Experimental Analysis Of Thermoplastic Cooler In Led Lighting Systems

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Abstract
Nowadays, Led lighting systems are becoming prevalent day by day due to an efficient light source. In fact, taken the luminous efficiency and also long life of Led lighting system must be cooled effectively. In recent years, leds designed by thermoplastic cooling systems are preferred in LED systems due to being more economical by comparison to the AL cooler. This paper, Thermoplastic material in cooler system, compared the AL cooling systems will be examined in terms of effects of leds as experimental.

Keywords: *Led Lighting, Thermoplastics, Energy Efficieny, Led Cooler, Temperature Losts, Energy Dissipation*

1. Introduction

Corresponds to the consumption of electrical energy consumed in lighting system, It produces heat and light energy which is caused by spending the energy of about 25% in our country [1]. Therefore, demanding for using of Led type sources are particularly efficient light sources, increased rapidly at the present time. But, designing by using Leds has the important issuies in order to obtain an efficient lighting system. Unless attention to these issues, Ensuring the efficiency of the Led systems is not possible, but also can cause serious problems in terms of life time of Leds. The most important of these issues, is the ones that heat energy occurring in junctions of leds can not be transferred effectively. Also increasing of light intensity can be produsedby driving at higher currents which can increase the temperature in junctions of leds[2]. Thus, it should be cool by making heat transfer effectively.

2. Structure Of Led Systems

Led is a shortened form which is defined as a light emitting diode. Having a solid-state crystal structure of Leds, provides unidirectional current flow. These crystal structure means that P-type and N-type silicon material is combined together that is called as junction point. The Electric Current flows from P-type(anode) to N-type(cathode)

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which provides foton emission and produces temperature in junction point [3].

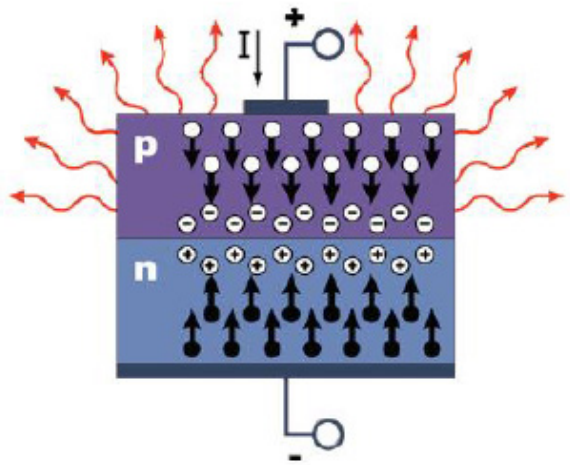


Figure 1. *Led Structure*

Generally, luminous Efficiency in leds emitting of monochromatic light, is related to the wavelength of light. But In today's technologhy, leds can produce all wavelengths in the visible spectrum therefore efficiencies and luminous intensities is reduced compared to monochromatic leds.

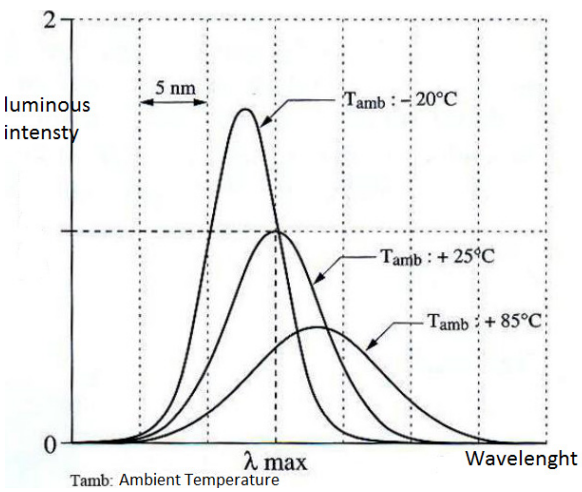


Figure 2. *Variations of Light Intensity and Wavelength of Led with Ambient Temperature*

In studies conducted on this subject, it is seen that the wavelength of the Leds is extended by increasing ambient temperature [3].

On the other hand, Compared to other lamps, Leds have advantages such as long life and low energy consumption. Leds have emerged since 1962 and production of their increased in recent years. However the most important of the problem that arise with the use of Leds is that the high temperature which spreads in junction points(tj) that effects the lifetime and efficiency as adversely[4]. Therefore, it needs to cool by special cooling systems. These kind of systems are classified in two parts as active cooler and passive cooler. Passive cooling systems are widely used in Led lighting fixtures due to the cheap costs. Therefore there is need for efficient cooling design which is considered the good thermal conductivity, cooling surface area, thickness, size and air groove. Therefore, it is important to make a good thermal analysis, simulation and tests[3] [5].

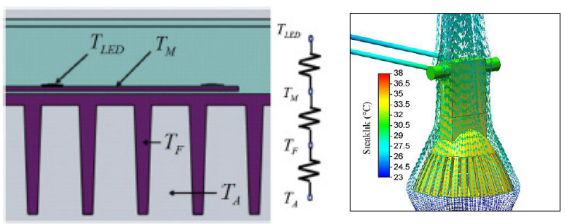


Figure3. *Thermal Flow*

3. Temperature Measurement Method Of Led Systems

The junction temperature of Leds can not be measured directly.Therefore, the bottom surface of the Led sources(TSP-solder point) is to be measured afterwards , calculated for junction temperature. For this reason, the thermal resistance(Rthj-sp) between the junction point and the welding

points must be known. Led junction temperature is to be calculated by the following equation [6].
In this equation;
TJ = TSP + (Rth j-sp x VF x IF) where;
T_J : Junction Temperature,
T_{sp} : Solder Point
V_f : Led Forward Voltage,
I_f : Led Forward Current,
R_{thj-sp} : Thermal Resistance Between Tj and Tsp.

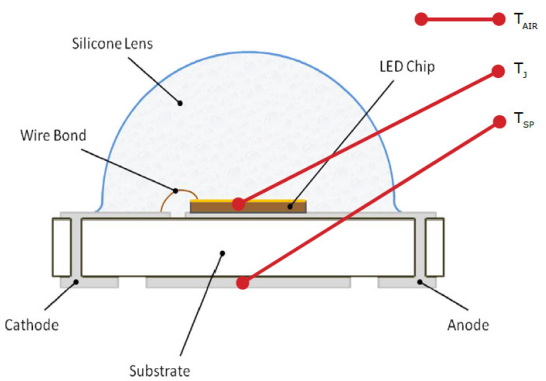
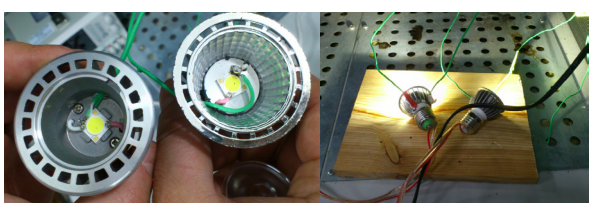


Figure4. *Led Junction Temperature(Tj) and Surface Relationships*

4. Experiments and Results

In this study, The temperature measurements of two identical led bulb with thermoplastic and AL cooler, are made in terms of cooling performance, and the effects to these both leds have been examined in terms of photometric performance and compared.



The temperature measurement and photometric results obtained in the experiments conducted which are shown in table1 and table2 respectively.

Table1. *Results of Measured Temperatures of Led bulbs*

Temperature in Parts (°C)	With AL Cooler	With Thermoplastic Cooler
Led Solder Point (Surface)	78°C	108°C
Cooler Outer (Surface)	65°C	57°C

Table2. *Results of Measured Photometric Values of Led bulbs*

Derived Data	With AL Cooler	With Thermoplastic Cooler
Radiant Flux (Watts)	0,56	0,58
Luminous Flux (lumens)	196	176
Scotopic Luminous Flux (lm')	341,80	368,40
Correlated Color Temperature (deg. K)	4896	5011
Luminous Efficacy (lm/W)	65,3	58,6
Power Consumption (W)	3	3

5. Conclusion and Discussion

In this study, two identical led bulb with thermoplastic and AL cooler prototypes were analyzed in thermal and photometric criteria as experimental point of view.

As it is seen from the data obtained, When compared AL and Thermoplastic cooling systems, The thermoplastic cooling material is not effective heat transfer compared the AL cooling material, is clear. Because Led surface temperature with thermoplastic material remains high compared to the sample with AL cooler , besides the differences between the Led surface temperature and the cooler outer surface temperature, are high value in spite

of the same as the volume of coolant and the position which masks the leds to the surfaces. Also because of the fact that the temperature in led bulb with thermoplastic cooler, is to be high compare to led bulb with AL cooler, even all system's power consumptions are the same, the point of view of which is analyzed in terms of photometric, it clearly shows us that the luminous flux negatively effected. Thus, it is seen that luminous efficiency of thermoplastic led bulb negatively effected compare to led bulb with AL cooler.

As a result, Because of using of the thermoplastic cooler which is low cost, may adversely affect the luminous efficiency of Led systems. Therefore these kind of systems surely must be examined detail.

REFERENCES

[1] K. O. Çoban, Aydınlatma Elemanlarının Verimliliği ve Enerji Kalitesi Üzerine Etkisinin İncelenmesi, Ankara, 2010.

[2] Y. Erol ve T. Canpolat, «Aydınlatma Sektöründe Yeni Nesil Power Led Teknolojileri,» %1 içinde Elektrik Elektronik ve Bilgisayar Sempozyumu, 2011.

[3] N. Gündüz, «Led Işık Kaynaklı Enerji Verimli Endüstriyel Aydınlatma Armatürü Optik Tasarımı,» 2012.

[4] U.S. DEPARTMENT OF ENERGY, «Energy Efficiency of LEDs,» 2013.

[5] J.-C. Wang, «Thermal module design and analysis of a 230W LED illumination lamp,» 24 January 2014.

[6] CREE, Inch., «Cree XLamp LED Long-Term Lumen Maintenance,» [Çevrimiçi]. Available: http://www.cree.com/LED-Components-and-Modules/Landing-pages/CXA.[%1 tarihinde erişilmiştir03 01 2015].