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Thermal Analysis Of Heat Sink

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Abstract

The main reason to undertake this project was to highlight the application of Mechanical Engineering sciences in other engineering branches primarily electrical and electronics. A 65W led street lamp having model was acquired from a leading electronics manufacturing company Optronics LED. The model was first inspected and then the dimensions were measured accurately using Vernier Callipers and the heat sink was found to be approximately of rectangular cross section. In the experimental setup the LED model was given power supply and was run for 2 Hours using thermo couples temperatures were measured at various distances along the heat sink the source temperature and ambient temperature was found to be constant after sometime. The results were recorded. Using the experimental results calculations were done to find the Reynolds number which led to the conclusion that the flow is laminar using the Nusselt number relation the convective heat transfer coefficient was obtained by assuming appropriate boundary conditions and Murray and Gardner assumptions. The value was used throughout the analysis. Further calculations were done to obtain thermal performance parameters. The thermal performance parameters were calculated and the models were created to perform Thermal analysis. LED lamps being a trending topic more and more research is being done in this area.

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Keywords: Heat Sink, Thermo Couples, Convective heat transfer coefficient, Laminar, Nusselt Number, Reynolds Number.

1. Introduction

Heat is produced within the LED device itself, due to the inefficiency of the semiconductor processes that generate light. The wall-plug efficiency (optical power out divided by electrical power input) of LED packages is typically in the region of 5-40%, meaning that somewhere between 60 and 95% of the input power is lost as heat. LEDs don't tend to fail catastrophic; instead, the output of the LED decreases over time. Note that this also happens for other light sources. Driving LEDs above their rated peak current causes the junction temperature to rise to levels where permanent damage may occur.

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The street light was installed in a vertical position by rigidly supporting from both sides by concrete that acts as an insulating material. The street lamp was exposed to air from both sides to emulate actual working conditions when it is installed on an electric pole. The connections were made keeping in mind the voltage supply. The digital readout temperature indicator (K type) was checked for line and neutral before making the connection to avoid a fuse blow. A thermocouple was connected to the digital readout and ambient temperature noted to verify the positive and negative side. Once confirmed, all eight thermocouples were attached to the readout and the probes were connected to the street lamp using thermal paste to avoid conduction losses. One thermocouple was exposed to the atmosphere to record ambient temperature.

Six thermocouples were attached on the fin surface at different points covering the maximum possible surface area and extremities as well to get a better range of values. The front glass panel was removed by unfastening the screws and a thermocouple was fixed on the LED surface with thermal paste. The panel was then fixed back to complete the setup. On conducting the experiment it was found out that the LED surface heated upto 84°C and the LED Board temperature was around 60°C. The LED board was fastened on the (Street Lamp) heat sink base using thermal grease to increase thermal conductivity and act as an adhesive. Because of this, the temperature between the LED Panel and Heat Sink dropped to 50°C this was considered as the source temperature in the analysis. The temperature was found out to be 30°C and was thus used throughout the project.

The most important input for the analysis was the value of heat transfer coefficient *h*. This value was calculated using the following Nusselt number approach as shown in below Fig 1 Fig 2 and fig 3.

2. Experimentation

The street light was installed in a vertical position by rigidly supporting from both sides by concrete that acts as an insulating material. The street lamp was exposed to air from both sides to emulate actual working conditions when it is installed on an electric pole. The connections were made keeping in mind the voltage supply. The digital readout temperature indicator (K type) was checked for line and neutral before making the connection to avoid a fuse blow. A thermocouple was connected to the digital readout and ambient temperature noted to verify the positive and negative side. Once confirmed, all eight thermocouples were attached to the readout and the probes were connected to the street lamp using thermal paste to avoid conduction losses. One thermocouple was exposed to the atmosphere to record ambient temperature. Six thermocouples were attached on the fin surface at different points covering the maximum possible surface area and extremities as well to get a better range of values. The front glass panel was removed by unfastening the screws and a thermocouple was fixed on the LED surface with thermal paste.The panel was then fixed back to complete the setup. The LED was switched on and initial temperatures were noted. Afterwards, the temperatures were noted again in intervals of 5 minutes till stagnation condition was reached. This concluded the experiment.

Fig.1: Thermal Couples connected at various places across the heat sink