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A Review on Experimental Design of Natural Convection of Heat Transfer from Aperture and Throughout Slotted Rectangular Pin Fin

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Abstract : Fins are used to sink heat from a system and keep that in working condition. Fins are extended surfaces which are used to cool various structures via the process of convection. Heat sinks with fins are generally used to enhance the heat transfer rate in many industrial applications such as cooling of electronic, power electronic, telecommunication and automotive components etcetera. In many situations where heat transfer is by natural convection fins offer economical and trouble free solutions. Heat indulgence techniques are the prime concern to remove the waste heat produced by systems, to keep them within permitted operating temperature limits. Heat indulgence techniques include heat sinks, fans for air cooling, and other forms of cooling such as liquid cooling. Generally heat transfer by fins is basically limited by the design of the system. But still it may be enhanced by modifying certain design parameters of the fins. Hence the aim of this paper is to study from different literature surveys that how heat transfer through extended surfaces (fins) and the heat transfer co-efficient affected by changing cross-section, climatic conditions, materials, design, weight etcetera. The objective of this paper is to present a best possible aperture pin fin and throughout hollow slot pin fin design for efficient cooling of a system in addition with apertures and their enlargement and how the conduction decrease with increase in convection.

Keywords : Fins, Extended surfaces, Convection, Sink, Techniques, System, Air Cooling, Liquid cooling, Parameters, Aperture, Slotted, Heat Transfer, design

INTRODUCTION

Fins are commonly used for cooling of various components in industries like turbines, heat exchangers, engines etcetera. Now days there are a high demand for light weight, compact and economical heat sinks. Fins are the important aspect in geometry of heat sink. A fin is generally a flat surface extended from heat sink surface. It is used for increment in heat transfer to and from environment by increasing the convective heat transfer surface area. Air-cooling also is accepted as an important technique in the thermal design of electronic packages, because besides its availability, it is safe, does not contaminate the air and does not add vibrations, noise and humidity to the system in which it is used. Using fins is one of the most inexpensive and common ways to dissipate unwanted heat and it has been successfully used for many engineering applications. Rectangular fins are the most popular fin type because of their low production costs and high thermal effectiveness. It is necessary to modify or design an advance fin because of its some advantages like no pump, no leakage, low maintenance and coolant and antifreeze solutions are not required for systems. For that computational, analytical and experimental studies are carried out for the fins geometry, material and its number and pitches. Common fin geometries that are used in industries are straight, circular and pin shaped. From the literatures reviews, there are many methods of heat removing. Out of all, for practical design of aperture and throughout slotted cooling fin, the work has been extended.

LITERATURE

R. Sam Sukumar stated that the modeling of continuous rectangular fin heat sink, rectangular interrupted fins heat sink and further designs of through holes models are designed in ”PRO-E WILDFIRE 5‟. Heat sinks, used in electronic devices, usually consist of arrays of fins arranged in an in-line manner Therefore for an optimal heat sink design, initial studies on the fluid flow and heat transfer characteristics of standard continuous heat sinks of different designs have been carried through CFD simulations. It is observed from the results that optimum cooling is achieved by the heat sink design which contains interrupted fins with holes. These heat sink designs promises to keep electronic circuits cooler than standard heat sinks and reduction in cost due to reduction in material.

Ashok tukaram pise et al [4], 2010, in this paper natural convection heat transfer from solid and permeable fins are investigated by experimental analysis. Permeable fins are formed by modifying the solid rectangular fins with drilling three holes per fins inline at one half lengths of the fins of two wheeler cylinder block. Engine cylinder blocks having solid and permeable fins were tested for different inputs like 75W, 60W, 45W, 30W and 15W. They had showed various temperature profiles, average heat transfer coefficient and the ratio of heat transfer coefficient of both fins.

Majid Bahrami reported experimental results on vertically-mounted rectangular interrupted fins. A proper selection of fin spacing and interruption sizes leading to high thermal boundary performance. Fin interruption leads to significant weight and thus cost reduction in heat sinks.

Golnoosh Mostafavi analyzed about steady-state external natural convection heat transfer from vertically-mounted rectangular interrupted finned heat sinks is investigated The optimum interruption length for maximum fin array thermal performance

is found and a compact relationship for the Nusselt number based on geometrical parameters for interrupted walls is presented using a blending technical for two asymptotes of interruption length. Additionally, fin interruption results in a considerable weight reduction and that can lead into lower manufacturing costs.

L. Dialameh et. al. [5] have did numerical study to predict natural convection from an array of aluminum horizontal rectangular thick fins of 3 mm< t < 7 mm with short lengths (L 6 50 mm) attached on a horizontal base plate. The three-dimensional elliptic governing equations of laminar flow and heat transfer were solved using finite volume scheme. Based on the verified model, fluid flow and thermal structure around various fins were illustrated and two types of flow patterns in the channel of the fin arrays were observed. Effect of various fin geometries and temperature differences on the convection heat transfer from the array was determined for Rayleigh numbers based on fin spacing of 192–6784 and applied correlations are developed to predict Nusselt numbers with corresponding non-dimensional parameters. They concluded that natural convection heat transfer coefficient increases with increasing temperature differences and increases with fin spacing and decreases with fin length.

Magarajan U. et. al. [18] have studied heat release of engine cylinder cooling fins with six numbers of fins having pitch of 10 mm and 20 mm, and are calculated numerically using commercially available CFD tool Ansys Fluent. The engine was at 150 C and the heat release from the cylinder was analyzed at a wind velocity of 0 km/h. Their CFD results were mostly same as that of the experimental results. So, they concluded that, it is possible to modify the fin geometry and predict those results, changes like tapered fins, providing slits and holes in fins geometry can be made and the optimization of fins can be done with the help of CFD results.

Wadhah Hussein et.al conducted experimental study to investigate heat transfer by natural convection in rectangular fin plates with circular perforations as heat sinks. The pattern of the perforations included 24 circular perforations for the first fin, and the perforations were increased as 8 for each fin to 56 in fifth fin. They distributed the perforations in 6-14 rows and four columns. They observed that the temperature along the non-perforated fins was from 30 to 23.7^0 at lower power 6 W. They observed that the drop in temperature between the fin base and the tip increased as the diameter of perforations increased. The temperature drop at the highest power of 220 W was from 250 to 49 ^{0}C for non-perforated fins. They concluded that the heat transfer rate and the coefficient of heat transfer increased with increased number of perforations.

M J sable et.al studied that the tall vertical fins restrict the heat transfer enhancement because of boundary layer development. They investigated the heat transfer enhancement technique for natural convection adjacent to vertical heated plate with multiple V type partition plates in ambient air surrounding. They found that V shaped partition plates with not only act as extended surface but also as flow turbulator. For heat transfer enhancement they had attached v shaped partition plates with edges faced upstream to base plates. They observed that when the plate height exceeds certain critical values the heat transfer in downstream region of the partition plate is enhanced because of the inflows of lower temperature fluid in to the separation region. They observed that among the three different fin array configurations on vertical heated plate, V type fin array design performs better than rectangular vertical fin array and V fin array with bottom spacing design.

Anusaya Salwe, numerically investigates the use of perforated pin fins to enhance the rate of heat transfer. Fins with different values of voltage under forced air are heated and temperature is measured by various sensors. In particular, the numbers of horizontal perforations, horizontal diameters of perforation on each pin-fin are studied. Results show that heat transfer in perforated pin fin is greater than solid pin fin. Pressure drop with perforated pins is reduced as compared with that in solid fins and more surface area get available which enhance the convective heat transfer.

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CONCLUSION

As all above literatures of convection heat transfer carried out to performed research and development work for the engine cooling system, thermal management of vehicles, the heat exchange in the vehicle as well as noted that heat transfer of the fin can be augmented by modifying fin pitches, geometry, shape, and material and wind velocity, extensively both theoretically and experimentally. It is found that through holes for the rectangular fin has better performance than straight rectangular fins of heat sinks and reduction in weight due to more material removal. On the basis of literature review, there is some work in scope of research in the field of convective heat transfer study on practical design of pin fin. Hence the proper design of aperture pin fin and throughout slotted pin fin can leads high convection and low conduction from base to tip.

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