

Application of Electronic Technology in Green Lighting Circuit

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Abstract

Green lighting circuit plays an extremely important role in restraining the pollution of resources, protecting the environment and reducing the waste of energy. How to achieve energy-saving in the lighting field, and make people achieve the best comfort, is an important issue. This paper summarizes the research status at home and abroad, and introduces several key electronic technologies in green lighting in detail, including electronic ballast, soft switch technology and intelligent lighting system. One of the major breakthroughs in green lighting is the application of high-efficiency electric light sources, among which the rapid development is the technology of LED lamp design. This paper introduces the application of LED lamps in green lighting and the development trend of LED lamps. The effect of LED lamp design technology on green lighting circuit and the measures to improve the quality of LED lamps are described in detail.

Keywords

Green lighting; electronic technology; energy saving measures; LED.

1. Introduction

Since the world experienced three scientific and technological revolutions, the process of industrialization has been developing very fast. High development not only gives us convenience, but also brings some bad effects. These effects indirectly lead to three major global crises: resource crisis, environmental pollution and ecological destruction. Energy is the center of every country's economy, but the earth's energy is not infinite, so we must take the idea and method of energy conservation and environmental protection as the goal, make rational use of the earth's resources, and find a green development path conducive to the environment. Green development is a means to achieve effective, harmonious and sustainable development of economic growth and social progress.

For the vast majority of countries in the world, developing green industry refers to promoting economic restructuring on the basis of non-processing industry emissions, which highlights the concept and connotation of green. Traditional lighting methods are prone to waste electric energy, generate more greenhouse gases, and seriously affect the environmental quality of our country. Therefore, our country's requirements for green lighting circuits have risen to a very important level. Green lighting circuit plays an extremely important role in restraining the pollution of resources, protecting the environment and reducing the waste of energy, so all countries in the world are studying and improving their own green lighting technology. Electronic technology occupies a very important position in the growth of green lighting circuit. The combination of electronic technology and lighting system can improve the utilization rate of resources more effectively, and provide reliable technical support for the practice of low-carbon environmental protection concept of life in China.

In the process of upgrading the structure of power industry in China, there are also problems of lack of power supply and low power efficiency. High power consumption and high power consumption constitute the main factor of low economic efficiency and continuous suppression

of environmental pollution. So we should make use of the current technology to save power resources as much as possible and ease the situation of electricity shortage. At present, green lighting contains great business opportunities. In order to achieve the goal of energy-saving lighting, we not only need to continuously improve the lighting quality, but also use modern science and technology to improve lighting engineering design and improve lighting efficiency.

2. Current Research Situation

In the late nineteenth century, the United States first discovered the problem of insufficient electricity and waste of resources, and began to focus on the development of "green lighting". Similarly, some other countries have found this problem and are committed to this research. The main growth stages of green lighting technology in foreign countries are: studying light sources from basic aspects; developing semiconductor lighting products; and manufacturing various special light sources. American scholars focus their research on solid-state lighting technology, which promotes the development of new lighting technology. The following are the contents of their research.

2.1. Design and Innovation of Light Source

High quality light bulbs and lamps have become the main indicators of green energy-saving lamps. The use of poor quality lamps will cause serious power waste. If the green energy-saving lamp is applied to urban roads, it needs to be combined with other requirements such as lighting, maintenance cost, lighting, ballast cost and so on to determine the effect. In order to improve the utilization rate of electric energy in lighting, efficient light sources must be used. At present, the most commonly used high-efficiency light sources are LED lamps, incandescent lamps and high pressure sodium lamps. LED lamps have the advantages of high efficiency, energy saving, good stability and high luminous flux. Its power saving capability is far higher than that of high pressure sodium lamp, and the price is low, which is the ideal choice for the best lamps and lanterns. Similarly, the use of energy-saving and reasonable automatic knob device structure can also help to maintain the normal voltage, reduce the occurrence of lamp damage, and improve power generation in a shorter period of time.

By analyzing the performance data of LED, the Department of energy made bold predictions based on the data. Within three years, the efficiency of LED lamps will continue to improve, reaching a level of about 1701 m/W, or even 2021 m/W. Therefore, LED products will probably replace all lamps in the next few years for their excellent performance. In LED lighting special lighting, Japan has considerable research and attainments. For example, they were able to take the lead in discovering the problems in traffic lighting and offering remedial measures, which enabled Japanese companies to gain more than 50% of the market share. Japan is not satisfied with the use of LED lights only for indoor lighting, so they expand the use of LED lights to outdoor lighting, such as car lighting and other fields. Light source fineness, brightness, small loss LED lighting technology has been widely used in human comfort, frontier medicine and other fields. Japanese companies have found a new type of white LED semiconductor light-emitting materials, which can not only imitate natural light to light body, but also create deep ultraviolet light-emitting diodes. The research and development of new technologies in the field of communication function will make greater breakthroughs and apply LED lights to broader fields.

2.2. Modeling Design

At present, in the form design aspect, we usually use the "3R" principle as the standard to realize the greening of product design. In the design of products, we should not only pursue technical indicators such as quality and power consumption, but also take into account the environment that the products can be used, and the ability to resist environmental interference, such as high

temperature, cold, whether rainwater will cause short circuit and so on. Ultimately, the goal of protecting the environment, reducing pollution, making lamps reusable and saving resources by a large margin is realized. In the overall design of lighting products, we should fully consider the size of lighting products, the size of lighting area and the scope of use of lighting products. In order to simplify the installation and the fastest speed, the overall product design in the form of disassembly combination can be closer to daily life. The shell color and indicator color design of lighting products can satisfy the following points: according to different environments, such as cloudy or dark, products can detect and produce different color light sources. We should consider the hidden dangers of color indicators, the problems in the annotation, and so on. The material of lighting products mainly depends on the use environment of lighting products. Not only should the material be resistant to high temperature, but also the durability and corrosion resistance of the product should be considered.

2.3. Current Limitation

The main problems in the design of green lighting products include:

- (1) The design of green energy-saving products mainly involves energy consumption, adding new technologies and reducing occupancy volume, ignoring the improvement of aesthetic appearance and material quality, and whether users' privacy will be disclosed. Product characteristics should be from the user's point of view, to produce products that satisfy users, and the selection of good materials can optimize the performance of products, make the lighting effect reach the best level, optimize the saving of resources and protect the environment.
- (2) After analyzing the life of green lighting products, it is found that the overall reliability of products, whether there are safety risks, and the use time of products cannot be well estimated at the current level. It is also necessary to strengthen the analysis and prediction of product life.
- (3) Green lighting technology has not been applied to public transport lighting, that is, most of the lights in highway, railway and other transportation systems have not yet adopted green lighting technology, which wastes a lot of resources.
- (4) The research on LED lamp, semiconductor light-emitting material, natural light-imitating body, deep ultraviolet LED lamp and LED lamp with communication function still needs to be carried out.

3. Key Technologies in Green Lighting

3.1. Application of High Frequency Electronic Ballast in Green Lighting Circuit

The electronic ballast is an electronic device that uses electronic technology to drive the light source to illuminate. In addition, inductive ballasts are also available. Most of the modern fluorescent lamps are embedded in electronic ballasts, because they are portable and even can be embedded in both electronic ballasts and tubes. Electronic ballasts can combine starter functions and improve or reduce flicker of fluorescent lamps by changing current frequency or current waveform (e.g. square wave). Traditional induction rectifiers are being replaced by electronic ballasts.

The application of electronic ballast in improving lighting system can quickly improve energy efficiency and quality, which is recommended by most engineers, and has been widely used. The recommendations are as follows:

- (1) Three color fluorescent lamps can be used instead of incandescent or halide lamps to improve energy utilization.
- (2) High-quality and low-harmonic products should be selected as far as possible. When choosing products, we should not only consider the low price, but also take into account the technical requirements and make a comprehensive comparison.

(3) For the fluorescent lamps less than 25W, the harmonic limit specified in GB.1-2003 is very extensive. If a large number of buildings are used, it will cause various adverse consequences. The corresponding remedy plan should be designed.

(4) The selected product should not only consider its total input power, but also consider its output luminous flux. According to regulations, the lumen coefficient of ballast should not be less than 0.95. The European Union stipulated lumen coefficient of more than 0.96.

3.2. The Role of Lamps and Lanterns in Promoting Green Lighting

3.2.1. Compact Fluorescent Lamp

From the current situation, compact fluorescent lamps in China are widely used in the form of D and U. Compact fluorescent lamps are widely used for their high efficiency and high quality. Compared with traditional incandescent bulbs, compact fluorescent bulbs can save a lot of electricity charges. According to the actual research, the cost of compact fluorescent bulb is about 30% of the traditional incandescent bulb, the service life is about 9 times of the incandescent bulb, and the energy efficiency is two or three times higher than that of the incandescent bulb. Thus traditional incandescent bulbs have gradually been replaced by compact fluorescent lamps.

3.2.2. Halide Lamp

Metal halide lamp mainly relies on metal halide as luminescent material. Metal halide exists in the lamp in solid form. Therefore, there must be a small amount of hydrogen or xenon in the lamp to ignite the bulb. After the lamp is ignited, it first works in the low pressure arc discharge state. At this time, the voltage of the two poles of the lamp is very low, about 18-20V, and the light output is very little. At this time, the main reason is heat energy, which makes the whole body heated. The metal halide introduced into the lamp evaporates continuously with temperature and becomes metal halide vapor. Under the action of thermal convection, some metal halides are decomposed into metal atoms and halogen atoms by arc at 5500-6000K. Under the action of electric field, metal atoms are stimulated to emit light, the other part of metal halides are not decomposed by arc high temperature. Under high temperature and electric field, molecular luminescence is directly excited.

Due to the different evaporation temperatures of various metal halides, these particles evaporate one after another to participate in the luminescence, so there are different atomic spectra. With the increase of temperature, the density of metal atoms in arc increases gradually, resonance absorption occurs, and the characteristic spectrum of atoms decreases gradually until it disappears, and expands to the long band. As the lamp temperature further increases and the heat balance is established, all metal halides evaporate, the molecular spectra appear, and the light color and brightness tend to be stable. The gas pressure in the lamp can reach tens of atmospheric pressure. The arc in the lamp changes from low-voltage arc discharge to high-voltage arc discharge. The voltage at both ends of the lamp rises from 18 to 20 V and gradually stabilizes to about 100 V, thus entering the normal light-emitting state. Metal halide lamp is a new type of light source with high performance and low cost. Its superior performance makes it suitable for almost all occasions, which greatly promotes energy saving, emission reduction and environmental protection. In recent years, the vigorous development of metal halide lamp represents the development trend of new technology of electric lamp, which meets the world's demand for energy-saving products.

3.2.3. LED Lamp

Compared with the luminous effect of traditional light sources, the LED light source is a low-voltage microelectronic product. It successfully integrates computer technology, network communication technology, image processing technology and embedded control technology. The size of the chip used in traditional LED lamps is 0.25mm*0.25mm, while the size of the LED used for lighting is generally more than 1.0mm*1.0mm. Innovations in LED packaging design

include high conductivity metal block substrates, flip chip design and bare disc casting lead frames. These methods can be used to design devices with high power and low thermal resistance, and the illumination of these devices is greater than that of traditional LED products. A typical high-light-flux LED device can generate several lumens to tens of lumens. The updated design can integrate more LEDs in one device, or install multiple devices in a single assembly, so that the output lumens are equivalent to small incandescent lamps. For example, a high-power 12-chip monochrome LED device can output 200 LM of light energy, which consumes power between 10 and 15W. The application of LED light source is very flexible, and can be made into light, short and small products of dots, lines and surfaces. The control of LED is very simple. As long as the current is adjusted, the light can be dimmed at will, and the combination of different light colors can change many ends. The use of timing control circuit can achieve a variety of dynamic changes. LED has been widely used in various lighting devices, such as battery-powered flash, micro-voice control light, safety lighting, outdoor road and indoor staircase lighting, as well as building and label continuous lighting.

The emergence of white LED is a substantial step forward from the identification function to the lighting function of LED. White LED is the closest to sunlight, which can better reflect the true color of irradiated objects. So from a technical point of view, white LED is undoubtedly the most advanced technology of LED. White LED has begun to enter some application areas, emergency lights, flashlights and other products have come out one after another. But because of the high price, it is difficult to popularize. The premise of popularization of white LED is price reduction, and price reduction must be possible only after white LED has formed a certain market scale. The integration of the two depends on technological progress ultimately.

With the development of material science, the performance of LED has gradually improved. Because of the wide application of GaN LED in solid-state lighting and display, it is of great significance and practical value to study the luminous efficiency of traditional GaN LED chips. Compared with common GaN LEDs, ITO surface has nano-coarsening structure, micro-pore/nano-composite coarsening structure and micro-column. The output optical power of nanocomposite roughened GaN LED chips increased by 11.3%, 15.8% and 17.9% respectively, and the output efficiency increased by 8.8%, 13.1% and 13.5% respectively, and the performance of the chips was not affected by this. For another new type of LED material, quaternary AlGaInP semiconductor material has direct broadband gap, and its luminous band can cover visible bands from red to yellow. Therefore, the high brightness of AlGaInP semiconductor material has been widely studied and applied to the preparation of various optoelectronic devices. With the further study of epitaxy growth process and material structure, the luminescence intensity of the material is further improved.

3.3. Application of Soft Switching Technology

Soft switching technology refers to adding resonant electronic components such as inductance and capacitance on the original basis, and forming resonance phenomenon through auxiliary converter network. Before switching on or off, the current will be reduced to zero, eliminating the overlap of current and reducing the influence of current rate. Soft-switching technology controls electromagnetic interference conditions, improves product safety performance, reduces the volume and weight of electronic ballasts, thus greatly reducing or even eliminating losses and switching noise.

The soft switch mainly includes two aspects, one is the soft opening, and the other two is the soft turn off. During operation, voltage is usually reduced to zero and current is raised to normal value, which is an ideal soft-start process. The ideal soft-switching technology does not produce switching loss and switching noise, and meets the requirements of low-carbon, energy-saving and environmental protection. At present, soft-switching technology is mainly used in low-power switching power supply.

Due to the working environment, equipment capacity and reliability, soft switching technology is rarely used in high power, especially in welding power supply. However, this does not mean that soft-switching technology cannot be combined with high-power power supply to achieve high-power supply. On the contrary, the development direction of welding power source in the future is to apply inverter welding power to soft switching technology.

3.4. Application of Intelligent Lighting Control System

With the rapid improvement of people's material, cultural and spiritual living standards, intelligent building automation system (Ba) is more and more widely used in intelligent buildings. Green lighting control system can not only meet the requirements of different lighting effects, but also improve the working environment, improve work efficiency, reduce the impact of grid voltage and surge voltage on lamps, and reduce the operation and maintenance costs of lamps. The system will automatically set up according to the lighting of each area, and change the programming of the lighting area to adapt to various occasions. The existing intelligent lighting control system has become an important part of intelligent office building design.

Intelligent lighting system is mainly composed of mobile lighting module, switch module, control panel, LCD touch screen, intelligent sensor, PC interface, time management module, handheld programmer, monitoring computer and so on.

Today's energy-saving lighting technology has made great progress and development. Intelligent lighting is developing towards the direction of industrial informatization, which basically embodies the concept of green energy and permeates the concept of energy saving. Therefore, with the development of society and the change of residents' consumption concept, the development of lighting technology is also developing. Based on the current development trend, intelligent lighting technology still has potential in practice, and intelligent lighting technology will be further applied and popularized in the market.

4. Conclusion

This paper introduces several key electronic technologies of green lighting, and expounds in detail the influence of the development of lamps on green lighting. The implementation measures of green lighting are prospected.

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