

Analysis of tunnel lighting energy-saving control system

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Abstract: With the continuous improvement of China's economic level, higher requirements are also placed on the construction level of traffic and road facilities. In the process of road construction, it is often necessary to carry out tunnel construction, but to ensure that the road tunnel has good traffic functions, provide good transportation services for social and economic development and people's daily travel, and do a good job of lighting facilities. Important facilities for tunnel traffic quality and safety. Based on highway tunnels, this paper conducts in-depth analysis on the application of energy-saving operation control technology for on-demand lighting, thus providing reliable suggestions for the construction of highway tunnel lighting facilities, to promote the continuous improvement of the construction level of highway tunnels in China, and effectively promote the development of China's transportation industry.

1. Introduction

Two-thirds of China's area is mountainous, hilly and other mountainous terrain. When constructing highways in these areas, in order to ensure the technical requirements of high-grade highways, tunnels are often needed to cross the mountains, effectively shortening the mileage and ensuring smooth traffic. And convenient, providing more convenient and high-quality traffic road services for social and economic development and people's daily travel. In the process of constructing highway tunnels, in order to effectively ensure the safety and efficient operation of highways, monitoring, communication, ventilation lighting, power distribution and other systems are usually deployed in highway tunnels to effectively ensure the quality and safety of road tunnels. At the same time, however, the application of these facilities will consume a lot of power, which has brought great pressure to the road operation management department. Especially with the further development of China's social economy, the demand for electric energy is increasing, the development speed of electric power construction cannot keep up with the pace of social and economic development, and the shortage of electric power is becoming more and more serious. In this case, the high energy consumption of road tunnels has also brought great pressure on China's power system. Therefore, it is very necessary to adopt energy-saving operation control technology in highway tunnels, especially in the lighting system of highway tunnels, because the proportion of lighting system load in the total load is as high as 30%, and energy-saving operation is adopted in the lighting system. Control technology can effectively save energy, reduce the operational pressure of highway operation management departments, and also play a positive role in promoting the further development of highway tunnels in China.

2. The main method of road tunnel lighting control

2.1 Lighting design requirements

When designing the lighting system of a road tunnel, it is necessary to use the driving visual characteristics of the road tunnel as the basis for the lighting design, and design the actual lighting requirements at different stages of the tunnel separately. When designing the

road tunnel lighting system, the road tunnel can be divided into four parts: the entrance section, the middle section, the transition section and the exit section. These four parts have different actual requirements for lighting. In the lighting design process, it is necessary. Consider this fully. In addition, when designing road tunnel lighting, it is necessary to abide by the requirements of relevant rules and regulations or regulations such as “Highway Tunnel Lighting Design Rules“ and “Highway Tunnel Ventilation Lighting Design Specifications“, and scientifically design to effectively meet the actual lighting needs of highway tunnels. Ensure the safety of road tunnels, and on this basis, effectively save energy and reduce unnecessary energy consumption [1].

2.2 LED stepless dimming control technology

In the highway tunnel lighting system, LED stepless dimming control technology is a method of controlling the brightness of the current source by using voltage. This control method can directly sample the current information and then isolate it to the primary switch of the power source. The duty system performs amplification control and then converts to a DC pulse current. The DC pulse current is filtered by a filter to achieve efficient control of the output current of the power supply. This control method effectively improves the controllability of power supply efficiency. The application of LED light wireless dimming control in highway tunnels, with the advantages of simple control circuit, can realize long-distance information transmission control and effectively ensure the lighting effect in highway tunnels, which ensures the traffic quality and safety in highway tunnels. Very important promotion.

3. Highway tunnel lighting energy-saving operation control technology

The application of lighting energy-saving operation control technology in highway tunnels must be fully integrated with the actual conditions of highway tunnels, not only in combination with objective factors such as different geological conditions and traffic volume parameters of highway tunnels, but also full consideration of different seasons and different weathers. Under the conditions of different time periods, the actual demand of the highway tunnel for lighting, so as to scientific design, effectively reduce unnecessary waste of power energy, and achieve good energy-saving effect [2]. In the design of highway tunnel lighting, it is necessary to fully consider the parameter changes of different objective conditions such as season, weather and time period, so that the lighting system in the tunnel can be changed with the changes of these parameters, so as to ensure the lighting requirements in the tunnel are met. Otherwise, it is likely to cause traffic safety hazards and pose a serious threat to people's lives and property safety. If the lighting conditions of road tunnels are much higher than the actual requirements, it will cause excessive energy consumption and waste a lot of power energy, which is extremely unfavorable for China to build a sustainable society. Therefore, in the lighting design, it is necessary to eliminate the waste of transition.

3.1 Energy-saving control device

The application of energy-saving control device in highway tunnel lighting system is one of the most economical and practical ways to realize energy saving of highway tunnel lighting. Among them, lighting control device is widely used in China.

3.1.1 SCR chopper type lighting energy-saving device

The thyristor chopper type lighting energy-saving device utilizes the principle of thyristor chopping, and controls the thyristor conduction angle of the thyristor to effectively remove a part of the input sinusoidal voltage of the power grid, thereby achieving the purpose of lowering the average value of the voltage. To achieve effective control of the voltage, and ultimately achieve the purpose of power saving. The advantage of this method is that it can quickly and accurately control the voltage of the lighting system, real-time adjustment in

time-division, and voltage regulation, and the device is small in size, light in weight and low in cost.

3.1.2 Self-deflecting buck regulation energy-saving device

The movement of the self-twisting transformer is combined with the taps of different fixed transformers in combination with the voltage level of the transformer to achieve the purpose of reducing the voltage of the grid and achieving the purpose of reducing the voltage. Compared with the thyristor chopper type lighting energy-saving device, the device effectively overcomes the defects of the thyristor chopper type lighting energy-saving device, realizes the sine wave output of the voltage, and is simpler and more reliable in structure and function.

3.2 Intelligent Control Technology

In the road tunnel lighting system, the application of intelligent control technology effectively realizes the energy-saving operation of the road tunnel lighting system. At present, the intelligent control technologies applied to highway tunnel lighting systems mainly include logic switch control methods, fuzzy neural control methods, stepless adjustment control methods, and the like. The main principle of the logic switch control method is to use the different arrangement and combination of the luminaires, combined with the digital signals provided by the field controller, to achieve logic control of the additional illuminators and to increase the additional brightness. The advantage of this method is that the control program and circuit design are relatively simple, and it is easy to repair and maintain. It is also flexible in the choice of lamps. However, the disadvantage is that the continuity is poor, and because the maximum brightness is used in lighting, A lot of power is wasted. The application principle of the fuzzy neural control method is the fuzzy neural network loop dimming control method. The use of this method can solve the problem that the highway tunnel lighting is difficult to establish an accurate mathematical model between the outside brightness, the vehicle speed and the traffic flow. It has an effective solution, and it can save a lot of power while improving lighting comfort. The stepless adjustment control method utilizes a thyristor as a basic control element, and then performs stepless dimming using an electronic controller. The application of this control method can change the illumination system in the road tunnel with the change of the light intensity outside the hole to achieve dynamic balance and achieve a more suitable lighting effect. At the same time, it can extend the life of the lamp, save the investment cost of the electrical equipment, simple control mode, and have a uniform level of illumination in the application state. At the same time, it can effectively avoid the appearance of the nighttime zebra effect, and is a very effective road tunnel illumination. System control mode.

4. Analysis of energy-saving benefits of using energy-saving operation control technology for highway tunnel lighting

In the process of designing the lighting system of the road tunnel, according to the actual lighting demand, the lighting dimming control technology is implemented to achieve the purpose of on-demand lighting, and the energy saving and economy of the tunnel lighting system are effectively realized. For example, in the construction process of the lighting system of the expressway tunnels such as Cistanche, Fengxi and Yanjiang in Chongqing, the principle of on-demand lighting is fully complied with, so that the energy-saving of operation control technology is fully reflected and achieved good results. The energy-saving effect makes the tunnel lighting system meet the practical needs and ensures energy saving and economy.

Taking the lighting system of the Yurong Expressway tunnel as an example, through the application of energy-saving dimming control technology, combined with the bright outside the tunnel and the traffic volume of the road section and the peak characteristics of the traffic flow, effective dimming control is implemented to avoid unnecessary Energy consumption to

achieve energy savings. Through comparative analysis and development, using energy-saving dimming control technology, the system energy consumption in the tunnel is reduced by more than 20% compared with the traditional lighting system, which greatly reduces the consumption of electric energy and effectively realizes the energy-saving effect [3].

5. Conclusion

China is a mountainous country. Many mountainous areas, hills and other landforms lead to the construction of highway projects. In order to meet the traffic requirements and reduce the number of rides, tunnels must be built during the construction of highway projects. Social and economic development and people's daily travel provide high-quality and convenient transportation services. The lighting system is an important part of the construction of highway tunnels, and even has a direct impact on the traffic safety of the tunnel. At the same time, the lighting system is also one of the important systems in the road tunnel that require a large amount of power consumption. Therefore, in the case of ensuring the lighting requirements of highway tunnels and traffic safety, energy-saving design of lighting systems, implementation of energy-saving technologies, and energy-saving effects are of great significance not only for the development of China's transportation industry, but also for promoting China's social economy. Sustainable development also has a positive impact.

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