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Using solar optical fibers for public buildings illumination in the South Urals

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Abstract

The article shows the problem of energy shortage and justifies the necessity of energy-saving activities to be applied in the lighting of buildings. The analysis of solar radiation throughout the year and the length of daylight availability in Chelyabinsk region is made. Based on the analysis of designs and technical characteristics of solar optical fibers their use in newly constructed buildings and social facilities is justified, disclosing the terms of using solar optical fibers in the Urals conditions. The data on the changes of the natural lighting in the room, depending on the time of the day, cloudiness, and the location of the buildings to the cardinal points is produced, the expediency of the combined lighting systems "solar optical fiber+ light-emitting diode" application, which will significantly reduce the lighting costs, is illustrated.

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Keywords: energy efficiency, solar optical fibers, illumination (lighting), solar radiation, light-emitting diodes.

1. Introduction

The priority trend of social and economic development of the Chelyabinsk region is the development of medicine, education, sports, culture and arts, which leads to the construction of major sports complexes, swimming pools, schools, kindergartens, medical centers, clinics, exhibition centers, museums and other public buildings.

Modern buildings have not only an interesting design, but also provide maximum comfort for guests: well-chosen lighting, ventilation and air conditioning, heating systems - resulting in an overall increase in electricity consumption in the region. But Chelyabinsk region already experiencing energy shortages (South Ural power plants

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can provide electricity demand is only 80%). [1]. In addition, the annual growth of tariffs for energy in the region is about 4%. [2]. All of the above makes think seriously about energy efficiency. Since the share of energy consumption for lighting in public buildings is 30-50%, the introduction of energy-saving-measures in these systems is especially important.

2. Rationale for the use of solar optical fibers

2.1. Traditional light sources

The traditional methods of energy efficiency increasing of lighting systems include:

- Replacement of artificial light sources others with greater light output and lower power consumption (for example, replacing incandescent lumps with fluorescent and fluorescent with light-emitting diode);
- Light flow of artificial light sources control using a variety of dimmers, light sensors, motion sensors and etc.

Energy-saving light sources, in addition to high luminous efficiency, low power consumption, long life time, has a number of disadvantages:

- Pulsing the light flux;
- Ultraviolet radiation;
- The presence of mercury in gas discharge lamps;
- The poor quality of some of the manufacturers of lamps.

All this leads to deterioration in health and limitation of the use of these light sources in public buildings, especially in children and medical institutions.

An alternative source is the use of natural light by using the solar optical fibers.

2.2. Solar optical fibers

Solar optical fiber is the light conducting device transmitting light at a distance by multiple reflections within the hollow structure having a reflective surface.

Advantage of solar fibers is that they can:

- To replace the source of artificial lighting during daylight hours;
- To reduce the heat inflow from the artificial lighting and thus the cost and power of conditioning equipment and operating costs;
- To receive the full spectrum of lighting (for the transmission of the completeness of colors of the interior space, as well as increasing operability and reduce fatigability, which causes the artificial light sources);
- To increase the level of comfort in the buildings;
- To include in the system a source of artificial lighting (for the dark time of day), adjust the brightness of the transmitted light or turn it off completely [3,4,5].

Thus, the installation of solar optical fibers in public buildings will not only reduce energy costs but also reduce the harmful effects of artificial lighting sources on human health.

2.3. Goals and objectives of the study

Objective: to investigate the possibility of using solar optical fibers in public buildings in the South Urals.

The research problem:

Evaluate the effectiveness of the use of solar optical fibers with regard to:

- Climatic features of South Urals;
- The amount of solar radiation reaching the surface, for different areas of the Chelyabinsk region;
- Lighting of buildings;
- Design features of optical fibers.

3. The climatic characteristics of the Chelyabinsk region

The climate in Chelyabinsk region is continental, which is determined by the position of the territory on the mainland. The main features of the climate are the long cold winter with frequent snowstorms, dry and hot summers with droughty periods.