APPLICATIONS OF CYLINDRICAL AND RADIAL HEAT SINKS FOR COOLING OF LED LIGHT BULBS: A REVIEW

N. L. Bhirud¹, P. H. Chaudhari², A.S. Dube³ and Y.R. Falak⁴

¹,² Mechanical Engineering Department, Sandip Institute of Engineering & Management,
³,⁴ Mechanical Engineering Department, Sandip Institute of Technology and Research Centre

ABSTRACT

Fin arrays on horizontal and vertical surfaces are used in variety of engineering applications to dissipate heat to the surroundings. Studies of heat transfer and fluid flow associated with such arrays are therefore of considerable engineering significance. The main controlling variables generally available are the orientation and the geometry of the fin arrays. The purpose of the present study is to study the recent literature available for the use of the heat sinks for the heat dissipation from LED light bulbs. The review of the latest research papers was carried out and reported here. It is found that more thrust is needed to be given on the reduction of the weight of these heat sinks. So it is proposed to carry out more research in this area. It is noticed that, the rectangular plate finned heat sinks are showing better performance with the area removed in the form of notches. So it is required to compare the performance of the finned arrays under notched and un-notched conditions.

Keywords: Fin Efficiency, Heat Transfer Coefficient, Notch & Un-Notch Fin, Nusselt Number, Thermal Resistance

I. INTRODUCTION

Fin arrays on horizontal and vertical surfaces are used in variety of engineering applications to dissipate heat to the surroundings. Studies of heat transfer and fluid flow associated with such arrays are therefore of considerable engineering significance. The main controlling variables generally available are the orientation and the geometry of the fin arrays. In case of short horizontal arrays, it is observed that the air entering symmetrically from both the ends gets heated as it moves towards the centre of the fin channel, as well as it rises due to decrease in density. So, the central portion of the fin becomes ineffective because hot air-stream passes over that part and therefore it does not bring about large heat transfer. This area is removed at the centre from fins and they became inverted notched fins. 10%-40% area removal increases the heat transfer rate. This modified geometry increase in heat transfer rate, reduces material cost and material weight.

II. LITERATURE REVIEW

The aim of the survey is to study the ongoing work in the field of LED cooling using the heat sinks. Various fin
geometries are studied and the brief is presented hereafter,

Kim et al, 2014 [1], compared the thermal performance of vertical cylindrical sink with Branched fins &
conventional plate fins & Proposed correlation for estimating Nu. With increase in angle of inclination, the drag
coefficient increased and the Nu decreased. The best thermal performance was obtained for vertical orientation.
Orientation effect was intensified by increasing the number of fins or the fin length.
Kim et al, 2013 [2], investigated natural convection from horizontal cylinders with longitudinal plate fins.
Numerical model considering for natural convection and radiation heat transfer was developed experimentally.
Kim et al, 2013 [3], investigated natural convection from vertical cylinders with longitudinal plate fins.
Proposed correlation for estimating Nu.
Lee et al, 2014 [4], heat sink of LED lighting was optimized with respect to its fin-height profile. Optimization
was conducted to simultaneously minimize the thermal resistance and Mass. The cooling performance of the
optimized design (pin–fin array with the tallest fins in the outer region) showed an improvement of more than
45%.
Lee et al, 2012 a [5], radiation effect on total heat transfer for radial heat sink was studied by varying emissivity.
Optimization was carried out for Rth with and without considering change in mass.
Lee et al, 2012 b [6], optimization of Mass and Rth for radial heat sink with pin fins was carried out. Compared
to LM fin array mass reduction of 35% was obtained for fin array.
Lee et al, 2011 [7], three types of radial plate heat sink (L, LM and LMS) were compared to determine the
optimum model. Multi-objective optimizations considering thermal performance and mass simultaneously were
performed.
Lee, 2010 [8], experimental and numerical investigation of natural convection in a radial heat sink was studied.
As the number of fins, fin length, and fin height increased, thermal resistance and heat transfer coefficient
generally found to be decreasing.
Dixit et al, 2013 [9], horizontal rectangular fin array with notched fins were investigated. Different shapes of
notches were numerically investigated. Heat transfer coefficient for fins with inverted notch is found to be more
in comparison with plane fins & triangular notch gives better heat transfer. Triangular notch gives better heat
transfer performance as compared to trapezoidal and rectangular notches.
Wange et al, 2013 [10], computational and Experimental analysis of Inverted notched fin arrays is carried out &
Inverted notched fin arrays gives better performance compared to plane fins.
Shen et al, 2014 [11], orientation effects on the fluid flow and heat transfer of rectangular fin heat sinks were
studied. The performances of four heat sinks were studied in 8 different orientations.
Sane et al, 2008 [12], computational and Experimental analysis of Natural convection heat transfer from
rectangular notched fin array. Notches enhance the heat transfer rate.
Elshafei, 2010 [13], the heat transfer characteristics of round hollow/perforated pin fin heat sinks subject to the
influence of its geometry, heat flux and orientation are investigated under natural convection. The heat transfer
performance for heat sinks with hollow/perforated pin fins was better than that of solid pins.
Maaspuro, 2013 [14], thermal model for LED spot light device has been created and simulated using a FEM.
Both external natural and forced convection conditions were simulated. Results indicated that LED junction
temperature can be reduced up to few degrees if grease with poor thermal conduction is replaced with the best
silicone materials.
Luo et al., 2007 [15], experimental research on an 80 W LED street lamp is described. Maximum surface temperature of the aluminum base of the lamp was found to be about 80°C. The junction temperature of the LED chips is nearly close to 120°C at an environment temperature of 45°C, which leads to poor reliability and lower life and optical efficiency.

III. CONCLUSIONS

Like other electronic devices, the maximum junction temperature of LED chips should be kept at a suitable temperature (normally below 150°C). The traditional types of heat sinks to cool LEDs mainly include metallic fin heat sinks which have the highest reliability. Many metallic heat sink geometries are studied and reported. Cylindrical heat sinks with longitudinal plate fins, due to the geometry of LED lightings, take center stage for cooling LED lightings. The rectangular plate finned heat sinks are showing better performance with the area removed in the form of notches. So it is required to compare the performance of the finned arrays under notched and un-notched conditions.

REFERENCES


