International Engineering Research Journal

EE311701551-Analysis of optimization in LED lamp fins by using various cross sections

Manoj Bhojane[1], K. P Kolhe[2], PrashantKumkale[3]

[1]PG Student, Department of Mechanical Engineering, Imperial COER, Pune, India
[2]Professor, Department of Mechanical Engineering, Imperial COER, Pune, India
[3]Assistant Professor, Department of Mechanical Engineering, Imperial COER, Pune, India

Abstract:

The demand for high light output LED systems lead to significant heat generation rates, so that higher heat fluxes result in elevated junction temperatures on LED chips in SSL lighting systems. Moreover, the changes on the junction temperature strongly impact the reliability, lifetime, light output and quality of the light. Because of their implicitly, reliability, low cost and silent operation, passive air-cooling systems are preferred in LED lamps. Thus, the optimization of the heat sink in an LED system is crucial. A-line LED lamps are investigated and a number of FOMs are proposed based on the performance, size and weight. There for we are studied with various shape of fin array such as Rectangular, Square, Circular, Spine and Plus Sign Shape fin. On comparison, plus sign fin array gives the greatest heat transfer than that of other extensions having the different shape of fin array with same height and base area finned surface .The efficiency of fin with plus sign fin greater as compare to other patter of fin. The temperature of a plus sign fin is minimum i.e. 47.46 ^{0}c

Key words:*array, convective heat, LED bulb, temperature, heat flux*

I. INTRODUCTION:

The most recent strong state lighting through light-emanating diodes (LEDs) has seen an inescapable pattern to deliver white light enlightenment. As one of the potential substitutes of customary glow or fluorescent light, LEDs have the unmistakable focal points in giving great radiance effectiveness, vitality sparing, and benefit life.

For LEDs of higher luminous intensity, a higher injection current ([20 mA) or multi-chip packaging is often necessary in illumination applications.

Since the execution and the lifetime of LEDs unequivocally depend on its temperature, the passable greatest intersection temperature, which is constantly viewed as critical execution marker of the warm and lighting configuration, was normally indicated as 125 _C . In the mean time, LED chip was constrained thermally for light yield, unwavering quality, and phosphor transformation effectiveness, and optically straightforward epoxy or silicone based materials would change shading if as far as possible were surpassed. Thusly, evacuation of the vast measure of the warmth created in LEDs remains a major test confronting current LED creators and warm administration engineers.

The most recent strong state lighting through light-transmitting diodes (LEDs) has seen an inescapable pattern to create white light brightening. As one of the potential substitutes of conventional glow or fluorescent light, LEDs have the particular points of interest in giving fantastic radiance proficiency, vitality sparing, and benefit life.

For LEDs of higher glowing force, a higher infusion current ([20 mA) or multi-chip bundling is frequently vital in enlightenment applications.

Since the performance and the lifetime of LEDs strongly rely on its temperature, the allowable maximum junction temperature, which is always regarded as significant performance indicator of the thermal and lighting design, was usually specified as 125 ^{0}C. Meanwhile, LED chip was limited thermally for light output, reliability, and phosphor conversion efficiency, and optically transparent epoxy or silicone based materials would change colour if the temperature limits were exceeded. Therefore, removal of the large amount of the heat generated in LEDs remains a big challenge facing current LED designers and thermal management engineers.

A 65W incandescent bulb produces about 1,000 lumens, which can presently be achieved with a 26W CFL lamp or a 12–15W LED array. The use of solid-state lighting requires arrays because a single LED is incapable of producing that much light output. High power LEDs, defined as those that consume at least 1 W, are the type of LEDs being considered for general illumination.

The recent lighting trend has been the changeover from incandescent bulbs to CFLs, since this transition increases efficiency by five times and lifetime by up to ten times. Lately, there has been little improvement in efficiency for all light sources except LEDs, as shown in Figure. Typical LEDs have an efficiency of around 75 lumens/watt, although prototypes are already capable of up to 150 lumens/watt. Because solid-state lighting is on course to be the source type with the best luminous efficiency, there is substantial motivation for using them in general lighting applications.

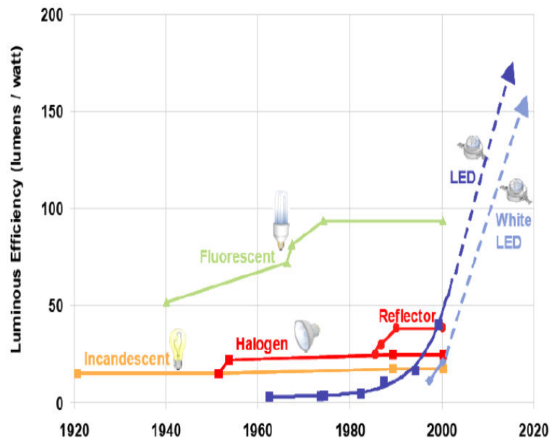

Figure . Luminous efficiency timeline for general illumination sources

As shown in the above Fig1.1 it is cleared that luminous efficiency is greater than incandescent lamp and fluorescent lamps, only if the LEDs are provided with the better thermal management.

II. LITERATURE REVIEW:

Y. Sing Chan and S. W. Ricky Lee [1] in the paper "Dispersing enhancement of high power Drove clusters for strong state lighting" examined the an investigative way to deal with decide the ideal pitch by using a warm resistance arrange, under the presumption of consistent radiant effectiveness. This work permits a Drove exhibit outline which is mounted on a printed circuit board (PCB) appended with a warmth sink subject to the regular convection and being approved by limited component (FE) models, the present approach can be appeared as a viable technique for assurance of ideal segment dispersing in a Drove cluster get together for SSL.

Christensen et al. [2] consolidated a 3-Dimensional Limited component model and warm resistor organize model to compute the effect of a reduced high power Drove exhibit thickness, and dynamic versus aloof cooling strategies on gadget operation. It was recommended that dynamic cooling, for example, constrained air convection, level warmth pipe and fluid cooling would be ideal to keep up high power LEDs under the most extreme temperature restrict. Be that as it may, for all intents and purposes the above techniques are impractical to fuse, it is ideal to enhance traditional blade plan.

Abdul Aziz and F. Khani [3] utilized the homotopy investigation technique (HAM) to build up an explanatory answer for the warm execution of rectangular and different sorts of raised illustrative blades. They inferred that outcomes delivered by HAM i.E. Arched explanatory balances have the preferred warmth dissemination over rectangular sort blade are more precise than direct numerical arrangements.

Chau et al. [4] researched and proposed the cooling upgrade plan of Drove warmth sources through an electro-hydrodynamic (EHD) approach, in which the constrained convection of air is accomplished by the particle twist because of gas release marvel. With this kind of plan, the sink temperature can be kept up in the scope of 20-300C from the pinnacle estimation of 650C without utilizing any outside cooling.

Mama et al. [5] proposed vibrating balance for warm administration of a Drove gadget. These vibrating blades, which are covered with thin copper and made out of piezoelectric material, can vibrate and direct warmth from the finned base utilizing piezoelectric impact, however the cost of these sorts of LEDs, are so high and consequently not effortlessly acknowledged by the client. So not appropriate for business reason.

S.A. Nothing [6] concentrated the impacts of balance length and blade dispersing for both introductions at an extensive variety of Rayleigh number. It has been found that addition of balances with any blade cluster geometries builds the rate of warmth exchange. Quantitative examinations of warmth exchange rate and surface viability for both walled in area introductions have been accounted for. Advancement of balance exhibit geometries for most extreme Nusselt number and finned surface viability has been led. Additionally connections were anticipated and were contrasted and the present and past test information and great understanding was found by S.A. Nothing.

Kim et al, 2013 [7], explored characteristic convection from vertical chambers with longitudinal plate blades.

Proposed connection for evaluating Nu.

Lee et al, 2014 [8], warm sink of Drove lighting was enhanced concerning its balance stature profile. Advancement was directed to at the same time limit the warm resistance and Mass. The cooling execution of the enhanced outline (pin–fin exhibit with the tallest balances in the external locale) demonstrated a change of over 45%.B. RamdasPradipet. Al. [9] had concentrated the numerous businesses are using warm frameworks wherein overheating can harm the framework parts and prompt disappointment of the framework. Keeping in mind the end goal to beat this issue, warm frameworks with powerful producers, for example, ribs, blades, perplexes and so on are attractive. The need to expand the warm execution of the frameworks, along these lines influencing vitality, material and cost investment funds has prompted improvement and utilization of numerous procedures named as "Warmth exchange Expansion". This system is likewise named as "Warmth exchange Upgrade" or "Escalation". Growth strategies increment convective warmth exchange by lessening the warm resistance in a warmth exchanger. Many warmth expansion methods has been evaluated, these are (a) surface unpleasantness, (b) plate perplex and wave astound, (c) punctured confuse, (d) slanted puzzle, (e) permeable confound, (f) folded channel, (g) wound tape embeds, (h) intermittent Crossed Ribs and Furrows. The greater part of these upgrade procedures depend on the astound game plan. Utilization of Warmth exchange improvement procedures prompt increment in warmth exchange coefficient however at the cost of increment in weight drop.

III. RESULT AND DISCUSSION:

3.1Mathematical:

Calculation are taken for a plus sign fin for finding a temp.

- Input Power: 50W
- Atm. Temprature:22 ^{0}C
- Height of fin: 30 mm
- Cross section area of fin:117 mm^2
- Total no. fin:59
- Surface area of fin:0.0012 m^2
- Convective coefficient h : 25 W/m^{2}k

The amount of heat generated by each fin:

$$= 50/59$$

$$=0.8474 \text{ W}$$

The temp. Generated at each fin:

$$0.8474=25*.0.0012*(Ts-22)$$

$$Ts=50.24\ ^{0}c$$

The temperature generated at plus fin array is 50.24 ^{0}c.similarly the temperature generated at circular, rectangular, spline, square fin array led bulb are as follow

Sr. No.	Name of array	Area of fin(m^2)	Surface temp.(^{0}c)
1	Rectangular	0.0084	56.01
2	Square	0.0012	69.61
3	Circular	0.000942	83.63
4	Spine	.001324	65.134

Table 3.1.1 list of temperature and area of fin

3.2Simulation:

ANSYS Work seat can be thought of as a product stage or structure where you play out your investigation exercises. At the end of the day, workbench enables you to arrange all your related examination documents and databases under same casing work. In addition to other things, this implies you can utilize a similar material property set for all investigations. and CATIA drawing programming is likewise utilized for drawing the model.

Circular 20 Spacing Fin:

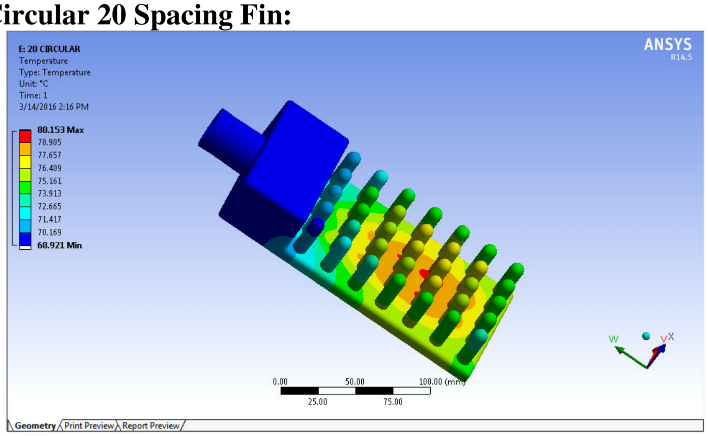

Fig. No. 3.2.1 As appeared above, after effective keep running of reenactment, found that the most extreme temperature reach by base plate by utilizing roundabout 20mm stick blades is close around 800C, and furthermore by utilizing planning programming we know the correct weight of this roundabout 20mm stick finned base plate which is only 0.63822Kgs.

Cross 20 Spacing :

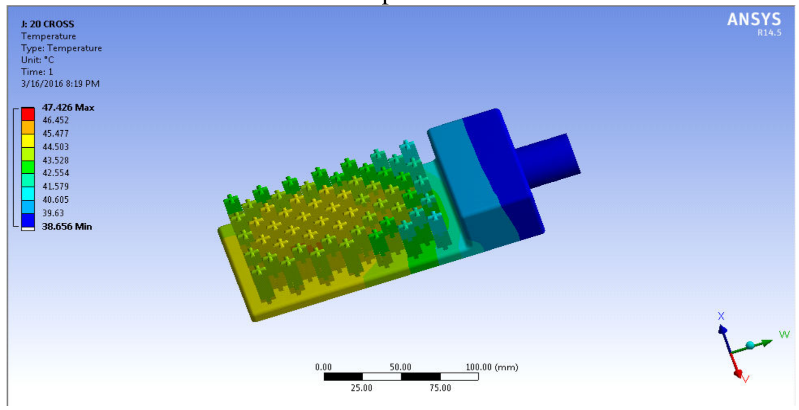

Fig. no.3.2.2 As shown above, after successful run of simulation, found that the maximum temperature reach by base plate by using cross 20mm plus sign fins is near about 47^{0}C, and also by using designing software we know the exact weight of this cross 20mm plus sign finned base plate which is nothing but .66961.Kgs.

Square 20 spacing:

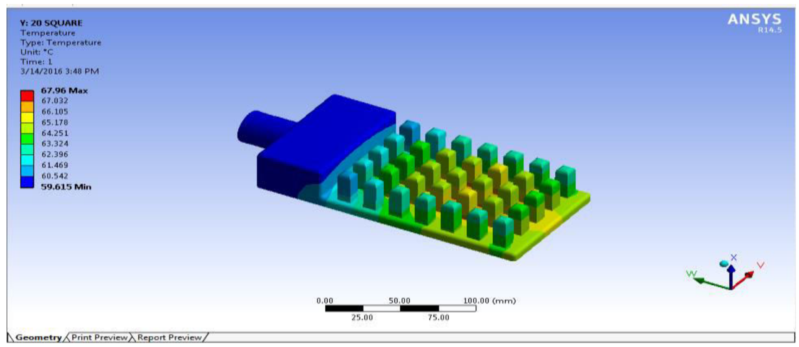

Fig. no.3.2.3 As shown above, after successful run of simulation, found that the maximum temperature reach by base plate by using square 20mm square fins is near about 68^{0}C, and also by using designing software we know the exact weight of this square 20mmfinned base plate which is nothing but .70245Kgs.

Spine 20 Spacing fin:

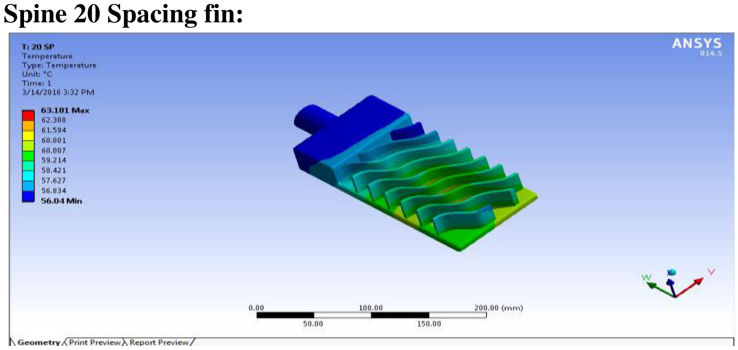

Fig. no.3.2.4 As shown above, after successful run of simulation, found that the maximum temperature reach by base plate by using pline fins is near about 640C, and also by using designing software we know the exact weight of this spline finned base plate which is nothing but .6065 Kgs.

Sr .No.	Arrays of fin with 20 spacing	No. Node	No. Element	weight (km.)	Max. temp. (^{0}c)	Min temp. (^{0}c)	Atm. Temp(^{0}c)
1	Circular	19676	10073	0.6382	80.153	68.921	22
2	Square	17650	8787	0.7024	67.96	59.615	22
3	Spine	21457	10998	0.6065	63.181	56.04	22
4	Rectangular	32186	17261	0.7940	53.821	47.902	22
5	Plus sign	69491	31006	0.6696	47.426	38.656	22

3.2.6Ansys simulation result table

3.3Experimental:

The best two resulted fin array led bulb are manufactured i.e. plus sign array fin and rectangular array fin. The material used for manufacturing is aluminum with thermal conductivity 210W/mk .Both lamp are switch on by supplying power battery of 12 V and 35000 amp. Take place for 3600 min duration and after that take a reading. The temp mentioned in testing room is 22 ^{0}c. the equipment used for measuring the temperature generated at heat sink is LED temperature measure gun.

Figure 3 .3 .1 .LED measure gun and lamp

The temperature of plus sign fin array is 48.69 ^{0}c
The temperature of plus sign fin array is 55.84 ^{0}c

IV. CONCLUSION:

Trial and ANSYS investigation is led over the organization's current ordinary rectangular finned plate and proposed cross sort finned plate with a specific end goal to discover improved answer for Drove light in common convection warm exchange. Unfaltering state regular convection warm exchange for rectangular balance and cross blade is tentatively introduced. ANSYS reproduction is done on programming ANSYS workbench variant 14.5 Discharge. It is watched that by changing the geometry of ordinary balance by proposed cross blade, convective warmth exchange coefficient increments and in addition the material required for balances is around 20% less over rectangular balance, henceforth the proposed balance is practical. Test, investigative and hypothetical outcomes are in great assentions.

References:

i. Y. Sing Chan and S. W. Ricky Lee in the paper “Spacing optimization of high power LED arrays for solid state lighting” Journal of Solid State Lighting 2014.

ii. .Christensen A, Ha M, Graham S (2007) Thermal management methods for compact high power LED Arrays. In: Proceedings of 7th international conference on solid state lighting, San Diego,CA

iii. Abdul Aziz and F. Khani

iv. Chau SW, Lin CH, Yeh CH, Yang C (2007) Study on the coolingenhancement of LED heat sources via an electro hydrodynamic approach. In: roceedings of 33rd annual conference of the IEEE IECON, Taipei, Taiwan, pp 2934–2937

v. 9Ma HK, Chen BR, Lan HW, Lin KT, Chao CY (2009) Study of an LED device with vibrating piezoelectric fins. In: Proceedings of 25th annual IEEE Semi-Therm, San Jose, CA, pp 267–272

vi. S.A. Nada, “Natural convection heat transfer in horizontal and vertical closed narrow enclosures finned base plate” International Journal of Heat and Mass Transfer 50 (2007) 667–679

vii. Hyun Jung Kim, ByoungHoon An, Jinil Park and Dong-Kwon Kim, “ Experimental study on naturalconvection heat transfe from horizontal cylinders with longitudinal plate fins”, Journal of Mechanical Science and Technology, 27 (2) (2013) 593 – 599.

viii. Daeseok Jang, Se-Jin Yook, Kwan-Soo Lee, “ Optimum design of a radial heat sink with a fin-height profile for high-power LED lighting applications” Applied Energy, 116, (2014) 260–268

ix. Cheng T, Luo XB, Huang SY, Gan ZY, Liu S (2008) Simulation on thermal aracteristics of LED chips for design optimization.Heat Mass Transfer (2013) 49:85–94 93 123 In: Proceedings of the ICEPT-HDP, Shanghai, China,pp 464–467

x. Kobayashi T, Sakate Y, Hashimoto R, Takashina T, Kanematsu H, Mizuta K and Utsumi Y 2012 Research on optimization of cooling structure of LED element*The-Asia-Pacific Interdisciplinary Research Conference* Irago,Japan, Nov.15-16th, 2012.