technology is not suitable for widespread promotion.

3.4. Innovative analysis

for new energy vehicles charging technology innovation, hope to get higher efficiency, the charging time shorten, lower cost, charging costs lower, both for developers and customers, longer life, namely, charge a charge can make the driving time longer, cooler driving experience, that is, the driver when driving more comfortable, hear less noise to make new energy vehicles in the market sales, to reduce the pollution of traditional cars.

4. Conclusion

This paper analyzes and studies the dynamic wireless charging technology of electric vehicles The working principle of dynamic wireless charging technology, the mode and pass of power supply guide rail are introduced Key problem, and points out the urgent problems of dynamic wireless charging technology for electric vehicles, These problems will be the main content of the future research on electric vehicles.

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