

New Energy Electric Vehicle Wireless Charging Technology

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ABSTRACT

With the global attention to renewable energy and environmental protection, new energy Electric Vehicles (EVs), as a green travel mode, are gradually becoming the development trend of the future automotive industry. However, problems such as inadequate charging infrastructure and long charging times limit the popularity of electric vehicles. The emergence of wireless charging technology provides a new way to solve these problems. This paper aims to discuss the principle, application status, advantages, challenges and future development trend of wireless charging technology for new energy electric vehicles.

KEYWORDS

New Energy; Wireless Charging Technology; Electric Vehicles.

1. INTRODUCTION

With the global emphasis on environmental protection and sustainable development, the new energy vehicle industry has developed rapidly. Governments have introduced policies to encourage the development and promotion of new energy vehicles in order to deal with the energy crisis and environmental pollution caused by traditional fuel vehicles. New energy vehicles, especially electric vehicles, have become an important direction for the transformation and upgrading of the automotive industry because of their zero-emission or low-emission characteristics. Wireless charging technology of electric vehicle is a new technology that transmits energy through magnetic field, and can realize the transmission of electric energy without plugging or unplugging the charging cable. This technology not only improves the convenience of charging, but also reduces the risk of human accidents and improves the charging efficiency. This paper will analyze all aspects of wireless charging technology in detail, in order to provide reference for the research and practice in related fields.

2. DEVELOPMENT OF WIRELESS CHARGING TECHNOLOGY

2.1. Early Exploration (late 19th to early 20th century)

In 1890, physicist Nikola Tesla conducted wireless power transmission experiments to achieve AC power generation, and conceived a bold plan to use the earth and the ionosphere as conductors for wireless power transmission, but it was not realized due to lack of financial resources. Although Tesla's idea was not immediately translated into practical applications, it laid the theoretical foundation for later wireless charging technology.

2.2. Budding Technology (early 21st century)

In 2005, BYD applied for a patent for a contactless inductive charger, marking the initial exploration of wireless charging technology in the field of electric vehicles.

In 2007, a research team at the Massachusetts Institute of Technology published in the journal Science the research results of wireless charging using the principle of electric magnetic resonance, and successfully powered a light bulb two meters away.

2.3. Initial Application (2010s)

In 2011, the first wireless charging electric vehicle was put into trial operation in Seoul Park, South Korea, marking a new stage for wireless charging technology for electric vehicles. Citing the content of Chen Liuqin's article, such as the development of foreign new energy industry [1]

In 2017, BMW announced that it would commercialize wireless charging technology in its cars. In the following years, Honda, Volvo, SAIC Zhiji and other car companies have demonstrated or launched their own wireless charging technology.

2.4. Market Focus and Acceleration (In Recent Years)

With the participation of technology giants such as Tesla, wireless charging technology has received more attention. Tesla's head of design has publicly stated that Tesla is developing its own version of wireless charging technology. The application of wireless charging technology in the field of electric vehicles has gradually transitioned from the experimental stage to the commercialization stage, and a number of car companies and technology companies have actively laid out the field. The content of Wang Xiujie's article is quoted, such as the development of China's new energy industrialization [2]

Electric vehicle wireless charging technology is mainly based on the principle of electromagnetic induction to achieve power transmission. A magnetic field is established between the transmitter and the receiver, and energy is transferred by changing the magnetic field strength and frequency. The transmitter generates a high-frequency changing electromagnetic field, and the coil in the receiver senses this changing magnetic field and generates an electric current, which transmits electrical energy to the battery of the electric vehicle.

3. APPLICATION STATUS OF WIRELESS CHARGING TECHNOLOGY

3.1. Application Scenarios

Wireless charging technology has a wide range of application scenarios in the field of electric vehicles, mainly including public places (wireless charging facilities are set up in shopping centers, parking lots and other public places to provide convenient charging services for past electric vehicles). Home applications (Installing wireless charging facilities in the home environment to provide overnight charging services for electric vehicles, saving electricity bills and reducing the load on the grid). Industrial field (in industrial places such as factories and warehouses, wireless charging facilities can improve charging efficiency and reduce costs due to frequent vehicle access).

3.2. Market Focus and Acceleration (In Recent Years)

Many automobile manufacturers and scientific research institutions at home and abroad are actively developing wireless charging technology, and have achieved certain results. For example, BMW, Audi and other brands have implemented wireless charging functions on some models; At the same time, China is also actively promoting the research and development and application of wireless charging technology, and has issued a number of relevant standards and policy documents to support

the development of the wireless charging industry. The content of Hu Yiming's article is quoted, such as the analysis of the entry mode of BYD new energy vehicles in the US market. [3]

4. ADVANTAGES AND CHALLENGES OF WIRELESS CHARGING TECHNOLOGY

Has certain advantages, convenience: no need to plug and unplug the charging cable, improve the convenience of charging. Security: Reduces security risks during insertion and removal operations. High efficiency: Through optimized design and intelligent control algorithm, the energy transmission efficiency and charging speed are improved. Flexibility: Applicable to different brands and models of electric vehicles, improving the compatibility of charging facilities.

At the same time, it also faces challenges and technical difficulties: long-distance and efficient wireless charging technology still has technical bottlenecks. Cost issue: The manufacturing cost and maintenance cost of wireless charging equipment are high. Standardization issues: Different brands and models of electric vehicles have differences in wireless charging interfaces and protocols, and unified standards need to be developed. Electromagnetic radiation: Electromagnetic radiation generated during wireless charging may have an impact on the surrounding environment. The content of Lin Luo's article is quoted, such as the development status of foreign new energy industry [4]

5. FUTURE DEVELOPMENT TREND OF WIRELESS CHARGING TECHNOLOGY

5.1. Technological Innovation

With the continuous progress of technology, wireless charging technology will achieve breakthroughs in improving transmission efficiency, expanding charging range, and reducing costs. For example, by optimizing the electromagnetic induction principle, using high frequency and high permeability materials, and developing new wireless charging technologies, the performance of wireless charging can be significantly improved. The content of Mu Xiaoming's article is quoted, such as the development research of new energy vehicles based on destructive innovative vision [5]

5.2. Standardization and Industrialization

With the continuous expansion of the electric vehicle market, standardization and industrialization of wireless charging technology will become an important trend in the future. Through the development of uniform standards and protocols, to achieve compatibility between different brands and different models; At the same time, promote the industrialization process of wireless charging technology, reduce production costs and improve market competitiveness. The content of Teng Fei's article is quoted, such as the research on BYD Auto brand equity evaluation and value-added protection measures [6]

5.3. Merging Other Technologies

Wireless charging technology will gradually integrate with other technologies, such as autonomous driving, the Internet of Things, artificial intelligence, and so on. By integrating these technologies, the intelligence level and use experience of electric vehicles can be further improved; At the same time, inject new vitality and momentum into the development of wireless charging technology.

6. THEORETICAL ANALYSIS

6.1. Working Principle

The wireless charging technology of new energy electric vehicles is mainly based on the principle of electromagnetism, especially the principle of electromagnetic induction and electric magnetic resonance. The principle of electromagnetic induction refers to that when the conductor is in a changing magnetic field, the induced electromotive force will be generated in the conductor, and then the induced current will be generated to achieve the transmission of electric energy. In the wireless charging system, the transmitting end generates an electromagnetic field in the coil through the current, and this electromagnetic field penetrates into the coil at the receiving end, thus generating an induced current at the receiving end to achieve wireless charging. The principle of electromagnetic resonance is to use the energy exchange between two oscillating systems with the same frequency to achieve wireless transmission of electrical energy. The wireless charging system is mainly composed of two parts: the transmitting end and the receiving end. The transmitting end usually includes a rectifier circuit, an inverter circuit, a transmitting coil, etc., which is responsible for converting electrical energy into a high-frequency electromagnetic field and transmitting it outwards. The receiving end includes the receiving coil, the rectifier circuit, the filter circuit, etc., which is responsible for receiving the electromagnetic field and converting it into electrical energy to supply the battery of the electric vehicle. In the process of wireless charging, no physical connection is required between the transmitter and the receiver, and the electric vehicle can be automatically charged by simply parking it near the transmitter.

6.2. Previous Problems

6.2.1. Technical Problem

Charging efficiency: The charging efficiency of wireless charging is usually lower than that of wired charging, because of the energy loss during electromagnetic induction transmission. How to improve the charging efficiency to meet the needs of users is an urgent problem.

Charging distance: The charging distance of wireless charging is short, generally between a few centimeters and tens of centimeters. In order to realize wireless charging of vehicles on the road, the problem of short charging distance needs to be overcome.

Charging standards: Wireless charging technology has not yet formed a unified charging standard, and there may be compatibility problems between products from different manufacturers. Developing a unified charging standard to promote the popularization of technology is the future development direction.

6.2.2. Security Problem

Wireless charging technology needs to avoid the effects of electromagnetic radiation on human health and ensure that no safety incidents occur during charging. Therefore, in the process of technology development and application, it is necessary to attach great importance to safety issues.

6.2.3. Cost Problem

The cost of wireless charging technology is also relatively high compared with wired charging, including equipment manufacturing costs and maintenance costs. This limits the wide application of wireless charging technology. How to reduce the cost to attract more users is one of the problems to be solved in the process of technological development.

6.2.4. Application Environment Limitation

The application environment of wireless charging technology has certain influence on its performance. For example, different weather conditions in an outdoor environment may have multiple effects on

the operation of the wireless transmitter; In indoor parking environment, heavy conditions such as wheel rolling should be considered. Therefore, these factors need to be fully considered in practical applications to ensure the stability and reliability of the technology.

7. CASE ANALYSIS

7.1. High Power Wireless Charging Technology

Case in point: The U.S. Department of Energy's Oak Ridge National Laboratory (ORNL) successfully demonstrated the first 270-kilowatt wireless electric vehicle (EV) charging technology, setting a new world record for wireless charging power. The system can charge 50% in 10 minutes, the efficiency is more than 95%, and has short circuit, overheat, overvoltage, overcurrent and other protection mechanisms to ensure the charging process is safe and reliable.

Significance: The breakthrough of high-power wireless charging technology has significantly shortened the charging time of electric vehicles, improved the charging efficiency, and provided strong support for the popularity of electric vehicles. The content of Wan Yijuan's article is quoted, such as the analysis of BYD's new energy vehicle market entry mode in the United States [7]

7.2. Dynamic Wireless Charging Technology

Case: Oak Ridge National Laboratory of the United States has also verified the 200-kilowatt high-power electric vehicle dynamic wireless charging technology, which can meet the 10-kilometer driving demand through 1 kilometer charging when the vehicle is running at high speed. In addition, China FAW has also built a high-power dynamic wireless charging road system in its innovation base.

Significance: Dynamic wireless charging technology provides greater possibilities for the endurance and convenience of electric vehicles, and is expected to become one of the mainstream charging methods in the future. It not only enables the electrification of roads, but also enables the dynamic connection of the transportation network to the smart grid, optimizing energy efficiency and safety.

7.3. Public Charging Stations

Case: Take Suzhou as an example, as of the end of June 2023, the number of new energy vehicles in Suzhou has reached 308,400, an increase of 93.9%. State Grid Suzhou Power Supply Company has increased the construction of charging infrastructure and the application of new technologies, exploring new technologies and new models such as "wireless charging" and "shared charging". The smart charging station of Dengwei Road has completed the upgrading and transformation of the wired and wireless integrated charging pile and has been put into use, realizing the "non-inductive" charging experience of the owner.

Significance: The construction of wireless charging facilities in public charging stations meets the citizens' demand for the convenience of charging electric vehicles and promotes the development of green transportation.

7.4. Vehicle Enterprise Layout

Case: Domestic major car companies such as SAIC, FAW, etc., have launched wireless charging power in 7.7 kilowatts to 11 kilowatts of mass production models; Huawei, BYD, Geely and others have also published patents for wireless charging of electric vehicles.

Significance: The active layout of vehicle enterprises has promoted the rapid development and commercial application of wireless charging technology. Wireless charging is expected to become a

new outlet for the electric vehicle industry and become one of the selling points of high-end electric vehicles.

7.5. Policy Support

Case: Last year, the Ministry of Industry and Information Technology issued the Interim Regulations on Radio Management of Wireless Charging (Power Transmission) Equipment, which became the first normative document in the field of wireless charging in China, providing basic support for the development and design of wireless charging systems.

Significance: Policy support provides a strong guarantee for the development of wireless charging technology, promotes the standardization and standardization process of technology, and is conducive to promoting the wide application of wireless charging technology.

8. CONCLUSION

As an emerging technology, wireless charging technology for new energy electric vehicles has wide application prospects and huge market potential. With the continuous progress of technology and the continuous development of the industry, wireless charging technology will play an important role in improving the vehicle experience, reducing operating costs and promoting the sustainable development of the automotive industry. In the future, we will continue to pay attention to the development of wireless charging technology and contribute to the popularization and development of electric vehicles.

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