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THERMAL ANALYSIS OF HIGH POWER LED PACKAGE WITH PERFORATION ON THE FIN BASE

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***Abstract*— Effective cooling is very important issue in a light emitting diode (LED) module because its performance and reliability decrease significantly as the junction temperature increases. The goal of this study is to improve the thermal characteristics of high power LED (light-emitting diode) package using a method that improves upon the poor ventilation and heat dissipation of a heat sink mounted on an LED module with natural convection. To achieve this perforation was made on the fin base of the high power LED. Using the Ansys16.0 the results of the temperature distribution of both conventional and the proposed model was compared and found that the junction temperature for a heat input of 20W on perforated model is 14.14% less than that of the conventional model.**

***Index Terms*— Heat Dissipation; Heat Sink; Junction Temperature; LED; Ventilation**

I. Introduction

Light-emitting diode (LED) lighting offers the advantages of a longer lifespan and greater energy efficiency than conventional lighting. LED lighting uses 75% less energy than incandescent or fluorescent lighting. Due to its greater energy efficiency, the market share of LED lighting is growing rapidly, and the market domain now includes high-power LED products. Light Emitting Diodes (LED) have fast response times and are capable of expressing a variety of different colors. They do not emit in ultraviolet or infrared wavelengths, are efficient compared to other light sources, have superior longevity, can be miniaturized, and are beginning to replace traditional light sources [1]. Compared with the traditional light sources, LEDs have long lifetime, high reliability and efficiency.

With the ‘‘energy saving, low-carbon economy’ ’characteristics, LED is the trend of the times as the ‘‘fourth generation’ ’lighting. Despite these advantages, because LEDs convert 75-85% of input electric Power into heat, increasing the input power can drastically increase the junction temperature of the LED [2]. The resulting increase in temperature influences the longevity of the LED, and if the junction temperature exceeds the maximum operating temperature, the circuits in the chip are cut and the LED fails [3]. The light output decreases with increasing the local temperature of an LED module at the same power input. Therefore, a technology for properly dissipating the heat from inside the LED package to the surroundings is as important as the electronic and optical characteristics.

One of the most critical issues for a horizontal fin base with natural convection is its lower cooling performance due to the poor ventilation between the fins and the fin base. Air circulation can be improved by introducing openings in the heat sink. For example, Tseng et al proposed openings in a printed circuit board (PCB) and reported a 12% increase in the heat transfer rate. Huang et al applied rectangular perforations in the fin base and achieved a 2.8 times increase in the heat transfer coefficient. Meng et al. [4] showed that the heat transfer rate could increase by up to 16.7% by perforating circular holes in the fin heat sink.

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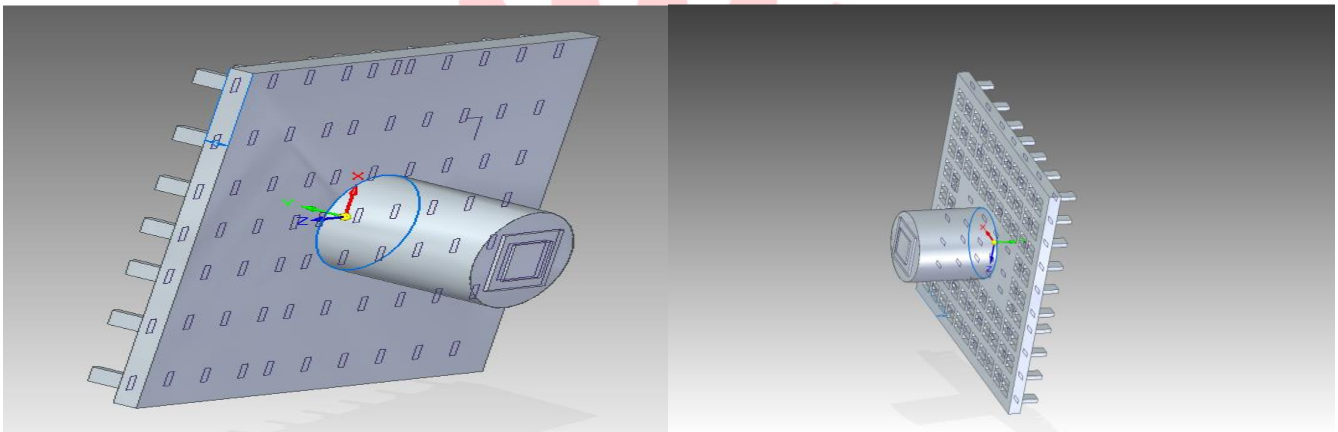
II. DESIGN OF THE MODEL

The dimensions for the high power led is taken from the research paper [5]. The size of the heat sink base is 60 × 60 mm, height of the heat sink is 5 mm with the diameter of 2.5mm, fins are of 2.5 × 1 mm and height of 5mm. Using the design software solidedge st5 the model is designed with the dimensions of the plate fin heat sink from the research paper [5].



(a) Existing model (b) Proposed model

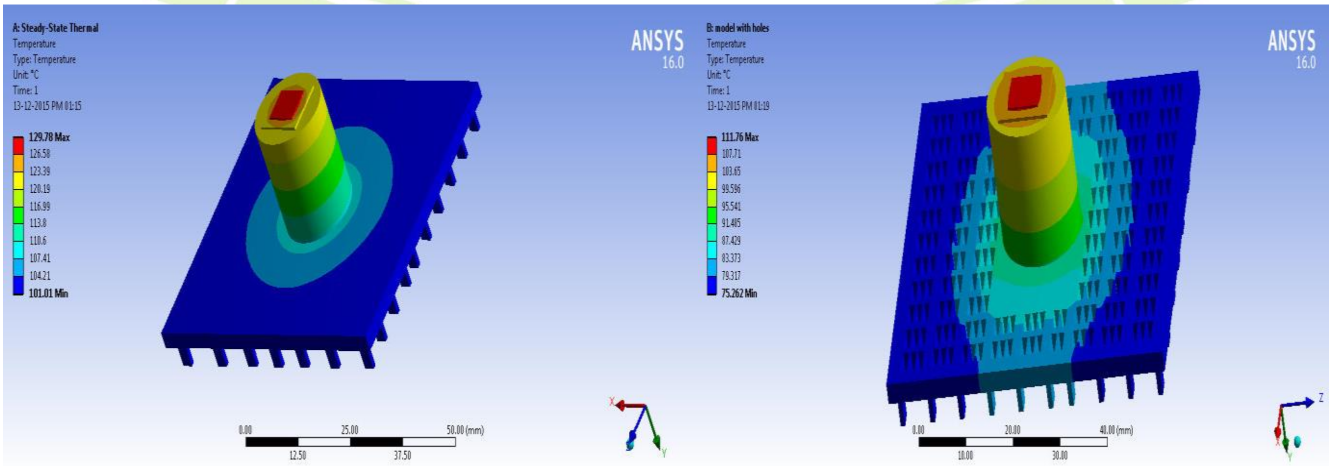
Fig. 1. LED heat sinks (a) Existing model (b) Proposed model

III. RESULTS AND DISCUSSION

3.1 Heat Dissipation Performance of Heat Sink Model

To investigate the heat dissipation performance of the existing and the proposed Model, steady state thermal analysis has been carried out on ansys 16.0. The temperature distribution for the various LED power input such as 18W, 20W, 25W.

At 18W of the heat supply on the LED for the conventional model the maximum temperature ranges from 129 °C to 101°C, for the same case of the heat supply on the proposed model the maximum and minimum are 111°C to 75°C which shows that is about 14% decrease in the junction temperature on the LED.



(a) Conventional model (b) Proposed model

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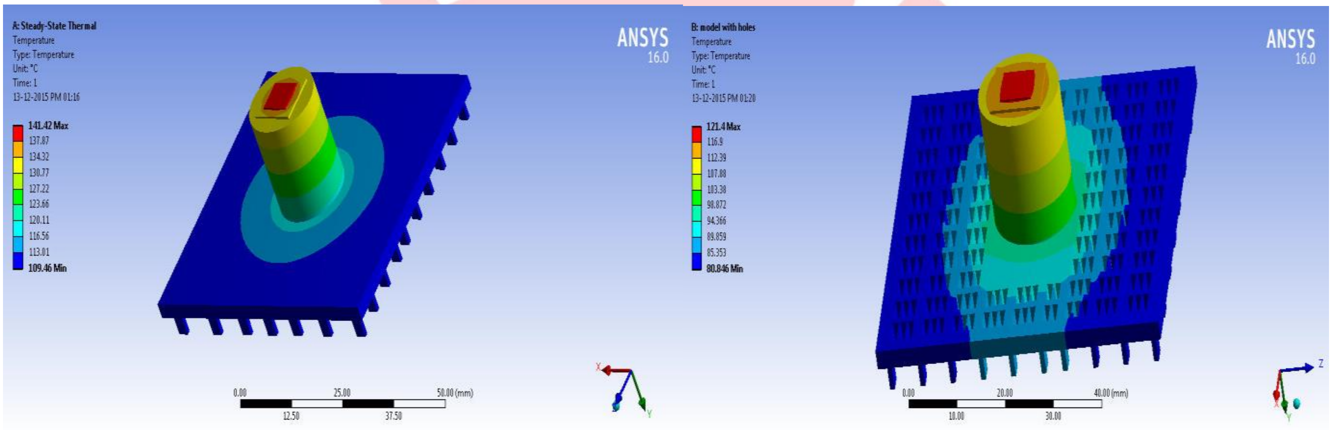
Fig. 2. Temperature contour at 18w (a) Existing model (b) Proposed model

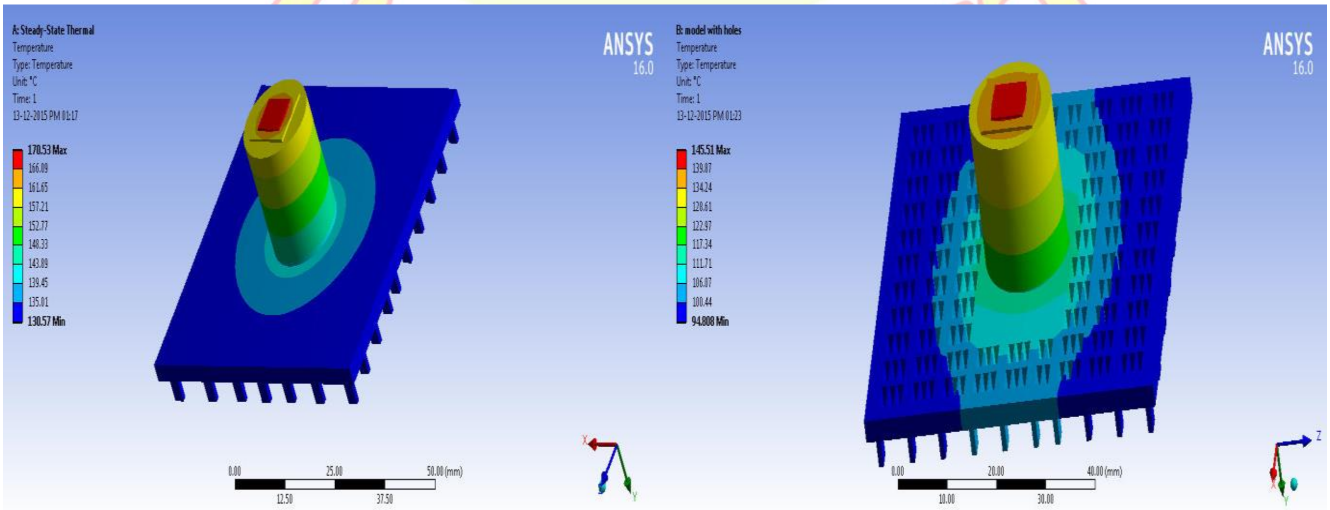
For 20W of the heat supply on the conventional model, the junction temperature 141°C, which is very higher than the optimum level, on comparison of the conventional with the proposed there is about 14.184 and on the fins side about 26% decrease on the temperature, which shows the effectiveness of the ventilation between the fin base and the fin due the perforation.



(a) Conventional model (b) Proposed model

Fig 3. Temperature contour at 20w (a) Existing model (b) Proposed model

For the higher input heat supply of 25W on the LED chip, the corresponding junction temperature of about 170°C was found on the conventional model, which is the state of LED failure, but on the proposed model the junction temperature is 145°C, on the both cases it clearly states that further cooling method is required for this applied heat supply such as forced convection will show better results.



(a) Conventional model (b) Proposed model

Fig 4. Temperature contour at 25w (a) Existing model (b) Proposed model

3.2 Comparison of the Junction of the Conventional With the Perforated Model

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In the Fig-5, it compares the junction temperature of the proposed model with the optimized design variables to those of the conventional models. On the x-axis of the graph heat input is taken and on the y-axis temperature is taken. And correspondingly line graph is plotted between the conventional and the perforated model. From the graph it is inferred that the junction temperature increased as the heat input increased. The proposed model exhibited the lowest junction temperature. For the heat input of 18W the junction temperature at the conventional and the perforated are 129 °C, 111 °C respectively and for 20W heat input the junction temperatures are 141°C, 121°C resp.

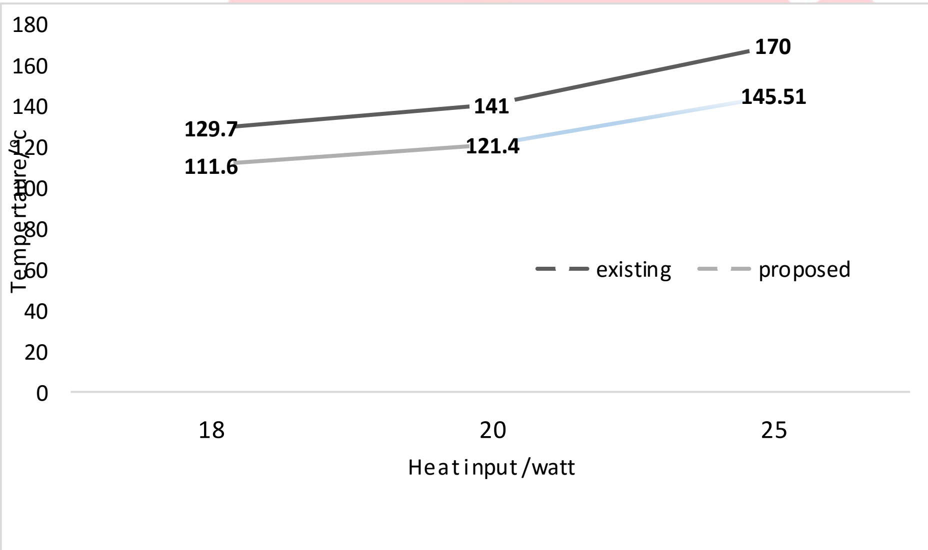

Fig 5. Junction temperature of the models at various heat inputs

IV. CONCLUSIONS

An improved cooling method was proposed for use with a horizontal fin heat sink mounted on an LED module. In the proposed model, openings were introduced in the fin base to improve the air circulation in the fin heat sink. The cooling performance of the proposed model was compared to those of the conventional model. It was found that the junction temperature of the perforated model is less than the conventional model. At 18W of the heat supply on the LED for the conventional model the maximum temperature ranges from 129 °C to 101°C, for the same case of the heat supply on the proposed model the maximum and minimum are 111°C to 75°C which shows that is about 14% decrease in the junction temperature on the LED. In addition, the proposed model can be used to achieve a reduction in the production costs because the total volume of the proposed model was smaller than those of the conventional model.

V. REFERENCES

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