Vol. 02, Iss. 1 (2024) 35-43, DOI: 10.61552/JME.2024.01.004

JME

Journal of Materials and Engineering

www.jme.aspur.rs

Research article

Study of Extrude Aluminum Alloy LED Bulb in a Passive Mode of Cooling System with a Different Array of Fin Structure

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Keywords:

Porosity
Heat transfer coefficient
Laminar flow
Heat transfer rate by convection

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Received: 10 September 2023
Revised: 17 October 2023
Accepted: 8 November 2023

A B S T R A C T

Nowadays, the world is running behind power generation as well as power saving. In the lighting industry, the L.E.D. bulb is used for lighting purposes. The main problem faced by the world is heat dissipation from a heat sink by active or passive cooling. The system accessories enhance the overall cost by using active cooling. This paper studied that it has been used to reduce the overall cost of L.E.D. bulbs by increasing the heat transfer rate concerning increasing heat transfer coefficient. It needs to understand the various parameters such as porosity, heat transfer rate, laminar flow, density, and heat transfer modes to achieve the above-desired result. Their application is for street lights, gardens, mall parking, and bulging decorative lights. The cross-shape fin array is a suitable replacement with porosity of more than 0.85 for a proper swirl during the cooling time for an active cooling system for an existing bulb.

1. INTRODUCTION

In the power world, energy is saved with the lightweight device's increasing lifetime. The new technology developed within the space of lightweight | of sunshine for utilization typically illumination applications is high power light emitting diode (L.E.D.). During lightweight heat is directly proportional to aglow therefore the side of this thermal management technique is additionally activated to extend the performance character and lifetime of lightweight. For minimizing the light-emitting diode temperature we've got to scale back the temperature at the junction of a light-emitting diode. Reducing the junction temperature cuts back the thermal resistance of a system. This could be achieved by well outline heat flow path by physical phenomenon through a conductor and anon by convection heat surface. On top of development is habitually applied to electronics for cooling purposes. Throughout the employment of a light- emitting diode

lighting system, further features should be thought-about for the implementation, i.e., Size, form, and building codes with lighting. Although they represent only 86% of the square heat sink, range, circular heat sinks with conical or cylindrical envelopes generally perform better than square heat sinks with pyramidal or square envelopes. The switch to pin circular fin sinks to reduce the best-shroud-case thermal resistance from zero to 40 K/W and zero to 35 K/W with a pumping power of 5W and a nearer temperature of 300 K. During this shift, the best-case shroud inclination angle decreased from 8° to 65.3°. Keeping the same extent as the circular sink with pin fins, a circular sink with straight radial fins was made. Its thermal resistance was zero to 32 K/W for identical pumping power and close top temperature. The thermal resistance of hybrid sinks with each pin fin and straight radial fins was the same.19 K/W for the established conditions. The major distinction between fluorescent and light-emitting diode lightweight sources Mercury vapor is employed in lamps for lighting purposes. Mercury vapor lamp can't emit lights and additionally needs a high voltage arc needed for lighting purpose.

Mercury vapor lightweight won't glow and the main downside is the potency of fluorescent lightweight. Light-emitting diode lightweight is higher potency than fluorescent light to eightieth. The Fluorescent lightweight is accessible following two sorts. 1. Linear fluorescents: the lifetime of this sort of sunshine is ten thousand to 20000 hrs. 2. Compact fluorescent: the lifetime of this sort of sunshine is 120000 to 20000 hrs. An international customary for checking AN intensity of sunshine is aglow potency. Unit of mensuration is lumens per watt. The performance of illumination areas follows, i.e., Beam Distribution ii. hue and iii. Brightness (whole lumen output), The Parameter contemplate for enhancing the industrial facet of lighting areas follow.

- Cost
- Environmental impact
- Application skillfulness
- Weight

2. LIGHT EMITTING DIODE PERFORMANCE ANALYSIS

2.1 Material analysis

Vahabzadeh et. al. Aluminum with a porosity of 0.85- 0.95 is an optimum material for L.E.D. Bulbs heat sink material by comparing FOM and an open structure is more efficient than a closed structure. Aluminum fins are used. Studied various properties like geometry, porosity, Biot number, and relative humidity. The least square method is used to reduce the error. Q is inversely proportional to fin length. Equation (1) is shown as:

$$\boldsymbol{U} = \frac{\mathbf{Bi3}}{\mathbf{W(2n+1)}} \qquad (1)$$

Relative humidity increases the temperature distribution. Ting Cheng et. al Silicon is used with thermal resistance. Equation (2) is shown as:

$$\text{THERMAL RESISTANCE} = \text{D/K} \qquad (2)$$

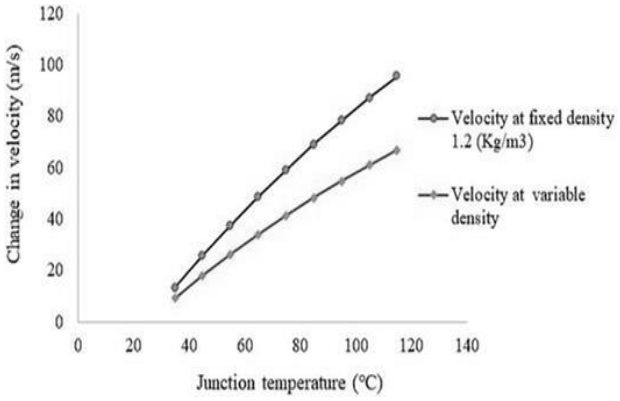

Fig. 1. Change in velocity w. r.t Junction temperature.

Zeng Dehuai et. al. 3-D integral fun boiling structure is used. The electron microscope is used for scanning . Sink materials and porosity at 25 °C have been found in Table 1 from various authors' studies.

Table 1. Sink Materials and Porosity At 25 °C.

Sl. No	Name of materials	Porosity	References
1	Aluminum	0.95	36,37
2	Ti-9Al-4v	.054	37
3	Silicon	0.95	47
4	Extruded Aluminum	0.67	36,43

2.2 Heat transfer analysis

Xiaoyan Liu et.al. [1] studied the heat transfer parameters such as convective heat transfer coefficient and dryness effectiveness. It found that the heat exchanger reduces the dryness fraction from 5.8% to 3.57%. Chulenyov A [2] factors like the coefficient of correction of convective heat transfer when the effect of evaporation is taken accounted then the difference in temperature between the drying medium and the surface of the material is affected. Here the most important factor is the latent heat of solvent vaporization. During the combustion of fuel, relation builds between the Heat and Mass exchange because of interaction among them. At constant pressure and temperature below the saturation temperature, condensation happens; hence he suggests avoiding the devices in which flow heat will be reversed way. Iligenskaya A.N. [3] Here we discussed a space variable heat transfer coefficient of heat flow condition on non-stationary heat flux. The inverse heat conduction method aims to reduce error up to the range of 0-3%. Using the I.H.P.C. method of parametric optimization solution, the coefficient is obtained up to a relative error mentioned earlier. T.V.S.M.R. Bhushan et.al [4] Experimental study of the effect of free convection heat transfer around the vertical square duct. The circumferential average temperature is measured using thermocouples using an Inconel heating element. During experiments, heat flux is constant. Various experiments were conducted in laminar and transition regions to investigate natural convection. The Nusselt number works inversely with the distance and clearance ratios. The Nusselt number increases with the increase in the Rayleigh number, and a power law fit line is used to correlate the average Nusselt number and Rayleigh number. L.V. Jing et al. [5] Experimental observation on the performance of heat transfer in Carbon dioxide as a working fluid by changing the parameter of inlet pressure mass flow rate and cooling water flow rate. The defined parameter has a major effect on heat transfer performance; an increase in inlet pressure mass flow rate and cooling water flow rate can improve the coefficient and heat transfer capacity. The heat transfer coefficient of carbon dioxide inside the tube is greater than water outside the tube. A small change in pressure affects largely on temperature of carbon dioxide, the heat transfer coefficient and, heat transfer capacity. The convective heat transfer coefficient will be more in CO2 than in water. Chunlin Xu et. al [6] By active cooling method, cool the device with the help of Ionic wind. The conclusive statement found is the velocity of wind is 699 anemometers, 4 min required for steady temperature is 1300C. Velocity is the directly proportional voltage as well as heat dissipation. Xiaolong Zhong1 [7] This paper mostly deals with simulation criteria of project or research parameters mentioned that Computational Fluid Dynamics Simulation shows that fluid Flow is a key factor in heat transfer. Liquid mass flowing in channels of micro-fin architectures, then the heat generated on the chip is removed. The cooling capability of the 2D carbon nanotube fin array is more efficient than that of the I.D. carbon nanotube fin array. Atal Bihari Harichandan et al. [8] The aerodynamic shape of fins of the conical heat sink with rectangular parameter results was found to compare conical fins with rectangular fins attached to the heat sink. The author concludes that staggered conical fins give better performance than staggered rectangular fins in terms of heat transfer, pumping power, and quality factor. Yangjian Xu1 et al [9] In the paper, steady thermal state stress and effect factors in which with the increase of thickness stress distribution is more optimum. Convective heat transfer surface coefficient increases, then thermal stress also reduces. The heat sink material is used Ti-9Al-4v. The result found is the purity of mental adversely effect on Thermal stress of work peace. Stress due to tensile is not found. If the porosity increases, the thermal stress of metal reduces [9-17]. Venkitaraj K P. [18] The convective heat transfer coefficient reduces the thermal stress more affecting. here we found probity in rectangular fin array by grooving various shapes like ellipse, square, and triangular holes with skin friction and found that triangular groves are better in the result. This paper guides us about the uses of thermocouples according to application, and a parameter is a temperature. Different authors were analyzed on maximum temperature up to 120 0C. In the laminar region, Re and Nusselt numbers behave linearly, but the transition region has nonlinear behavior. j type thermocouple is used with a response time of 0.1 sec. 130 W heat supplied, Prandtl number considered Air as 0.7. and 0.74. The formula

used is Ra and Nusselt number [10,14, 19, 20]. Here also defined and transient Flow depend upon position and religious number. Equation (3) for the calculation of the Convective Heat Transfer Coefficient is mentioned by following authors.[10,14, 20-23]:

$$Nu = 0.8516(ra)\text{^}0.198 \quad (3)$$

Lihong Xie [24] where k1=Schubert equation k2=0 machine is stationary, k3&k2 from the table. By using an empirical equation, find a heat transfer coefficient. Air temperature plays an important role in boundary conditions. fins=height, thickness, pitch. Conductive thermal resistance is neglected. The empirical equation (4) is used:

$$h = \mathrm{k}_1(1 + \mathrm{k}_2 \mathrm{u}_{\mathrm{air}}{}^{\mathrm{k3}}) \quad (4)$$

As well as, the angle of inclination plays an important role in Heat transfer rate. Change in air temperature, as well as the thermal resistance, comes into the picture are Packaging, Bonding, spreading, and convection thermal resistance. Sun Lingfang [12] This paper deals with the resistance factor in fluid during vertical heat convection through passive mode. Find the number of resistance such as flow following resistance, thermal fouling resistance, and cleaning effectiveness. Korniliev M.G [13] This Paper deals with the study of natural convection in room surfaces by convection heat transfer mode. The factor affecting Heat transfer is as air moment, heating, and cooling capacity. He found that the Grashoff number lies in between the range of 108 to 1011. The slip condition is inverse to Grashoff numbers. Hazim B Awbi [15] This Paper deals with the study of natural convection in room surfaces. The factor affecting Heat transfer is as a moment of air, heating, and cooling capacity. He found that the Grashoff number lies in between the range of 108 to 1011. The slip condition is inverse to Grashoff numbers. S. Majid Nazemi et al [23]. Fins are cooled by 3-D printed cooler than a conventional cooling in with got success in reducing the temperature up to 900C at an input of 50W. Homotopy Analysis Method is used to study the temperature distribution of porous fin w.r.t Internal Heat Generation. 3-D integral fun boiling structure is used. The electron microscope is used for scanning. Mushtaq Ismael Hasan [16] This Paper deals with differentiation with various types of fins. Various types of material and phase changes were studied, i.e., n-Octadecane as well as RT-44. Concerning expansion ratio and inversely to expansion length, the microchannel heat sink is going to increase. The momentum equation is used to reach a conclusive statement. Rectangular, square and circular fins are used. Circular fins provided better performance than the other two fins. Xing Fu et al [19-22] This paper deals with more than 1000W power-led cooling with heat pipe with some mathematical values. The temperature was 92oC at 121W. The pitch of the fin is 3mm. F=35.08, and thermal resistance is 2.3-5k/W. Sink material and temperature analysis have been observed in Table 2 from the literature review.

Table 2. Sink material and temperature analysis.

Sl. No	Sink Materials	Watt	Temperature	Ref. No.
1	Extruded aluminum	50W	35 ℃	41,42
2	Extruded aluminum	110W	96 ℃	32
3	Carbon nanotube	100W	135 ℃	6
4	Aluminum Sheet	125W	120 ℃	4
5	Aluminum	121W	92 ℃	19
6	GaN	120 W	108 ℃	48
7	Aluminum	100 W	102 ℃	51

2.3 Light emitting diode mathematical analysis

Zhang Lina et al [22] The Author defines good characteristics of L.E.D. bulbs are energy saving, environmentally friendly, small volume, quick response, high reliability, and convenient control [25-33]. Lippong Tan et al [34] This paper explains the empirical equation of junction temperature and a lifetime of LED BULB k= Stefan Botlsman constant (8.617*10-5 eV/K) Ea.=active energy(0.5). when temperature increases by 40 to 50 degrees Celsius then life decreases by 42000 to 180000 hrs. decreases. Entropy generation is studied with a porosity of Circular fin Reynold that porosity, as well as Reynold number, relate directly with entropy generation in Equation (5)

$$t = e\text{^}(\frac{Ea}{kTj}) \quad (5)$$

Figure 1 shows the lifetime of LED bulbs decreases with junction temperature with active energy variable paratha meters. It was observed that the lifetime of LED is almost constant after 75 ℃ junction temperature.

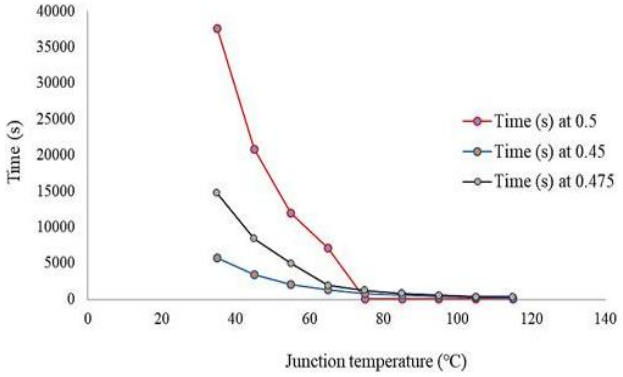

Fig 2. Time vs. junction temperature variation.

N. Kumar [32] Define three parameters required in Heat transfer i.e. fin material, fin shape, and thickness of sinks with the consideration of properties like thermal conductivity, heat transfer coefficient, and specific heat. The relation between heat flux and temperature at different materials and the shape of fins are directly affected. Lippong Tan et al [33, 35] Various type of fins, is used like straight, T-shape, Y-shape and cross shape in natural convection heat mode. The properties of Aluminum are thermal conductivity of 202.4 W/mK, density of 2719 kg/m3 well as the specific heat of 871 KJ/Kg as mentioned in Equation (6):

$$\Delta\rho = (1 - \beta(T - T_0)) \qquad (6)$$

Density variation with junction temperature has been shown in Figure 2. It reveals that the density decreases with the increment of junction temperature.

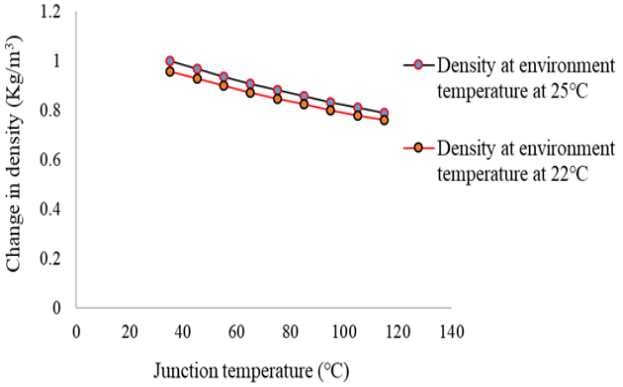

Fig. 2. Change in density with junction temperature.

Bouncy force and momentum relation are affected by changing pressure as mentioned in Equation (7):

$$\rho g = \rho_0 g(-\beta(T - T_0) - 1) \qquad (7)$$

Zhang Zhizheng Thickness cannot be increased due to the thickness and thermal performance related to the Binomial equation

2.4 Analysis of porosity

S. Hoseinzadeh et.al [25-27] Heat transfer through porous fins in laminar Flow in an isotropic medium. Darcy model is used. The method is used for studying. The author concludes that with increasing porosity, heat transfer rate, as well as heat dissipation, also increase. The iteration method is useful for the calculation of heat transfer rate. Mariana Lucaciet.al. The porous material used for cooling L.E.D. bulbs reduce the temperature by 370 C. Shoji Mori [28] a Honeycomb structure is used to reduce the time to convert a film boiling is converted into nucleate boiling La Rochelle, France et.al. [29,30]. Porous is mostly used in the heat exchanger, cooling of gas in the turbine. The laminar flow of heat is studied in a porous square cylinder. Darcy and Brinkman-Forcheimer model is used. The most important thing is that laminar Flow uses a force equation. Permeability is greater than 10-6, then Flow cannot pass, and the aspect ratio of fins affects the heat transfer rate. Dipankar Bhanjaa et. al [35-43] Gauss-Seidel and elimination method behavior of heat transfer rate method busing a various parameter like density, heat transfer coefficient, thermal conductivity, and thickness. Velocity porosity, Grashoff number, the field of magnetic as well as a power law. as well as heat transfer rate [44-55]. Equation (8) is shown as:

$$v = \frac{gK\beta(T - Ta)}{y} \qquad (8)$$

Figure 3 demonstrates that change in air velocity decreases with change in air density drastically. Figure 4 shows the velocity increases with junction temperature with fixed and variable density.

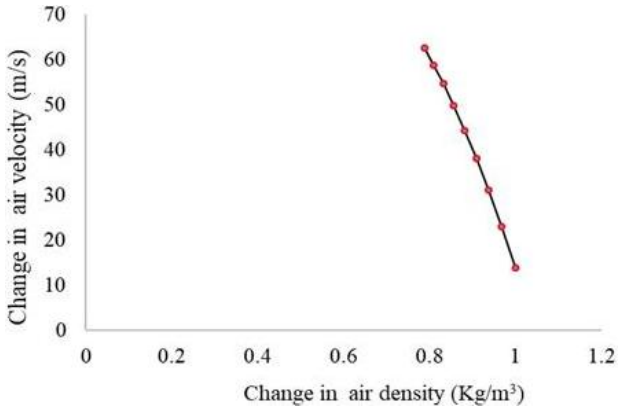

Fig. 3. Change in air velocity with change in air density.

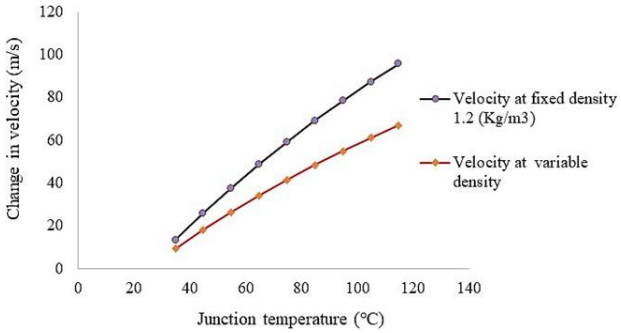

Fig. 4. Change in air velocity with junction temperature.

3. CONCLUSION

After reviewing the above-mentioned paper on the working of L.E.D, bulbs in the field of Geometry following conclusion will find.

- Proper selection of geometry is very important in appearance, weight, and sustainability in road wind and other circumstances.
- As per the Fin geometry, many fin shapes are discussed like rectangular, triangular, square, pin fin, circular, curve shape, and cross shape fin, which is the best option among the defined fin.

Material of Fins:

- Aluminum, copper, and Ti-9Al-4v are used for fins in different conditions as well as characteristics as per application, but considering the factor of cost as well as availability, Aluminum is an optimum option in the Heat Transfer point also.
- Aluminum used helps to reduce the changes in existing L.E.D. Bulbs.

Heat Transfer

- Major role in Heat transfer through L.E.D. The bulb is a Heat sink. The design of a Heat sink plays a major role in Heat Transfer.
- The convection mode of heat transfer plays a major role over another mode of conduction. In which passive cooling mode will be a good option to maintain FOM. Nusselt number, as well as Grashoff number, play a key role in heat transfer analysis.
- The main objective of Heat transfer rate enhancement by increasing the convective Heat transfer coefficient.

Simulation & Analysis

Various methods are defined, like Gauss Elimination. Guess Sidel, Rangi Kutta, Iteration Methods, and infinite order methods are used for a numerical solution and analysis. The iteration method is the most prominent method for finding a numerical study. Fluent is a better option in the simulation field, which reduces our effort and provides clear guidance for the experimental setup.

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