Research and Practice of Testing Technology for the Use Characteristics of Electric Bus

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Abstract. Electric buses are widely used at present, and the social demand for vehicle maintenance and inspection technology is increasing. Compared with traditional cars, electric buses have a large number of electronic control units and complex structures. Traditional inspection ideas and methods are difficult to be accurate reflect the status and failure of electric vehicles. In this paper, through the discussion of the main problems in the detection of electric buses, the high-voltage online detection process, the outage detection process and the research and practice of detection methods of using characteristics of electric bus vehicle are determined. The detection methods of characteristics such as consumption rate and power transmission and insulation between vehicles provide technical references for the correct use, technical support and technical integrity of electric buses.

1. Introduction

As the problems of traditional petrochemical energy sources, atmospheric pollution, and climate warming that affect human living environment become increasingly prominent, how to achieve sustainable development of the automotive industry and harmonious living with nature has become the most urgent solution for the future development of the automotive industry subject. Under this background, new energy vehicles have received widespread attention from governments and automobile companies around the world, and major automobile companies in the world have invested heavily in research and development of new energy vehicles. Since 2014, China's new energy vehicles have developed rapidly, with an annual output of 84 thousand vehicles, accounting for 0.35% of China's automobile output [1]. In 2018, China produced 1.27 million new energy vehicles, an increase of 59.9% over the same period last year. Among them, the output of pure electric vehicles was 986,000, an increase of 47.9% over the same period of last year. New energy vehicles are showing explosive growth. Based on national design, many auto manufacturers will gradually adapt to the trend of global electrification and place long-term strategic development focus on new energy vehicles. Among them, pure electric vehicles account for a high proportion of new energy vehicles, which is the focus of development, especially the application in passenger transportation industry is more and more extensive. Compared with traditional cars, new energy vehicles have a large number of electronic control units and complex structures. It is difficult for traditional detection tools and methods to reflect their performance status and determine faults. The number of electric buses is increasing, the working frequency is high, and the working load is large. The detection and analysis of its performance changes will have a positive effect on improving transportation efficiency. In order to improve the competitiveness of the electric bus market and the technical integrity of the vehicle, it is very important to study and analyze the performance testing technology of electric vehicles.
2. Currently Existing Major Problems

2.1. The Lack of Core Technology for Use Enterprises
After investigations by many enterprises and users, it is known that due to the influence of factors such as technological secrecy and the instability of new energy vehicle technology, enterprises currently rely on the technical support of automobile manufacturers for the detection and maintenance of new energy vehicle technology. The communication link (OBD) of automobile technical status data is not uniform among various automobile manufacturers, and the communication protocol is not disclosed. Due to the lack of technical information and technical personnel, the user unit is basically unable to carry out routine technical inspection and maintenance work.

2.2. Various Detection Risk Factors
Because electric vehicles are driven with a voltage higher than the human body safety, it is easy to cause personal injury during detection, which leads many enterprises to struggle. For safety reasons, they dare not and did not have the ability to ensure the safety of detection. Therefore, many companies have shifted the testing of electric vehicles to sales or manufacturing companies.

2.3. High Professional Level of Testing Equipment and Insufficient Penetration Rate
At present, the testing equipment of electric vehicles are basically supported by automobile manufacturers and are customized products. There are basically no similar products on the market. Testing can only be done by manufacturers, which seriously restricts the use of enterprises, reduces production efficiency and increases the burden on transportation production.

2.4. Insufficient of Technical Power of Using Enterprise
Because electric vehicles belong to new technologies, their working processes and principles are relatively complicated. It is difficult to adapt to the changes of new technologies in a short time for the technical strength of using enterprises. Some enterprises directly use the inspection and maintenance technicians of transmission vehicles for the inspection and maintenance of new energy vehicles. The technical connection is discontinuous and the inspection cannot be carried out normally, which directly affects the normal development of transportation and production.

The above analysis is also applicable to electric buses, and its problems are also very obvious. Therefore, it is urgently required to develop a test method and process that can be operated in accordance with the actual operation of the electric bus, and carry out scientific analysis on this basis to meet the technical management needs of the electric bus and improve the transportation efficiency and efficiency of the transportation enterprise.

3. Determination of Testing Process
The testing specifications for pure electric vehicles include two types of high-voltage circuits (B-level circuits, hereinafter referred to as high-voltage or high-voltage circuits) with a voltage greater than 60V online detection and power-off detection. High-voltage online detection refers to the detection work and items without disconnecting the power supply of the power battery, and the power-off detection refers to the detection work and items under the state of disconnecting the power connection between the power battery and all electrical equipment. The electrical equipment used in high-voltage online testing may carry high-voltage electricity, which has a certain degree of danger. Extra care must be taken during testing to prevent accidents. During power-off detection, the risk factor is small, only less protection is required.

4. Determination of the Testing Parameters and Testing Process of the Use Characteristics for the Using Electric Vehicle
After the pure electric vehicle participates in the transportation work, due to the impact of the load used, the number of battery charge and discharge, and functional attenuation, the overall use characteristics
of the vehicle will decline. This part mainly uses specific detection methods to reflect the degree of
decline in vehicle usage characteristics, providing a technical reference for vehicle status analysis and
continued use.
The detection parameters are: driving range, energy consumption rate, power transmission and
insulation characteristics between vehicles.

4.1. Continuous Driving Mileage Detection

4.1.1. Testing ideas and principles
The driving range of an electric vehicle refers to the distance travelled by the power battery on the
electric vehicle from the fully charged state to the end of the test specified by the standard. It is an
important economic index of the electric vehicle. After being used for a period of time, due to the
deterioration of battery performance and the influence of other transmission factors, the driving range
of the electric bus will decrease, which will affect transportation production. Therefore, the detection of
driving range is particularly important. At present, the detection method is relatively complicated, and
it is difficult for the general user to meet the detection conditions and requirements. The change in
driving range is the vehicle performance that users directly care about. The test items can be divided
into two types: road test and bench test. It is also possible to simplify the detection specification
according to the characteristics of the user unit, and as long as the conditions of use of the vehicle are
consistent, it can also qualitatively reflect the continuous mileage status of the vehicle. Simplified testing
specifications using units can be carried out according to their own unit conditions. For example, the
conditions such as road, load, speed, etc., as long as they are the same in different detection items, can
also reflect the continued driving state of the vehicle.

4.1.2. Testing instruments and equipment
Testing instruments and equipment can choose chassis dynamometer and related testing instruments.
The car chassis dynamometer simulates the road surface through the roller and is loaded with the loading
device to realize the simulation of various operating conditions of the car [3]. During the continuous
driving range detection, the use of the chassis dynamometer to load the vehicle to simulate the road
running state can improve the detection efficiency.
When the vehicle is traveling on a fixed site, it needs a specific speed and distance. The speed and
odometer of the vehicle itself cannot be used for detection due to display errors. In order to accurately
reflect the driving status of the vehicle, it is necessary to use additional testing equipment to measure
the measured speed and the distance travelled. The instruments and equipment currently used are mainly
vehicle road detectors. The detection principle of the detector is non-contact measurement, which
accurately reflects the actual movement state of the vehicle through photoelectric induction, radar wave
or GPS signal. For power consumption, a universal charging pile can be used.

4.1.3. Detection method
After the vehicle's basic testing conditions are met, the driving range can be detected in two ways:
(1) Indoor testing
It mainly relies on the chassis dynamometer to load the vehicle. Under the specific testing conditions,
the mileage of the detected vehicle is evaluated by the mileage displayed by the chassis dynamometer.
The detection method is simple and easy to implement.
(2) Road detection (outdoor)
In outdoor testing, the testing conditions are more demanding. The vehicle to be tested needs to be
connected to a non-contact road tester, the purpose of which is to detect the driving speed and distance,
and the driving mileage is also obtained by the non-contact road tester. This kind of detection method
has high cost, complicated detection process and high requirements.
4.2. Energy Consumption Rate Detection

4.2.1. Testing ideas and principles
The energy consumption rate of an electric vehicle refers to the value obtained by dividing the electric battery recharged to the capacity before the test by the electric vehicle after the prescribed test cycle, and the electric energy obtained from the charging station divided by the mileage travelled. This parameter is an important reference index reflecting the energy conversion efficiency of the in-use vehicle. After an electric bus is used for a period of time, the energy consumption rate will rise. If the consumption rate rises too much, it will inevitably affect the improvement of the normal transportation efficiency of the vehicle. The test items can be carried out on outdoor roads, or on indoor benches. Bench testing needs to be carried out in conjunction with a chassis dynamometer. Outdoor roads can also be selected for simplified detection based on the conditions of the user unit. When using simplified detection, it is necessary to ensure the consistency of the detection specifications of the vehicle in different detection periods.

4.2.2. Testing instruments and equipment
The instrument and equipment requirements for this parameter detection are the same as those in 3.1 “Driving mileage detection”.

4.2.3. Detection method
After the basic vehicle detection conditions are met, the energy consumption rate of electric vehicles can be detected in two ways:
(1) Indoor testing
Mainly rely on the chassis dynamometer to simulate the basic conditions of the operation of the electric bus. During the test, the chassis dynamometer provides the driving mileage parameters of the vehicle to be checked, and the charging equipment provides the technology to detect the power consumption, the ratio of the consumed power and the mileage of the electric bus provides energy consumption rate of the bus which is combined with the national standard for scientific evaluation. The detection method is simple and easy to implement.
(2) Road detection (outdoor)
When testing outdoors, the testing conditions are harsh. For outdoor testing, the vehicle to be tested needs to be connected to a non-contact road tester. The tester can provide the mileage under specific conditions. The charging equipment provides the power consumption of the vehicle to be tested, and then calculates to form the energy consumption rate parameter value and conduct scientific evaluation. This kind of detection method has high cost, complicated detection process and high requirements.

4.3. Detection of Power Transmission and Insulation Characteristics between Vehicles

4.3.1. Testing ideas and principles
Compared with traditional cars, the proportion of electric systems in electric cars has greatly increased. At the same time, in order to meet the needs of electric drive, electric vehicle power systems use high voltage systems of several hundred volts. If the high voltage system leaks, this voltage will cause harm to people [4]. The use of effective insulation devices is an important measure to protect personal safety. Therefore, electrical insulation is an important item of high-voltage safety for electric vehicles. According to the current safety requirements for human body (DC10mA, AC20mA) in the relevant standards, GBT18384-2015 "Safety Requirements for Electric Vehicles" stipulates that the minimum requirements for insulation resistance are: DC 100Ω/V, AC 500Ω/V [5]. If insulation failure occurs in the electrical system, depending on the degree, it will cause progressive consequences. The detection method can use a special instrument to detect the voltage or current leakage, or a simple detection method to measure its insulation resistance.
4.3.2. Testing instruments and equipment

(1) Withstand voltage tester
According to its function, it can be called electrical insulation strength tester, dielectric strength tester, etc. Its working principle is: apply a voltage higher than normal to the insulator of the device under test for a specified period of time, the voltage applied to it will only produce a small leakage current, and that shows the insulation is good. Three modules of program-controlled power supply module, signal acquisition and conditioning module and computer control system form the test system. Choose two indicators of the pressure meter: the maximum output voltage value and the maximum alarm current value.

(2) Megohmmeter
Megohmmeter is a measuring instrument commonly used by electricians. There are two types of shaking table (pointer type) and digital table. The scale of a megohmmeter is in units of megohms (MΩ). The megohmmeter is mainly used to check the insulation resistance of electrical equipment, household appliances or electrical lines to the ground and between phases to ensure that these devices, electrical appliances and lines work in a normal state, and avoid accidents such as electric shock injury and equipment damage. If you use a shaker, you should use a megohmmeter with 1000V or above. Before the measurement, the power supply of the tested circuit or electrical equipment must be disconnected, that is, the insulation resistance is not allowed to be measured while it is live. And it must be confirmed that no one is working on the line or electrical equipment. This instrument measures the insulation resistance value of the measured object and reflects the insulation of the object from another angle.

4.3.3. Detection method
This test needs to disconnect the high-voltage power of the electric bus power battery. When testing, connect the two test terminals of the pressure tester or megohmmeter to the power transmission equipment (or wire) and the body respectively, and judge the insulation between the two terminals based on the readings of the tester or megohmmeter.

5. Summary
The use characteristics of electric buses are important characteristics that characterize the technical status of the vehicle. Selecting representative parameters such as cruising range, energy consumption rate and power transmission and insulation characteristics between vehicles can effectively reflect the working state of the vehicle. The effective evaluation and analysis of vehicles facilitates the timely detection and resolution of problems, so as to ensure and improve the transportation efficiency of electric buses, promote the development of the road transportation industry, and betterly serve the national social and economic development.

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