Experimental and Transient Thermal Analysis of Heat Sink Fin for CPU processor for better performance

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Abstract: The advancement of the digital computer and its utilization day by day is rapidly increasing. But the reliability of electronic components is critically affected by the temperature at which the junction operates. The designers are forced to shorten the overall system dimensions, in extracting the heat and controlling the temperature which focus the studies of electronic cooling. In this project Thermal analysis is carried out with a commercial package provided by ANSYS. The geometric variables and design of heat sink for improving the thermal performance is experimented. This project utilizes thermal analysis to identify a cooling solution for a desktop computer, which uses a 5 W CPU. The design is able to cool the chassis with heat sink joined to the CPU is adequate to cool the whole system. This work considers the circular cylindrical pin fins and rectangular plate heat sink fins design with aluminium base plate and the control of CPU heat sink processes.

Key words: Heat sink fin, CPU Processor, ANSYS, Transient Thermal Analysis

1. Introduction

In the present era, the trend to design electronic products becomes thinner, lighter, shorter, & smaller. Due to the actuality that shrinking in the dimension of these electronic components will consequence in a drastic increase in the heat generation rate when evaluating with previous products. For this reason, an efficient cooling system to remove the high heat generation and consequently maintains the reliability and stability of the products, have gained much attention. The heat sink component is the most common heat exchanger for CPUs and has been extensively exercised in order to provide cooling utility for electronic components. The conventional heat sink module utilized the natural as well as forced convection cooling technique; dissipate heat from CPUs to the ambient air. The combination of the heat sink and fan design usually involved in this forced convection cooling technique. Cheng-Hung et al [1] developed a three-dimensional heat sink design to estimate the optimum design variables. Temperature distributions are dignified by using thermal camera for the optimal heat sink modules and results are compared with the numerical solutions to validate the design. C.J. Kobus et al [2] investigate the effect of thermal radiation on the thermal performance of heat sink having pin fin array by theoretical and experimental approach. Dong-Kwon Kim et al [3] compared the thermal performances of two types of heat sinks i.e. plate-fin and pin-fin and used a volume averaging approach based model for envisaging the pressure drop and the thermal resistance. Emrana et al [4] performed a three-dimensional numerical simulation is in order to investigate the flow dynamics and heat transfer characteristics in a micro channel heat sink. Goshayeshi et al [5] conduct numerical studies on vertical fins, attached with the surface. Natural convective heat transfer find out from heated plane, which is kept into air with horizontal and vertical surface. Li et al [6] investigated the performance of plate fin heat sinks with cross flow. The effect of different parameters like the fin width, fin height, Re. number of cooling air on the thermal resistance and the pressure drop of heat sinks were studied. Mehran et al [7] examined numerically and experimentally, Steady-state external natural convection heat transfer from vertically-mounted rectangular interrupted fins. FLUENT software is employed to develop a 2-D numerical model of fin interruption effects. An experimental Numerical parametric study was performed to investigate the effects of fin spacing, and fin disruption.

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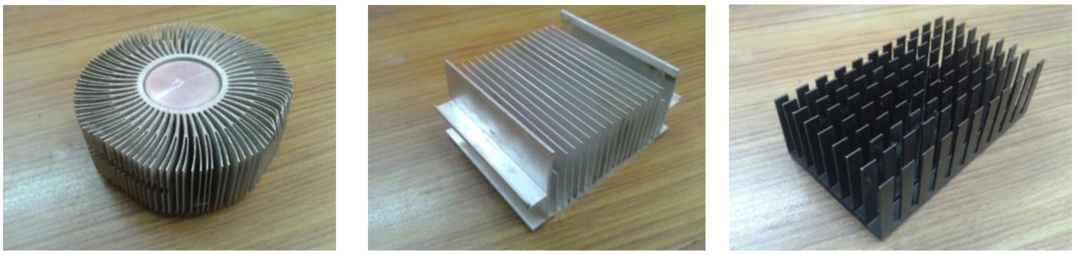
Mahmoud et al [8] examined numerically and experimentally, Steady-state external natural convection heat transfer from vertically-mounted rectangular interrupted fins, fin height ranging from 0.25-1.0 mm and fin spacing from 0.5 to 1.0 mm was taken. Qarnia et al [9] using numerical approach investigates the heat transfer by natural convection during the melting of a phase change material. Sable et al [10] investigated the natural convection of a vertical heated plate with a multiple v- type fins having ambient air surrounding. In this paper, the CPU cooling performances of a computer chassis with rectangular and circular pin fin heat sinks were investigated using transient thermal analysis and the results were compared. An alternative model of heat fins has been designed to increase heat dissipation. These fins utilize thermal analysis to identify a cooling solution for a desktop computer, which uses in a 5W CPU. In ANSYS both the materials existing and proposed materials is analysed and the results of steady state and transient thermal analysis are taken for comparison.

2. Experimental set up

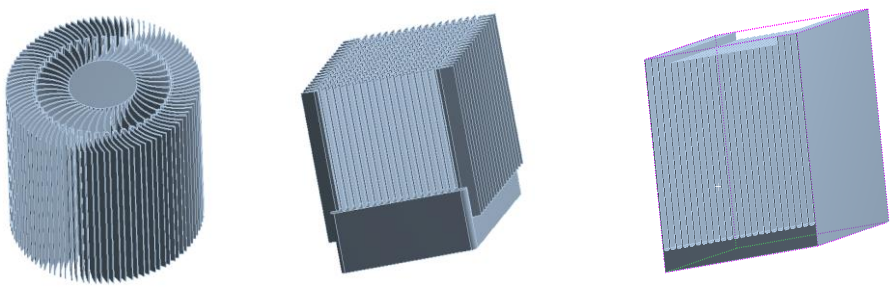
Experiments were conducted to investigate forced convective cooling performance of an air cooled parallel plate fin heat sink circular ,with coated and without coated rectangular pin fins between the plate fins. The original parallel plate heat sink was fabricated consist parallel plates of length 53 mm with cross-sectional area of 1.4 mm in width by 20 mm height for each plate. The second heat sink has the same geometry of original one but with some circular pins between the plate fins. Thermal and hydrodynamics performances of the heat sinks have been assessed from the results obtained for the pressure drop, thermal resistance and overall performance with the free stream air velocity ranging from 4.7 to 12.5 m/s. Fig 1(a),(b) and (c) represents circular fin , rectangular fin with coated and without coated.



(a) (b) (c)

Fig 1 Photo image of (a) Circular fin (b) Rectangular fin with coated (c) Rectangular fin without coated

2.1 Modeling and Analysing of heat sink fins



(a) (b) (c)

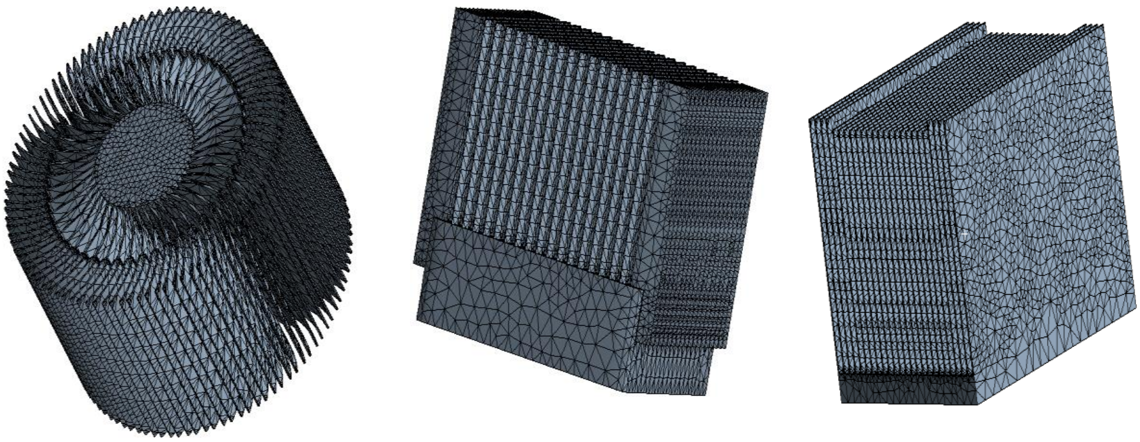
Fig 2 Model image of (a) Circular fin (b) Rectangular fin with coated (c) Rectangular fin without coated

The flow of work used in each simulation. The steps are the following.

- Creation (reception) of 3D model
- Preparation of the model before taking it into FEM software such as elimination of bad geometry, simplification of unnecessary parts and improvement of contact regions
- Basic inputs in ANSYS workbench15.0. This information will allow the model to work properly during simulation and will define the behavior of the parts during the analysis
- FEM inputs. These parameters will control the computational time and the accuracy of results in the simulation. A special analysis of factors is performed in order to define them.
- Simulation is carried out by the software
- Results obtained need to be evaluated and judged as good or bad before presenting them in the report.

Fig 2 (a),(b) and (c) represents the model of circular fin , rectangular fin with coated and without coated.

2.2 Meshing of heat sink fins



(a) (b) (c)

Fig 3 Meshed image of (a) Circular fin (b) Rectangular fin with coated (c) Rectangular fin without coated

Table 1 Mesh details for heat sink fins

S.No	Heat sink fin	Mesh size	Element type	No of nodes	No of elements
1	Circular fin	5mm	tetrahedron	73712	233998
2	Rectangular fin with coated	2mm	tetrahedron	41730	92289
3	Rectangular fin without coated	3mm	tetrahedron	53904	163653

Fig 3 (a), (b) and (c) represents the meshed image of circular fin, rectangular fin with coated and without coated.

2.3 Boundary conditions

Selection of the proper boundary conditions is important in the analysis of structures. For a static analysis, it is common to use a simpler assumption of supports without considering the soil system stiffness. However for dynamic analysis, representing the soil stiffness is most important. The boundary conditions used are corresponding to a double-pinned axle and the model is prevented from translation and rotation in all directions.

2.4 Transient Thermal Analysis

Transient thermal analysis shows temperature and other thermal parameters that vary over time; which are input in evaluating the structural analyses which is a steady-state thermal analysis. The induced loads in a transient analysis are functions of time that can separate the load versus time curve into load steps.

3. Results and Discussions

3.1 Analysis of Existing heat sink fins

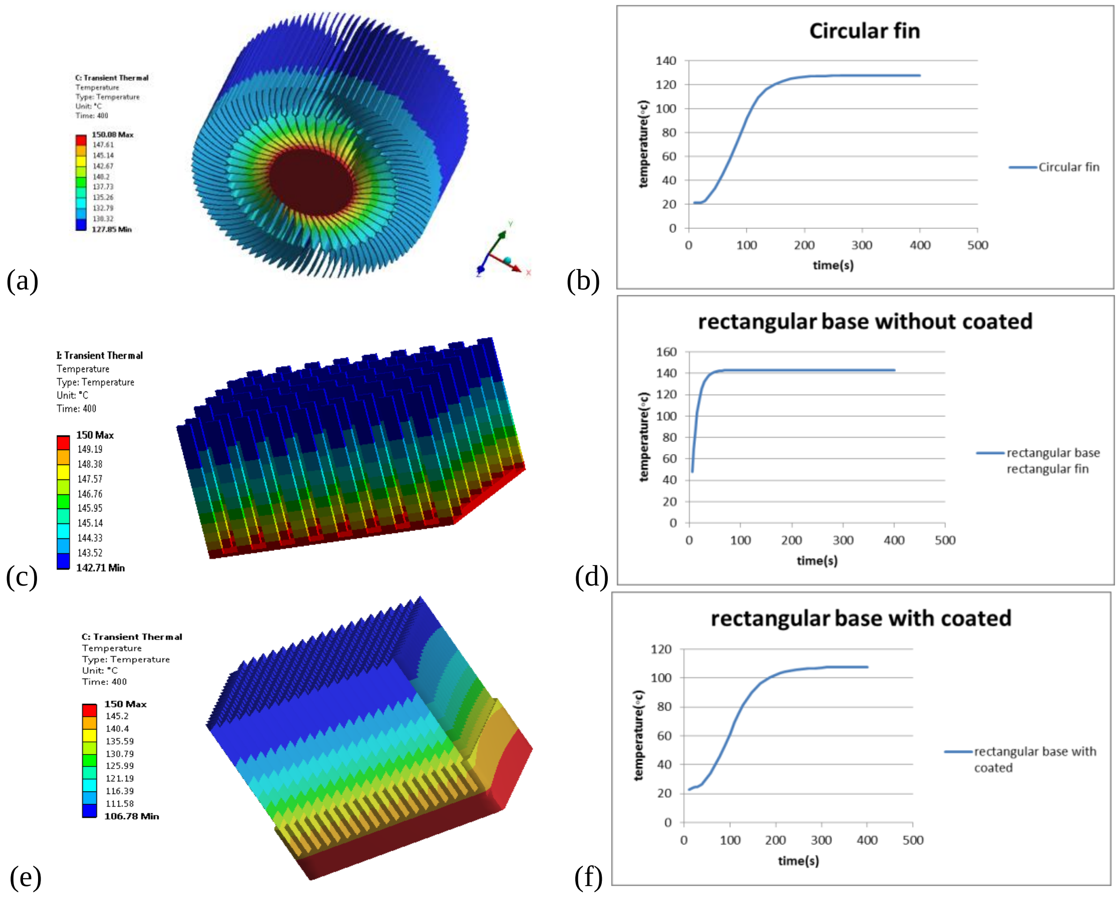


Fig 4 Meshed image and Transient thermal analysis of (a) Circular fin (b) Rectangular fin with coated (c) Rectangular fin without coated

3.2 Proposed models and its analysis

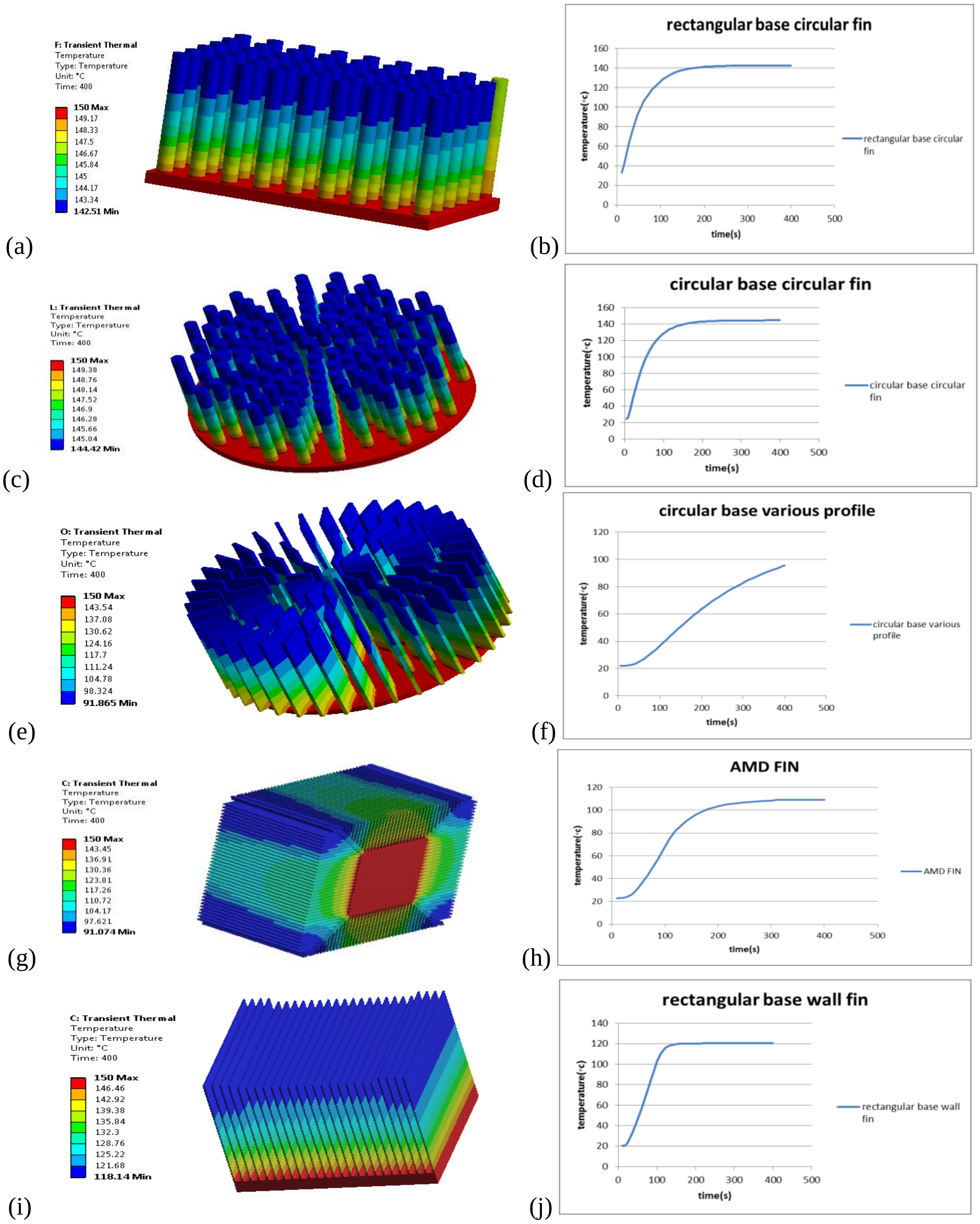


Fig 5 Meshed image of (a) Rectangular base circular fin (b) Circular base circular fin (c) Circular base various profile fin (d) AMD fin (e) Rectangular base wall fin

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3.3 Proposed models comparison of analysis

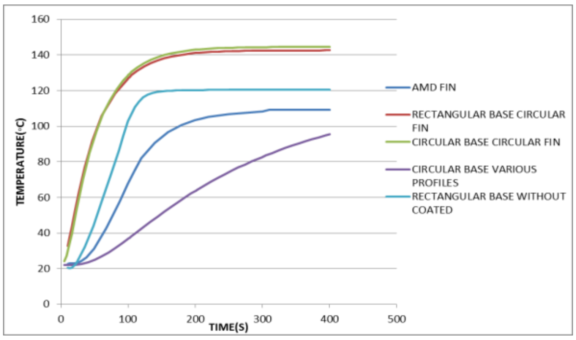

Fig 6 Comparison of analysis of proposed models

4. Conclusions

An alternative model of heat fins has been designed to increase heat dissipation. In ANSYS both the materials existing and proposed materials is analysed and the results of steady state and transient thermal analysis are taken for comparison. From the observations the following conclusions are made:

- CPU cooling performances of a computer chassis with rectangular and circular pin fin heat sinks were investigated using transient thermal analysis and the results were compared. The heat sink temperature difference results have been compared with an experimental result to find out best heat sink designs, and it shows the good correlation.
- Model 3 is proposed due to maximum heat dissipated, compare to other proposed models.

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