Research on Energy Saving Measures of Residential District Lighting System

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Abstract: In today's world, energy issues are a key issue related to national security and sovereignty issues. All walks of life are making suggestions and actively practicing energy conservation. As a major energy construction industry, designing an energy-saving lighting system in the construction of residential communities is very meaningful for energy conservation. This paper believes that when designing residential district lighting energy-saving systems, there are many types of lamps to be considered, such as the lack of natural light, safety issues and different time requirements for lighting in some areas. The countermeasures adopted are clear. In this case, the lighting requirements and the different lighting areas are designed, and intelligent switches and LED lights are installed. Through the energy-saving design of the lighting system, the effect of optimizing the lighting control and effectively utilizing the natural light is achieved in effect. This system not only has an effect on the lighting skills of residential areas, but also has reference significance for the design and optimization of lighting systems that are common in life.

1. Introduction

Energy is an important indicator to measure a country's overall national strength. As a national policy to maintain long-term stable and sustainable use of energy resources, it is an important strategic task for governments around the world. China needs to adopt a utilization method with high technology content, low energy consumption and low environmental pollution to achieve an energy-saving development model. Residential district lighting is often neglected because of its small individual size, which is neglected by its huge comprehensive energy consumption, thus neglecting the comprehensive planning of the residential community lighting system. Lighting energy conservation is microscopically one of the core components of building energy efficiency. Lighting energy conservation mainly includes optimization of illumination source, design of illumination distribution and control of illumination time to maximize the effective utilization of illumination.

2. Residential lighting system problems

2.1 Some areas have no natural light source

Residents are a complex place, and each site has different requirements for care, especially for lighting time and intensity. According to the requirements of natural light, residential areas are mainly divided into indoor and outdoor areas. The natural light mentioned in this paper does not include the direct light emitted by a general artificial light source, but only includes all possible vibration directions of the direction perpendicular to the direction of propagation of the light wave, and does not exhibit a natural light source of polarization. The use of natural light is very useful for energy saving in the light source of a cell.
2.2 Different lighting needs at different times
In addition to the different requirements for natural light, the lighting system of residential areas should have different designs for lighting requirements at different times. Due to its own particularity, the residential area's demand for the light itself varies from indoor to outdoor. Because the community is more responsible for living and function, people are more immersed in their own private space. Therefore, whether day or night, outdoor lighting can be turned on in someone's dark time; indoor lighting is different, giving natural people control, making them ready for use, time can't be controlled, only from the light source hardware used.

2.3 The number and variety of lamps
A real problem is that the number of buildings in residential areas is very large, and the number and variety of lamps are followed.

| Lamp type/style                  | Open type | Protective cover | Grille |
|----------------------------------|-----------|-----------------|--------|
| Straight tubular fluorescent lamp| 75%       | 70%             | 65%    |
| Compact fluorescent lamp         | 55%       | 50%             | 45%    |
| Low power metal halide lamp       | 60%       | 55%             | 50%    |
| High-intensity discharge lamp     | 75%       | 60%             | 60%    |
| LED downlight                     | \         | 55%             | 60%    |
| LED flat light                    | \         | 70%             | 75%    |

Fig.1 Efficiency comparison of lighting fixtures

Listed above are the types of lamps and their powers commonly found in residential lighting systems. Through the investigation of the chart, this paper believes that when selecting lighting fixtures, we should focus on the research of light-emitting diode-diode flat lamps and straight-tube fluorescent lamps. Based on the perspective of energy saving, these two types of lamps should be applied with emphasis.

When selecting the lighting fixtures of residential areas, special consideration should be given to the use of lamps with appropriate protective measures in particularly humid places; in outdoor locations, lamps with a degree of protection not less than IP54 should be used.

2.4 Lighting system pays more attention to safety
Compared with other large lighting systems that use the same amount of electricity, such as factory lighting systems, subway lighting systems, etc., residential lighting systems pay more attention to safety issues. In residential areas, security issues are mainly classified into security for severe weather and safety for children in the elderly. For the safety of bad weather, there are mainly disaster-resisting and emergency response capabilities in the face of typhoons and other weather conditions. When the weather is bad, you must be able to survive. If you can’t hold it, you need to have a contingency plan, even how to recover quickly. It should also be the design of the lighting system. Part that should be considered. For children's safety issues, residential lighting should be more important than other lighting systems, because the community itself is a major scenario for raising children. The current mainstream method is to use electricity from children at power locations to avoid it.

3. METHODOLOGY

3.1 About lighting specifications
An important criterion for measuring energy efficiency when designing residential lighting systems is luminous flux. The expression of luminous flux is as follows:
\[
H = K_m \int_0^\infty \frac{d\phi(\lambda)}{d\lambda} V(\lambda) d\lambda
\]

In the formula, \(V(\lambda)\) — spectral light (visual) efficiency; \(K_m\) — the maximum value of the spectral (visual) performance of radiation, in lumens per watt (lm/W). In the case of monochromatic radiation, the \(K_m\) value under bright visual conditions is 683 lm/W (at \(\lambda = 555\) nm). The luminous intensity of the illuminant in a given direction is the quotient obtained by dividing the luminous flux of the illuminant in the solid angle of the direction by the solid angle, that is, the luminous flux per unit solid angle. The illumination intensity in any scene can meet this minimum standard, because we design a global consideration, and our goal is based on energy saving perspective. Therefore, our main idea is to meet the minimum light intensity of energy saving under the premise of practicality, but does not interfere with the adjustment of the user. Based on this idea, we design a lot of energy-saving facilities in the public area when designing, and use various gradients in the light energy of the personal area.

### 3.2 Regionally differentiated strategy

As mentioned above, there are many factors to consider when designing residential lighting energy-saving systems. For the sake of simple division, we mainly divide them into commercial and civilian systems. Under this classification, we will make a comprehensive consideration of various factors.

| Room or place         | Illumination standard value (lx) | Lighting power density limit (W/m²) |
|-----------------------|----------------------------------|-----------------------------------|
|                       | Current value                    | Target value                      |
| living room           | 100                              | <6.0                              | <5.0                              |
| bedroom               | 75                               |                                   |                                   |
| restaurant            | 150                              |                                   |                                   |
| kitchen               | 100                              |                                   |                                   |
| bathroom              | 100                              |                                   |                                   |
| staff dormitory       | 100                              | <4.0                              | <3.5                              |
| garage                | 30                               | <2.0                              | <1.8                              |

Fig.2 Civil area lighting power regulations

The civil area is mainly divided into living room, bedroom, dining room, kitchen, bathroom and garage. We see that in the civilian area, the main area for electricity use is the restaurant, and the area with less electricity is the garage and bedroom. In this scenario, our design will give users more freedom.

| Room or place          | Illumination standard value (lx) | Lighting power density limit (W/m²) |
|------------------------|----------------------------------|-----------------------------------|
|                        | Current value                    | Target value                      |
| Ordinary office        | 300                              | <9.0                              | <8.0                              |
| High-end office        | 500                              | <15.0                             | <13.5                             |
| meeting room           | 300                              | <11.0                             | <8.0                              |
| Business lobby         | 300                              | <9.0                              | <10.0                             |

Fig.3 Office area lighting power regulations

The office area is mainly divided into ordinary office, high-end office, conference room and service hall. Through the standard value of illumination, we can clearly feel that the lighting requirements of the office area are much higher than the civilian area. The office area in the residential area is a large area, not only the commercial buildings around the community, but also the area directly used as the office area. These are all organic components of residential communities. Under the national laws, regulations and policies on the free use of construction land, we need to consider this factor in design. Among them, the highest demand for office space is the type of high-end office. In addition to energy saving in the design of the lighting system, we can also regularly carry out energy-saving electricity education in the form of special circumstances such as high-end office electricity.
3.3 Install smart switch
Due to the complexity of the system, the installation of intelligent switches is very important for energy conservation. In different areas, the use time and duration of the lamps are different. When not in use, the light is turned off during natural light intensity, which is required for our intelligent lighting. Specifically, take the regional garage that every residential community now has as an example. Because most of the domestic garages are built underground or semi-underground, the garage is a relatively dark environment. We first need to determine if someone is parking, when someone turns on the lights, and when no one is off. Garage monitoring is as much as possible through infrared monitoring instead of light recording. In the daytime, our lighting system needs to be turned on, but it doesn't need strong light, try to use natural light; at night, there is no natural light night, the light intensity needs to be wide, for safety reasons, no one wants to leave safely, can give the user remote control switch settings.

3.4 Using LED lights
Through research, we found that LED lights are a very energy-efficient luminaire, and they have a variety of products of various types of brightness to choose from. The LED lamp is generally composed of a light-emitting semiconductor material, which is cured with silver or white glue onto the micro-bracket, and then connected to the chip and the circuit board with metal, and then sealed with epoxy resin. In life, light-emitting diodes are commonly used as semiconductor materials. It is a solid-state semiconductor device capable of converting electrical energy into visible light, which can directly convert electricity into light. This conversion is very efficient and dominates the market. The LED is basically a small chip that is encapsulated in epoxy, so it is very small and very light. Low power consumption. LED power consumption is very low, generally the operating voltage of the LED is 2-3.6V. The operating current is 0.02-0.03A. That is to say: it consumes no more than 0.1W. Long service life, LED life can reach 100,000 hours at the right current and voltage. High brightness, low heat, LED technology is advancing with each passing day, its luminous efficiency is making amazing breakthroughs, and prices are constantly decreasing. Environmentally friendly, LEDs are made of non-toxic materials, unlike mercury-containing fluorescent lamps that can cause pollution, and LEDs can be recycled. Rugged and durable, the LED is completely encapsulated in epoxy, which is stronger than bulbs and fluorescent tubes. There are no loose parts in the lamp body. These features make the LEDs hard to damage.

4. Evaluation

4.1 Optimize lighting control
Through the design of energy-saving systems, one of the key areas of our work is the optimization of various control systems for lighting systems. Among them, the switching system is typical, and the power consumption of the cell is controlled by intelligently adjusting the switching time and illumination intensity of the entire lighting system. Among them, the switching system is typical, and the power consumption of the cell is controlled by intelligently adjusting the switching time and illumination intensity of the entire lighting system. Take the high-end office we used in the previous section as an example. We optimize the control of lighting by optimizing the switch, strength and hardware to achieve energy savings. During the period of non-use, because the high-end office not only has the function of lighting, but also has the function of corporate image display, it cannot be completely closed. So we set up a low-power, color-changing LED light that illuminates it according to the needs of different scenes when no one is there. When used, its main purpose is to be magnificent, limited in hardware optimization, but can optimize the stability of the current. Irregular current changes cause unstable power consumption, which will cause a large amount of power consumption of the transformer. We will save this part of electricity by adding a device that stabilizes the current.
4.2 Effective use of natural light sources
In the application process of the system, an energy-saving measure that the system focuses on is to make full use of natural light. In addition to fully energy-efficient use of electrical energy, the use of electrical energy or less energy is also an effective way to save energy. However, in this case, the requirements for illumination control cannot be lost, so the best way to make up is to supplement it with natural light. This requires us to add an electro-less lighting system to the lighting system, which is both energy efficient and safe to use. By using PC material, it absorbs natural light efficiently, and then introduces a light pipe responsible for light distance transmission. The light pipe reflects the light, and finally the diffuser produced by the special process at the bottom of the system transmits the natural light according to the requirements. The way is released to the area that needs to be illuminated. The use of natural light is not limited by hardware conditions when the illumination intensity is appropriate. With the development of technology, more and more photosensitive materials have been developed, and the cost and convenience of cost-effectiveness will be greatly improved in the process of use. By effectively utilizing natural light, the use of energy can be significantly reduced.

5. Conclusion
Energy is a key concern of all countries in the world. There are two concerns about energy performance. One is to increase mining and purchasing power, and the other is to save money. The effective use of energy is reflected in all aspects of social life, of which lighting systems that make up the majority of social energy use are among them. In this paper, the representative representative of the lighting system, residential district lighting as an example, by identifying the problems, looking for energy-saving measures and designing a feasible energy-saving lighting system. The system has a significant role in optimizing energy control measures and utilizing natural light. The system can be applied not only to residential district lighting, but also to the feasibility and reference significance in other scenarios.

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