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Performance Evaluation of Aluminium Sloted Heat Sink for Efficiency Improvement

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***Abstract* - In this study, different heat sink geometries used for electronic cooling are studied and compared to each other to determine the most efficient. The goal is to optimize heat transfer of the heat sinks studied in a range of configuration based on fin geometry. Heat sinks are thermal conductive material devices designed to absorb and disperse heat from high-temperature objects (e.g. Computer CPU). Common materials used in the manufacturing of heat sinks are aluminum and copper due to their relatively high thermal conductivity and lightweight. Aluminum is used as the material for the heat sinks studied in this research project. To, experimental results from a wind tunnel test conducted were compared to numerical results generated to establish a validation case. Best practices in running numerical simulations on heat sinks along with suitable models for simulating real-world conditions were determined and analyzed. The two main thermal performance-evaluating parameters used in this project are pressure drop (ΔP) and thermal resistance (R). Thirteen numerical CFD simulations were run on different heat sink fin extrusion geometries including the traditional rectangular plate, arc plate, radial plate, cross pin, draft pin, hexagonal pin, mixed shape pin fin, pin and plate, separated plate, airfoil plate, airfoil pin, rectangular pin, and square zig-zag plate heat sinks. It was observed that different fin geometries and dimensions affect the performance of heat sinks to varying extents.**

The square zig-zag plate heat sink from results obtained had the lowest thermal resistance of 0.25 K/W with the separated plate having the lowest pressure drop of 11.94 Pa. This information is relevant in the selection of fan type, size, and model of heat sink for electronics cooling. Also, another important conclusion drawn from this project is the existence of no definite correlation between the thermal resistance (R) and pressure drop (ΔP) parameters when evaluating heat sink performance.

Keywords: Heat Sink, CFD, Heat Transfer.

I. INTRODUCTION

Scope of Project in broad sense

Performance of mini-channel heat sink was mainly evaluated using theoretical and mathematical analysis. Mini-channels heat sinks are using Al_2O_3-H_2O (DI) at two different volume concentrations of .01% & .05%. Theoretical analysis was not sufficient for prediction of the actual performance of the mini-channel based heat sink as this analysis was based upon certain assumptions. So the obtained results were investigated and validated through experimental procedures.

1.1 Modes of Heat Transfer

Heat is a form of energy, hence can be transferred from one medium to another to conserve it. As a result of the law of energy conservation, heat transfer or thermal energy is transferred from a higher thermal energy surface or object to a lower medium or object. Heat transfer occurs in different modes under different conditions. The three modes of heat transfer that exist include conduction, convection, and radiation.

1.2 Electronic Cooling

Electronic cooling over the years has become more important due to the increase in heat flux generated in electronic devices. All electronic devices generate heat during operation. For an efficient, fast, and reliable operation of these gadgets, cooling needs to take place in order to keep the temperature within devices acceptable for functionality. Several methods of electronic cooling exist; the most widely used include heat pipes, heat sinks, and impinging jets.

1.3 Conduction Heat Transfer Method

Conduction mode of heat transfer takes place within a solid or at the interface where objects are in contact. In a solid material, heat is transferred through conduction as a result of the vibration of atoms against one another within it without the material not necessarily moving as a whole. In heat sinks,

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conduction takes place in two different phases. First is the heat transfer through conduction between the object being cooled and the base or bottom surface of the heat sink. The second phase is conduction within the heat sink from its base to the extruded fins. Heat from the hot bottom base of the heat sink is conducted to the extruded fin for dispersion to its surroundings.

II. METHODOLOGY

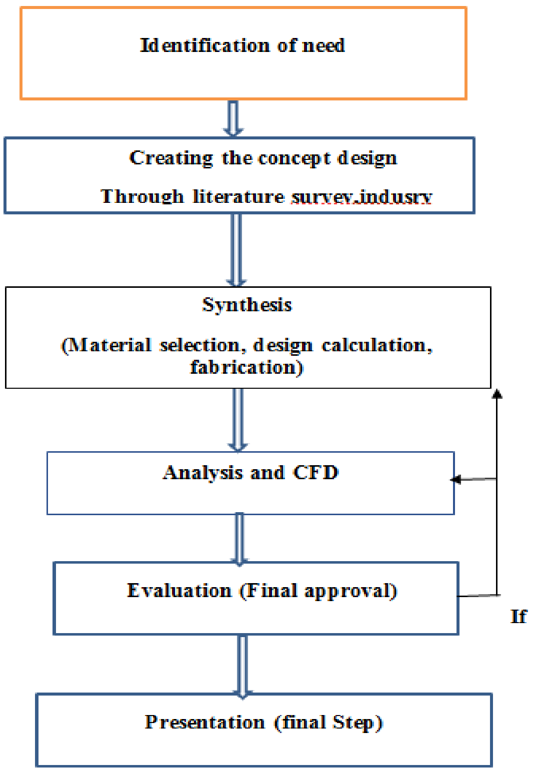
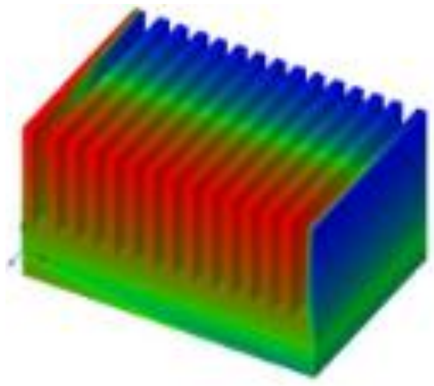


Figure 1: System Architecture

CAD Model Generation

For the CAD modeling of the heat sinks studied for this thesis, Solid works [40] was used. The generation of the model can be separated into two different parts: the base and extruded fins which are the main parts of the heat sink.

First, a sketch of the heat sink base was generated and extruded to form its thickness. Dimensions and shape of the base can be seen in Figure 4.Next, a sketch of the pin or plate fins was generated across the base of the heat sink and extruded. For faster and simple modeling of the extruded fin ones, one sketch was created and extruded the linear pattern function was used to create the number of pin or plate fins desired. This parameter was also kept constant in all the heat sink models generated for better comparison results. For the pin fin heat sinks, the fins were arranged in a 13 X 25 matrix order while the plate fin heat sinks had 25 fins. Figures 5 (a) and (b) shows an image of the plate and pin fin heat sinks and their fin arrangements respectively. In order to ensure the accuracy of heat sink performance results obtained and compared, the dimensions for the base and extruded fin height and width (diameter) were kept constant for the differently shaped heat sink designed generated.



There are two types of 3D Solid Modeling

1. *Parametric modeling* allows the operator to use what is referred to as "design intent". The objects and features created are modifiable. Any future modifications can be made by changing how the original part was created. If a feature was intended to be located from the center of the part, the operator should locate it from the center of the model. The feature could be located using any geometric object already available in the part, but this random placement would defeat the design intent. If the operator designs the part as it functions the parametric modeler is able to make changes to the part while maintaining geometric and functional relationships.
2. *Direct or Explicit modeling* provides the ability to edit geometry without a history tree. With direct modeling, once a sketch is used to create geometry the sketch is incorporated into the new geometry and the designer just modifies the geometry without needing the original sketch. As with parametric modeling, direct modeling has the ability to include relationships between selected geometry (e.g., tangency, concentricity).

Heat transfer

As previously mentioned in literatures, heat transfer characteristics of the LED package can be analyzed by the structure function method. It discusses the heat capacity parameters and thermal conductivity of the properties along the one-directional heat flow path. In order to derive the structure function, the thermal evaluations were firstly identified, followed by the heating or cooling curves. By transforming the curves, the structure function can be thus determined.

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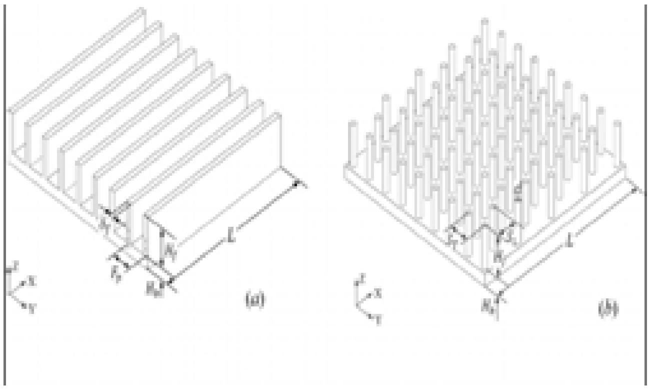
In this project the Heat sink of the power amplifier has been optimized for more heat transfer, less weight and less pressure drop using CFD analysis. The heat sink is mounted in the power amplifier on which different electronic components are mounted which dissipates heat. This project aims to simulate the heat distribution over a heat sink using Ansys fluent simulation tool to serve the goal of investigating and studying the effect of integrating phase change materials into the heat sink in order to improve the cooling performance and consequently increase the efficiency of electronic chips. It also investigates the importance of the density and thermal conductivity and how it affects the peak time. Moreover, experiments were performed in order to verify the obtained simulation results.



To this study, a validation case was established based on the literature review conducted to ensure results obtained from the simulation run were accurate and the assumptions and models used were valid. Using experimental results from Loh and Chou's [42] work on the comparative analysis of heat sink pressure drop using different methodologies, a validation case was established. In their work, a theoretical, experimental, and numerical study was done and compared to each other for validation. For the theoretical method, three equations for solving pressure drop were derived from the force balance on the heat sink and the Flemings.

III. RESULTS AND CONCLUSION

We efficient device for cooling of the electronic equipment's. In future these types of heat sinks can be used in big data devices, server room, gaming pc and other data processing electronic devices. Due to space limitations of a heat sink in a computer, it is not possible to increase the height of the heat sink. Therefore, the base plate is attached with heat sink to enhance the performance rather than increasing the height of heat sink. Improvements on heat sink designs are possible by the use of CFD. It is possible to design a new heat sink with suitable base plate which has better thermal performance and uses less material using CFD simulations.

REFERENCES

[1] Tu-Chieh Hung, Wei-Mon Yan, Xiao-Dong Wang, Chun-Yen Chang, "Heat transfer enhancement in microchannel heat sinks using nanofluids", International Journal of Heat and Mass Transfer 55 (2012) 2559–2570.

[2] AltayyebAlfaryjat, Lucian Miron, Horatiu Pop, Valentin Apostol, Mariana-FlorentinaStefanescu and Alexandru Dobrovicescu, "Experimental Investigation of Thermal and Pressure Performance in Computer Cooling Systems Using Di_erent Types of Nanofluids", nanomaterials 29 August 2019.

[3] Hao Li, Xiaohong Ding, Dalei Jing, Min Xiong, Fanzhen Meng, "Experimental and numerical investigation of liquid-cooled heat sinks designed by topology optimization", International Journal of Thermal Sciences 146 (2019) 106065.

[4] Amin Jafarimoghaddam, Sadegh Aberoumand, "A Comparison between heat transfer performance of rectangular and semicirculartubes considering boundary effects on Brownian motions in the presence of Ag / water nanofluids: Applicable in the design of cooling system of photovoltaic cells", Xiao-Dong Wang, North China Electric Power University, CHINA July 28, 2017.

[5] Ali Ijam, R. Saidur, P. Ganesan, "Cooling of minichannel heat sink using nanofluids", International Communications in Heat and Mass Transfer 39 (2012) 1188–1194.

[6] Ghasemi, SeyedEbrahim; Ranjbar, Ali Akbar, Hosseini, Seiyed Mohammad Javad, "Cooling Performance Analysis of Water-Cooled Heat Sinkswith Circular and Rectangular Minichannels Using Finite Volume Method", Iran. J. Chem. Chem. Eng. Research Article Vol. 37, No. 2, 2018.

[7] Mr. A. Sivakumar, Dr. N. Alagumurthi and Dr. T. Senthilvelan, "Effect of CuO/ Water Nanofluid Heat Transfer IN Serpentine Shaped Microchannel Heat Sink", International Journal of Mechanics and Thermodynamics. ISSN 2278-361X Volume 5, Number 1 (2014), pp. 1-12.

[8] Ravindra Kumar, Mohd. Islam, M.M. Hasan, "Nanofluids as Heat Transfer Enhancers in Microchannels - A Review", Journal of Basic and Applied Engineering Research Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 1, Number 2; October, 2014 pp. 65-68.

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