EVALUATION OF COMPETITION AND DEVELOPMENT FOR LED ROADWAY LIGHTING

Horng-Ching Hsiao, Chih-Hung Chang, Neng-Chung Hu, Tsai-Hsiang Chen, Yuan-Bin Liu, Kuan-hsien Liu and Chun-Yu Hsiao

Department of Electrical Engineering,
National Taiwan University of Science and Technology

High performance lighting engineering design has being the most concern and interest topic due to energy saving and green house considerations nowadays. The light emitted diode, LED, is a choice of newer, energy saving light sources for higher luminous quality, and being the focus of the world. Recently, applying LED to roadway lighting design is the hottest object based on the energy saving and practical luminous performances reasons. However, there are four key technical problems must to be solved to realize a efficient lighting fixture: (1)higher luminous efficacy for the chip die, (2)loss reducing of the driving circuit, (3)heat dissipation solution, and (4)higher luminous distribution design for the fixture.

Today, the luminous efficacy of the commercial LED is in the level 80 lm/W approximately, only 35 % of the total energy consumption based on the theoretical limit of the luminous efficacy of LED, while 65 % of the energy becomes the worst problem, heat flow hazard. Consequently, one has to solve the heat by suing heavy and costly metal material to avoid heat influence on LED lifetime when LED fixtures were designed to substituted conventional high pole roadway lighting sources. But the recycling of the numerous heat conduction metal materials will be the worst impact to the environment which was ignored for long time. The best solution for the heat manipulation is waiting for a higher luminous efficacy LED chip which will comes to be true in 2012-2015 with a noticeable level of 150 lm/W, while only less than 40 % of the total energy, cheaper and easier to designed, has being transfer to heat. Thus, the main focus will be the optimal design among illumination, luminance, color rendering and luminous distribution of the luminaires for LED applications, both in interior or exterior, and being the major concern during economic and competition evaluation for various light sources.

The paper is devoted to study the characteristics and vision responses of roadway lighting for different illuminants. According the roadway lighting design criterions and the relative codes, the quality evaluation model of roadway lighting quality was established based on series of individual performance index functions according to the lighting parameters, such as illumination, luminance and energy consumed. An evaluating algorithm for road way lighting performance has been proposed to quantitative evaluate the quality of roadway lighting engineering based on the individual performance index. In addition, the commercial software DIALux was used to simulate and design a better roadway lighting planning through optimization and economic theoretical techniques for various light sources, including mercury lamps, high pressure sodium lamps, ceramic metal halide lamps and LED. The test exampling roads/streets in Taipei city, Taiwan, are selected to certify the evaluation model. The economic benefits and lifecycle of different alternatives are also included during the evaluation process.

The results show that the ceramic metal halide lamps will be the most suitable light sources for roadway lighting today based on the lighting effectiveness and human vision needs, even the mesopic vision effect and theory be included during evaluating. However, LED will be an alternative, suitable for street lights with pole height less than 8-meter and power consumption less than 150 W. A better and practical roadway lighting alternative is proposed which composed by the combination of LED lighting with light poles less than 8-meter for street walker and LED indicating lines along the road. Finally, the research results provide the applicability of roadway lighting with respect to various illuminants and the luminous performance index of roadway lighting quality evaluation.

Keywords : roadway lighting, luminous distribution, color rendering index, LED.

Corresponding addressing author: hchsiao@mail.ntust.edu.tw