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Design and Development of Aluminum-based Heat Sink for Electronic Gadgets

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Abstract--- ***The aim of the present study to investigate the optimum weight and maximum heat dissipation of the heat sink. The materials and fin design as a two-major factor to increase the heat dissipation from the electronic chip. Show 3D analysis is verified with accessible exploratory information in the existing data for a continues finned heat sink. To identify the heat dissipation and mean temperature distribution of the heat sink for natural convection. Results reveal that the 6063 aluminum alloys with case II fin design have maximum heat dissipation of the heat sink compared to 6061, 7071 alloys. The heat dissipation of heat sink case II fin design is greater than the case I fin design under all the material condition, due to the airflow of the design. The mass of the case 1 fin design is lesser than the case II fin design. In addition to, the case I fins increase the heat transfer rate and have a higher weight than regular case II fin design. Moreover, it was concluded that case II fin design has the lowest temperature without raising the weight of the heat sink, which implies that the better performance in comparison to the other designs.***

Keywords--- Heat Sink, Aluminum, Heat Dissipation, Heat Flux, natural convection, radiation.

I. INTRODUCTION

The Thermal analysis as plays a vital role for various engineering applications, particularly in the analysis of electronic gadgets. The heat dissipation plays a vital role in many industries, particularly electronics gadgets. The industries have led stringent light weight using advanced electronic technology. Hence, the light weight with efficient heat transfer as key and they need to develop the electronic gadgets for engineering application[1]. Besides, interest for financially savvy cooling arrangement has been expanding because of market interest for less expensive electronic gadgets. The research mainly focuses on the thermal management of heat flux gadgets due to the issue due to the volume, density, high area to volume ratio, and mass of the heat sink. In addition to the wide range of research for a cost-effective cooling solution are still in armature condition due to market demand for cheaper electronic devices[2–4].

The execution unwavering quality and future of electronic gadgets are emphatically influenced contrarily by the temperature distribution. The many electronic gadgets are generally cooled by constraining natural air convection and they are claiming the air cooling is yet the most widely recognized, straightforward, dependable, and minimal effort cooling procedure. Agents are searching for lighter and tiny design with higher speed of the electronic processes more than old outlines. In this manner, the rate of heat produced in the powerful gadgets will increment moderately[5–8].

The heat generation issue should be illuminated direly to guarantee smooth working of the gadget and development of the hardware business. In addition to, trademark length of the cooling gadgets should be diminished to enhance smallness of the system. Subsequently, small scale channel heat sink is the best cooling answer for high-control thickness gadgets. The design of the heat sink is significant to comprehend the component of the heat exchange improvement. Scientists have found that components of heat exchange can be enhanced through the diminishing of the heat limit layer, liquid blending and increment liquid stream speed inclination on the heated surface[9–12].

An average heat sink used to cool gadgets contains numerous discrete surface or flush mounted segments. A case heat sink containing nine parts with various heat dispersal appears. It is made of rectangular plate balances and a base plate. In any case, the shape isn't constrained to rectangular, and fin can have another cross-area, for example, triangular and trapezoidal. The primary design paradigm is to guard part temperatures underneath qualities to anticipate overheating. If the finis far separated, a solitary balance heat exchange examination is satisfactory, however, this approach is restricted in down to earth applications, which regularly require a count of the stream and heat move in channels between the balances. Outlining a balance exhibit is inherently more difficult than a single balance case[13,14]. A blade cluster issue contains more factors, a significant number of them with inverse impacts, for example, the area of the heat creating parts, the number and geometry of the balances, and the external volume of the exhibit. Also, the measure of assembling material and the power utilized by pumps or fans can influence the outcome. Now and again, a to some degree expound scientific arrangement can be utilized, however such multi-target improvement issues can simply be fathomed numerically[15–17].

Most of the past investigations on smaller scale stick blade heat sinks concentrated on enhancing the balance geometrical shape, cooling liquids and balance game Design[18]. Ricci et al[19]. Explored that the stick blade heat sink with various states of balances (roundabout, square, triangular and rhomboidal) masterminded in line under steady heat transition limit conditions. The cooling fluids as another major parameter for effect the heat dissipation. In recent literatures, they mainly focused on the cooling fluid and heat transfer rate. But still heat dissipation have more challenging recent electronic applications.

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Most electronic gadgets are reached about 33% efficiency of the heat dissipation of the existing model and some researcher are investigated the liquid cooling heat sink model, it's got better efficiency comparable to the air cooling system due to the ease of fabrication, high integration, quiet operation, high cooling capacity, compactness, anti-seep and multiple pattern. However, liquid cooling system also possible for leakages in the heat dissipation system.

Ahmed and Ahmed et al[20,21]. investigated the optimization of heat sink by considering the various geometric parameters of heat sinks to improve the thermal performance. They proved that the trapezoidal grooved MCHS provided better heat transfer enhancement with low increase in the friction factor compared to the rectangular and triangular grooved heat sinks.

Raghuraman et al[22]. did the numerical examination, 30 of aspect ratio is the favored decision and a measure of the heat dissipation is at an ideal level. Although, the micro-scale channel is usually utilized for the design of heat sink cooling, the proficiency of the heat sink cooling is reduced addition with the stream of substantial temperature contrast amongst inlet and outlet. This is the primary motivation to pull in and urge more specialists to enhance the heat expulsion abilities of the miniaturized scale channel heat sink.

Li and Shi et al[9]. upgraded the thickness of a HS base with various heat exchange limit conditions. They acquired connections for constrained convection air and fluid working liquids as far as heat sink territory proportions to a heating source, and the least heat obstruction. They connected a condition for these three parameters to streamline the heat Design of the heat sink analyzed.

Kim et al[23]. what's more, Li and Chen enhanced the heat execution of a plate-blade heat sink with various widths and statures of balances. They got 30% diminishment in the heat obstruction contrasted with the level plate-balance heat sink. This lessening was expanded with expanding of the stream rate and diminishing of the heat sink length. They announced that expanding of the blade width caused a lessening in the heat opposition at first until the point when a specific esteem and after that expanded. Higher blade statures indicated bring down heat opposition.

Lin et al[4]. analyzed vertical and angled designer balance heat sink to make extended the surfaces of heat sink keeping the cross-sectional zones inside the fin cluster. Their trials uncovered that the angled designer fin heat sink demonstrated preferred heat exchange rate over that with vertical balances. For high-weight fan, the additional cooling impact diminished the CPU case temperature around 60^{o}C utilizing angled balances. Wang et al.[3]investigated the heat sink with and without tabulators situated at the blade surfaces of the heat sinks. Their outcomes demonstrated that the planned full balance alongside the structure furnished heat exchange raises of 25% with contact ruination of heat sink 20%. They expressed that the intruded-on balances still offer great improvement in completely created district without evident increased. The aim of the current research to analyze the maximum heat dissipation and optimum weight of the heat sink .

II. METHODOLOGY

A schematic diagram of the heat sink, with electronic processor as figure 1. The electronic gadget is simulated as a constant heat flux at the top wall of the sink. The parameters varied along this study are; the materials and design construction of the heat sink. The dimension of the heat sink both base is 5 X 68 X 68 mm^3. The case I of the fin dimension is 1 X 68 X 27 mm^3, and its formed 24 fins at the top of the base. The case II 529 square fins are arranged inline forms on both side, the dimension of the fin 1X 1 X 27 mm^3. The size of the processor is 31 X 31 X 4.24 mm^3 and its produce heat flux supplied to the bottom of the substrate block is considered 50 kW/m^2. The sample model of heat sink with processer before and after mesh as shown in figure 2. The mesh size of the heat sink is 15 element division and Brick 8node 70 as element types. The properties of the various aluminum alloy as shown in Table 1.

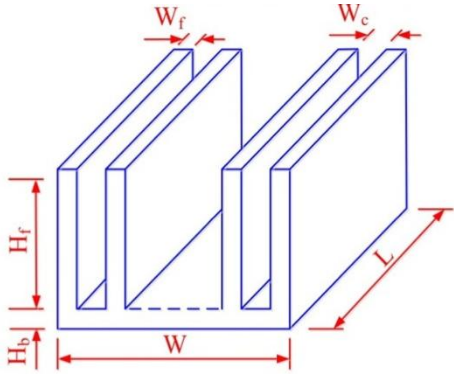

Figure 1: Schematic diagram of heat sink

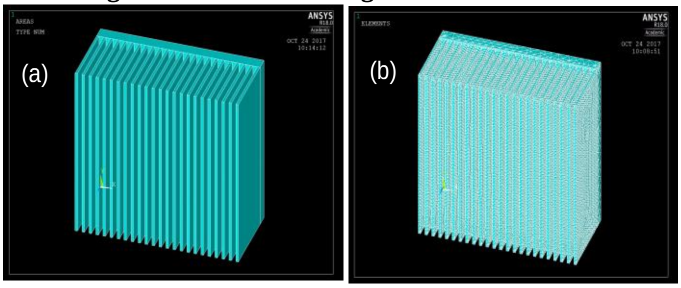

Figure 2: Before and mesh of heat sink – Case I

Table 1: The Materials properties of the aluminum alloy

Sl.No	Materials	Density (g/cm^3)	Thermal Conductivity (W/m-K)
1	7075 alloy	2.71	202
2	6061 alloy	2.7	193
3	356 alloy	2.72	172
4	6063 alloy	2.7	200

Air Cooling: Natural Convection

The Natural convection of the air cooling is most common cooling system for most of electronic gadgets. The air flow is relatively free and tend to slow down the air by fins , and is low efficient when the air is passes through the narrow flow and over many fins arrangements.

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The magnitude of the natural convection heat transfer between a surface and an air is directly related to the flow rate of the fluid.

$T_f$by convection is expressed as,

$$Q=h_cA(\delta T) =h_c A\delta(Ts–T_f) \text{ (W)} \qquad - 1$$

Where, A is the heat transfer area and h_c is the heat transfer coefficient The value of h_c is mainly depends on the surface geometry and the fluid flow type.

III. RESULT AND DISCUSSION

The temperature distribution of the case I heat sink as shown in figure 3. The temperature distribution aluminum alloy 1 as slightly greater than the other three alloys. In alloy 3 as reached lower rate. Similarly, the case II heat sink distribution also alloy 1 as a greater temperature distribution as shown in figure 4. The temperature distribution of the heat sink case II as better compare to case I, due to air flow through the fins, and the temperature also distributed evenly in all the regions.

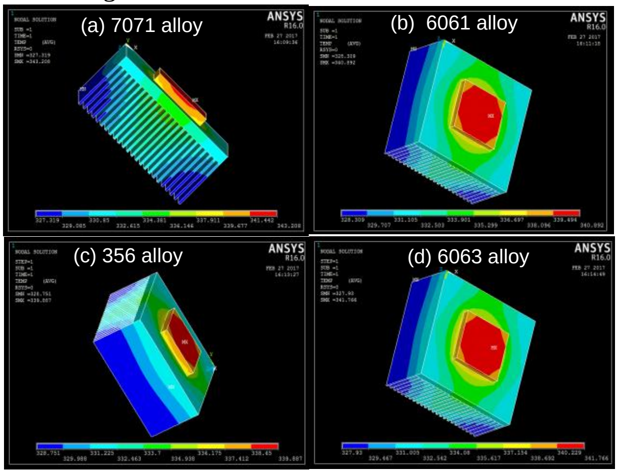

Figure 3: Temperature distribution of heat sink case I

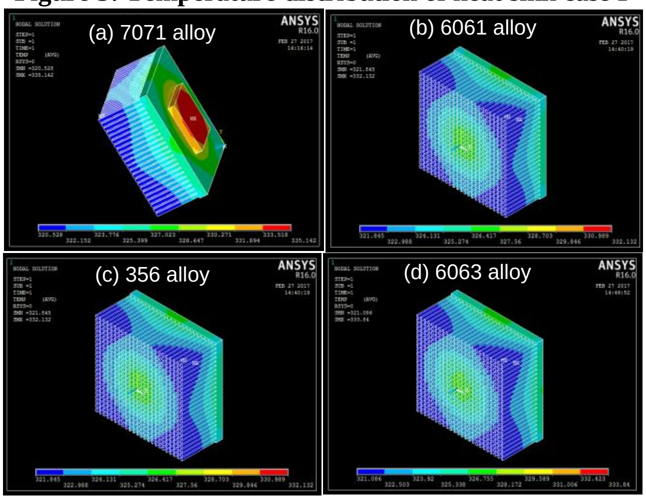

Figure 4: Temperature distribution of heat sink case II

The nodal distribution of heat flux case I as shown in figure 5. The rate of heat dissipation is increases with increase the thermal conductivity and the weight of the materials also plays major role in the heat sink. In case II have less weight compared to case I and the fin optimization of case II as shown the better heat dissipation and the 7071 alloy has shown the better heat extracted from the processor as shown in Figure 6.

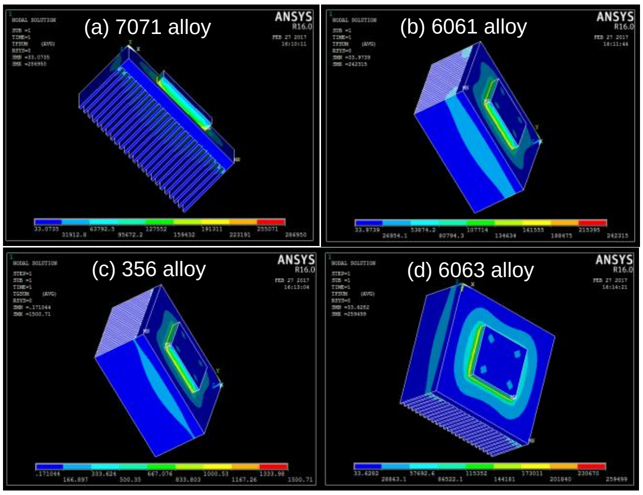

Figure 5: Heat flux of heat sink case I

The fin structure of the heat sinks as increased the heat dissipation of the case II. Hence the structure of the heat sink fins and air flow over the fins are given the better heat transfer rate and also the air gaps between the fins each other. The case II fin arrangement gives the air flow in the all directions and it gives whirling motion of air creates at the centre of the heat sink and they dissipate the heat much better than the existing model of the heat sink.

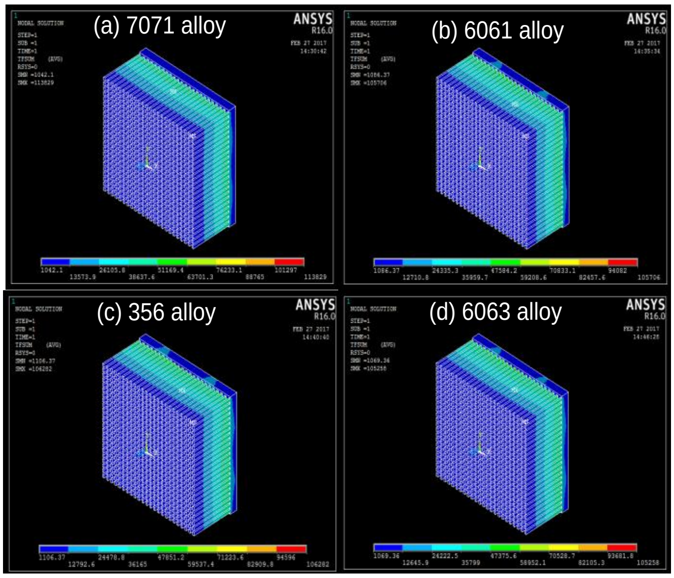

Figure 6: Heat flux of heat sink case II

IV. CONCLUSION

This paper made an attempt to design and analysis the heat sink for processor heat dissipation by combining both natural and forced convection air under different aluminum-based materials. The 6071 aluminum alloys with case II fin design have maximum heat dissipation of the heat sink compared to 6061, 6063 and 356 alloys. The heat dissipation of heat sink case II fin design is greater than the case I fin design under all the material condition, due to the airflow of the design. The mass of the case 1 fin design is lesser than the case II fin design. In addition to, the case I fins increase the heat transfer rate and have a higher weight than regular case II fin design.

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Moreover, it was concluded that case II fin design has the lowest temperature without raising the weight of the heat sink, which implies that the better performance in comparison to the other designs.

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