Analysis of Charging Strategy of Electric Vehicle Battery-bsse on the Operation Mode of Power Exchange

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Abstract. With the increasingly urgent demand for environmental protection, electric vehicle as a non-polluting means of transportation is becoming more and more popular, and has become the focus of research. This paper first analyzes the current demand of electric vehicle for power exchange, then introduces the operating cost of electric vehicle for power station, and finally analyzes and discusses the battery charging strategy in the power station.

Keywords: Charging Strategy, Electric Vehicle Battery, Power Exchange

1. Introduction
With the enhancement of people's awareness of environmental protection, the traditional fossil fuel vehicles are gradually replaced by new energy vehicles due to the pollution problem. As a non-polluting vehicle, electric vehicle has become the focus of research. As one of the core components of electric vehicle[1], battery charging strategy has an important impact on the performance of electric vehicle. Due to the long charging time of electric vehicle battery, which has become the main factor limiting the development of electric vehicle, the mode of changing battery point has become one of the research directions. In the mode of electric vehicle changing[2], the owner of electric vehicle only needs to change the battery in the nearby power station, which can greatly shorten the charging time and facilitate the travel of the owner[3]. Therefore, it is of great practical significance to study the operation mode of electric vehicle switching, including charging cost, storage cost and equipment cost, and find out the optimal strategy of battery charging scheduling.

2. Analysis of electric vehicle power exchange demand
At present, the electric vehicle switching mode is still in the primary stage, so there is no mature switching model, and Monte Carlo method can get the digital characteristics of variables according to the frequency of an event based on random test[4]. Therefore, based on the travel distribution model of the existing vehicles, using the Monte Carlo method, through the simulation of the travel distribution and residual electricity distribution of each electric vehicle, we can get the electric vehicle power change demand model in the statistical cycle[5].
Figure 1. Proportion of private car trips

According to the travel time and proportion of driving of Chinese residents, it is taken as the travel proportion of electric vehicles and distributed evenly, as shown in Figure 1 above. The electric vehicle consumes the most electricity in operation, so it is necessary to establish the model based on its daily driving behavior. In addition, due to the influence of vehicle speed on power consumption, the assumption is made that the running speed of electric vehicle meets the normal distribution, and the vehicle speed is constant in a fixed time unit.

The power exchange service is based on a certain threshold, which is called the power exchange threshold. There are two kinds of thresholds. One is the threshold under the condition of low power, that is, the power exchange demand under the condition of low battery power, which is called the low power threshold. The other is that the battery power is about medium, but in order to increase the trip, the power reserve and exchange demand exists, which is called the reserve threshold. These two scenarios are the most common scenario in the power exchange scenario, so they can be used as the basic basis for the power exchange service.

It can be seen from the definitions of two kinds of switching thresholds that the low power threshold of electric vehicles is generally lower than the reserve threshold. The service time of electric vehicle in daily driving meets the uniform distribution. Based on the operation law of the vehicle, figure 2 below is the time distribution model of electric vehicle power change obtained according to the Monte Carlo method.

Figure 2. Distribution of daily electric vehicle demand
3. Operating cost of electric vehicle for power station
The cost model of electric vehicle switching is shown in Figure 3, and the cost statistics are shown in Table 1 below.

![Figure 3. Cost model of electric vehicle switching](image)

**Table 1. Cost statistics of electric vehicle switching**

| Costs                  | Cost details                                      |
|------------------------|---------------------------------------------------|
| Battery charging       | Electricity price cost and basic electricity price cost |
| Storage battery        | Battery to be used, charging battery and battery to be charged |
| Charging Equipments    | Cost of battery charger for charging               |

4. Battery charging strategy in power station

4.1. Small current equalizing charging method
The charge balance system of the power station is composed of a detection system, a charge control module and a charge balance system. The charge balance system and the vehicle management system communicate with each other, and realize the intelligent control of the charge balance system through the vehicle detection system. Based on the data of each cell collected by the vehicle detection system, the operation state of the charger and small current charge balance is controlled by the parameter setting in the charging stage, and then the charge balance of the battery pack is realized according to the state of the battery.

In the later stage of charging, small current equalization is adopted, and the charging voltage waveform is shown in Figure 4. The battery pack is charged intermittently, so as to shorten the charging time. When the battery is not charged, it will protect the overcharged single battery, so that it has enough time to dissipate heat, and finally achieve the overall balance of the battery pack.
4.2. Optimization of battery charging strategy

Figure 3 shows the operation cost of the battery charging strategy of the power exchange station, and the establishment of the operation cost model of the power exchange station needs to eliminate the influence of two non-linear factors by algorithm. The first factor is the maximum charge quantity of the battery. The maximum charge quantity of the battery is in the period of the lowest electricity price, while the demand for power exchange is less in this period. Therefore, the number of rechargeable batteries in this period will be higher than the number of batteries that need to be replaced, so it only affects the cost of equipment, but not the cost of battery charging and storage. The second factor is the iterative calculation of the storage battery cost. For the cost of battery storage, the way to eliminate the nonlinear factors is to linearize the constraints.

5. Conclusions

Monte Carlo method is used to simulate the characteristics of trip distribution and power exchange demand distribution of electric vehicles in a day, and the power exchange operation cost model is constructed. In addition, the equalization strategy for battery charging in power plants not only achieves high accuracy, but also significantly improves the power utilization efficiency, simplifies the system structure and achieves good equalization effect compared with the traditional voltage equalization strategy. By using the integer linear programming algorithm to optimize the charging strategy, it can significantly reduce the operating cost of the switching station.

Acknowledgement

Research Projects of Science and Technology Program of Hubei Education Department: "Development Problems and Countermeasure Research of Electric Vehicle Battery replacement Switching Mode: Taking Hubei Province as an Example", Project No. B2019249.

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