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Thermal Management of Ground Heat Exchangers Applied in High Power LED

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Abstract : The p-n junction temperature of LEDs directly influences their operating life and luminous efficiency. An excessively high p-n junction temperature minimizes the output flux of LEDs, decreasing their brightness and influencing the photon wavelength; consequently, the operating life of LEDs decreases and their luminous output changes. The maximum limit of the p-n junction temperature of LEDs is approximately 120 °C. The purpose of this research was to devise an approach for dissipating heat generated in a confined space when LEDs operate at low temperatures to reduce light decay. The cooling mode of existing commercial LED lights can be divided into natural- and forced convection cooling. In natural convection cooling, the volume of LED encapsulants must be increased by adding more fins to increase the cooling area. However, this causes difficulties in achieving efficient LED lighting at high power. Compared with forced convection cooling, heat transfer through water convection is associated with a higher heat transfer coefficient per unit area; therefore, we dissipated heat by using a closed loop water cooling system. Nevertheless, cooling water exposed to air can be easily influenced by environmental factors. Thus, we incorporated a ground heat exchanger into the water cooling system to minimize the influence of air on cooling water and then observed the relationship between the amounts of heat dissipated through the ground and LED efficiency.

Keywords : helical ground heat exchanger, high power LED, ground source cooling system, heat dissipation
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