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Natural Convection Heat Transfer from Modified 1Degree 2 Degree And 3 Degree Outward Expansion of Pin Fins

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Abstract:
Electronic appliances are usually become overheated when they work consistently. Heat sink is used to extract heat of the system by adding fins to the base plate. In current work modified pin design is used to remove the heat. Traditional fins and modified fins both are tested under steady state condition and the test are conducted under natural convection of the air. The result reveals the better performance of modified pin as compared to conventional pin. The experiment has performed on the ANSYS software.

Keyword: Modified Fins, Conventional Fins, Total Heat Flux, Angle of expansion of modified pin fin, ANSYS software.

I. INTRODUCTION

Heat sink is used to remove the heat of electronic components and rate of heat transfer can increase with fin installed with the base plate. In Recent research tapered cylinder fins, hollow pin fins are used in special conditions [1]-[2].Number of researches have been conducted to improve the efficiency of pin fin [3]. The change in geometry of fins help to improve the efficiency of the fins [4-6].Discussed the optimisation of rectangular profile circular fins with variable thermal conductivity and convective heat transfer coefficients [7].It has been found that several design factors are important in the design of heat sinks. The geometrical parameters of fins transverse and longitudinal pitch between adjacent fins, number of fins, materials of fins, surface finish of fins, inclination of fins are most of important parameters to affect thermal performance of heat sinks [8]-[12].

II. MODELLING

The current work is based upon conventional as well as non-conventional pin fins. The new design of pin fins is tapered pin fins profile. In figure 1 conventional pin fins are shown and figure 2 represent modified pin fins. The change of shape is visible from both the figures 1and 2.The angle of expansion is 1 degree 2 degree and 3 degree respectively. In both figures the heat source is taken at the bottom of base plate and there is no any other source of heat supplied to the heat sinks. The heat transmission takes place in two forms conduction and convection. Initially the heat is transmitted in heat sink is due to conduction and secondly the heat is thrown out from fins in the form of natural convection of the air.

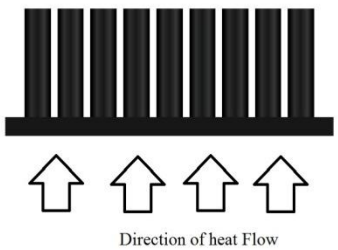


Figure. 1. Conventional pin fin heat sink (Front view)

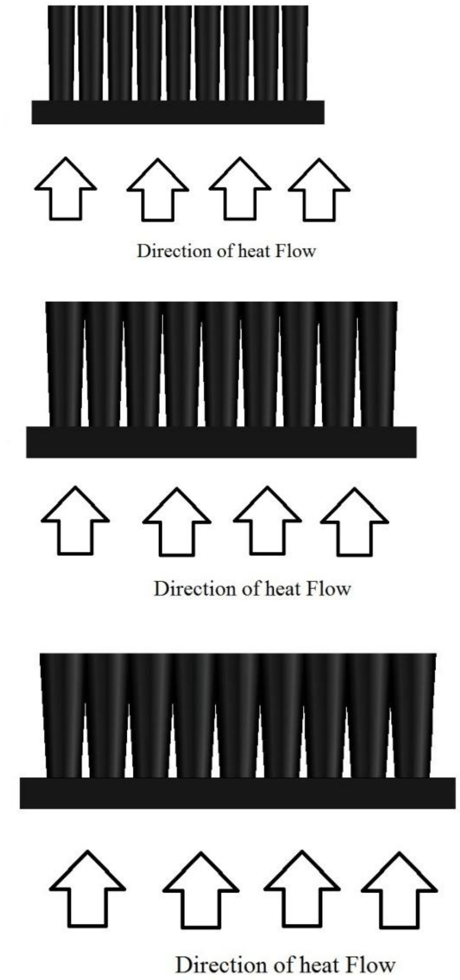


Figure. 2. The modified pin fin heat sink with 1 degree 2 degree and 3 degree of expansion (Front view)

III. PHYSICAL MODEL AND GEOMETRIC PARAMETERS

The isometric view of traditional circular pin fins is shown in figure number 3.The dimension of fins is taken as L=Length, W=Width and Hf=Height of Sink. The geometrical parameter is taken as for current work is L=100mm, W=60 mm Hf=40mm Hf = t+h height of pin fin h =32mm Thickness of base plate t=8mm Fin Number N=45 Distance of fins, calculated at the base plate surface P= 10mm The modified Pins are expanded outward 1 degree, 2 degree and 3degree but other parameter are fixed.

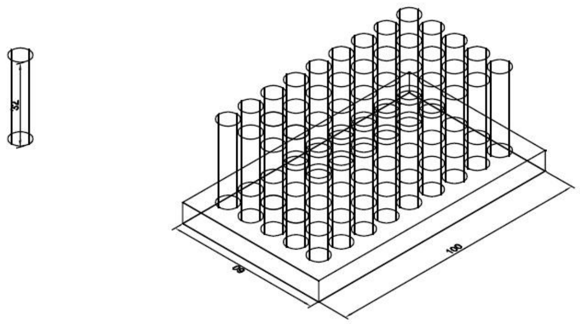


Figure.3. Geometric parameters of heat sink (isometric view)

IV. ASSUMPTIONS

The following assumption is taken to conduct the current experiment.
1) The air is incompressible.
2) Natural convection of air
3) convective heat transfer is uniform.
4) No external heat supplied except heat of sink itself.
5) First of all heat received by bottom face of base plate and temperature is uniform at the base plate.
6) Contact resistance is negligible between the fins and base material.
8) Material considered for thermal analysis is isotropic and homogenous.

V. BOUNDARY CONDITIONS

To analysis the present work boundary conditions are fixed as given bellow.
a) Ambient Temperature T_a=22 ^{0}c =295K
b) Convective heat transfer coefficient h=24W/m2K
c) Power of heat Source P=200 W

VI. MATERIAL PROPERTIES

Aluminium alloy 7050-T7651 has been used for analysis of present work. The mechanical and thermal properties of this alloy are given below:
Thermal Conductivity 153 W/m-K
Density 2.8×1000 Kg/m^3
Specific Heat 0.83 J/kg k
Melting point 488 ^{0}C

VII. THERMAL ANALYSIS

The thermal analysis is carried out in the simulation of ANSYS simulation software. The model designed for heat sinks is shown in figure 4 show the isometric view with zero degree expansion and modified pin with heat sink with 1degree 2degree and 3 degree expansion outward. After the selection of material the boundary conditions are decided afterward mesh is generated for current model and subsequently simulation is run.

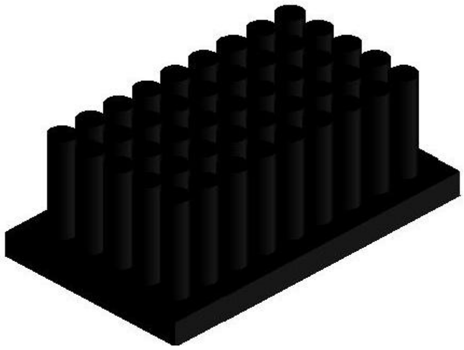


Figure.4.(a) Isometric view of Conventional pin fin heat sink (zero degree expansion)

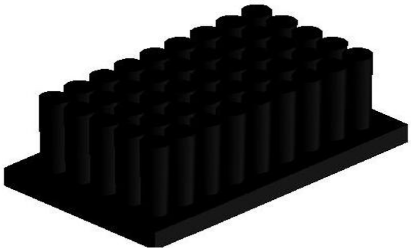


Figure.4.(b) Isometric view of Modified pin fin heat sink (one degree expansion)

Figure.4. (c) Isometric view of Modified pin fin heat sink (two degree expansion)

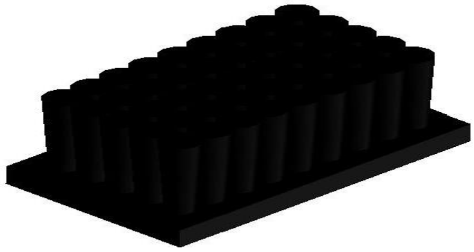


Figure.4.(d) Isometric view of Modified pin fin heat sink (three degree expansion)

VIII. SIMULATION RESULT

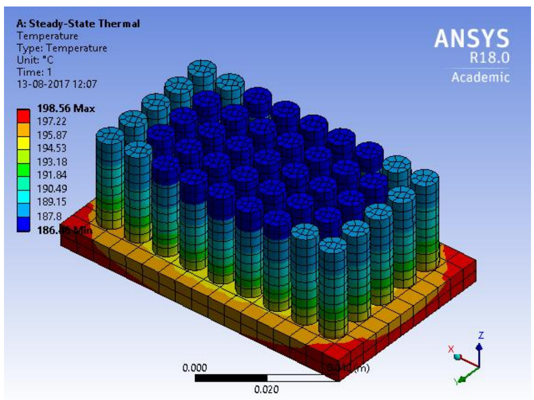


Figure.5.(a) Temperature of Conventional pin fin heat sink (zero degree expansion)

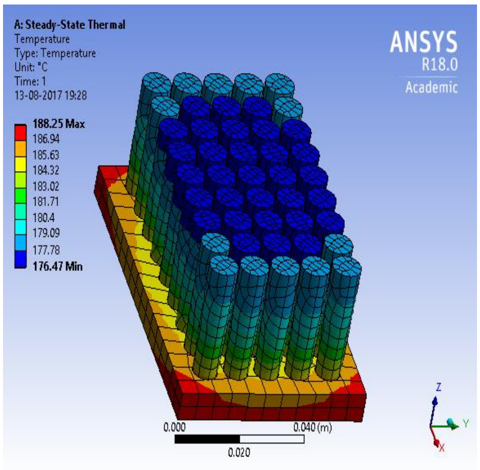


Figure.5.(b) Temperature of Modified pin fin heat sink (one degree expansion)

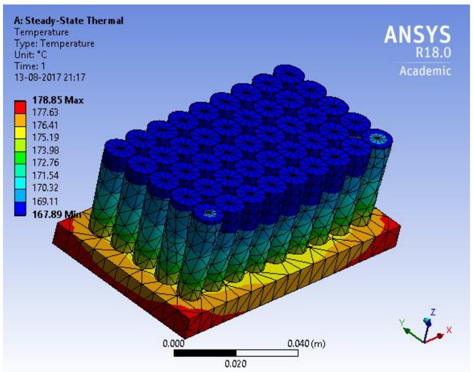


Figure.5. (c) Temperature of Modified pin fin heat sink (two degree expansion)

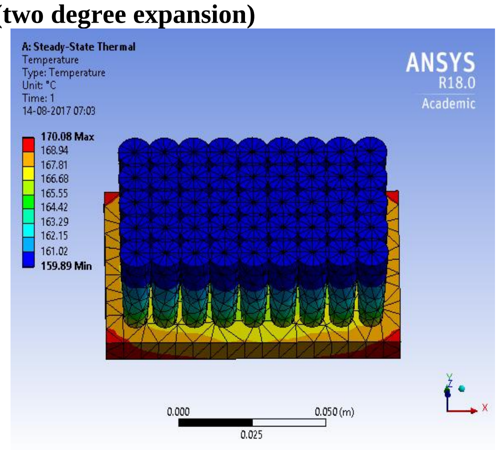


Figure.5.(d) Temperature of Modified pin fin heat sink (three degree expansion)

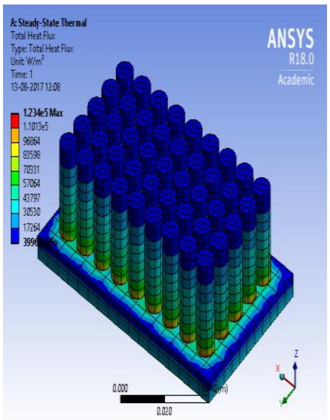


Figure.6.(a) Total heat flux of Conventional pin fin heat sink (zero degree expansion)

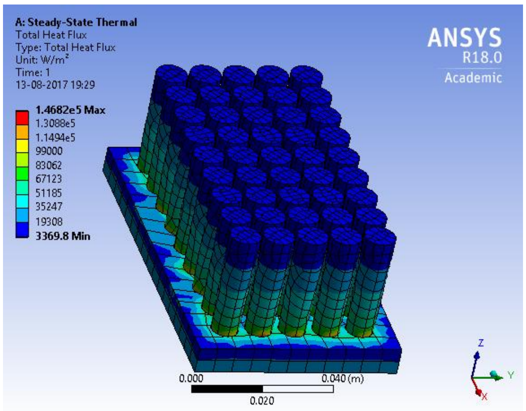


Figure.6.(b) Total heat flux of Modified pin fin heat sink (one degree expansion)

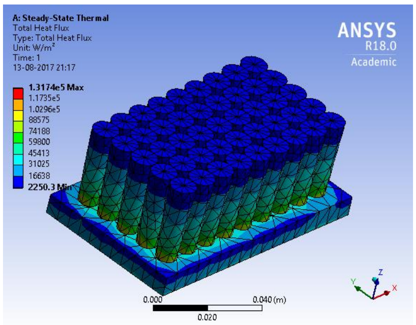


Figure.6.(c) Total heat flux of Modified pin fin heat sink (two degree expansion)

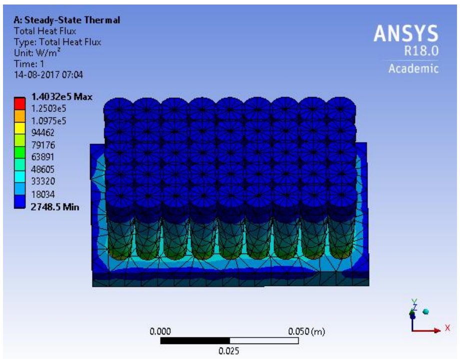
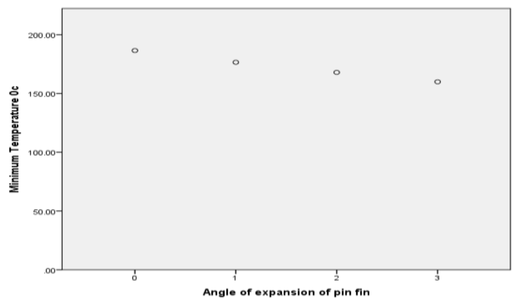
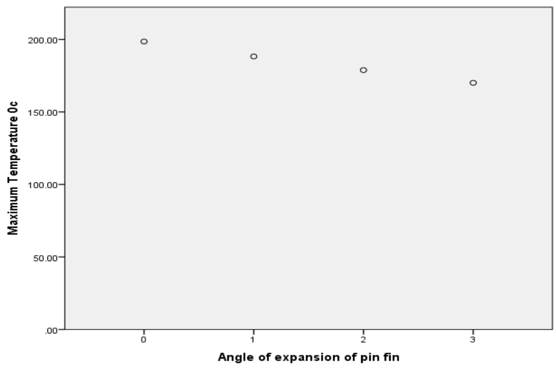


Figure.6.(d) Total heat flux of Modified pin fin heat sink (three degree expansion)

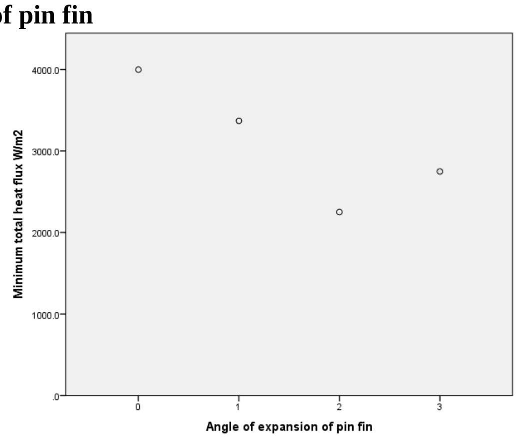
The final result obtained from the ANSYS software is represented in Figure 5 and 6.The temperature of the body is visual from the colour of the body. The Red colour is symbol of highest temperature and blue colour show the lowest temperature of the body. Similarly colour coding used for total heat flux shown in figure 6.The maximum total heat flux is visualised by red colour on the other hand minimum total heat flux is shown by blue colour.



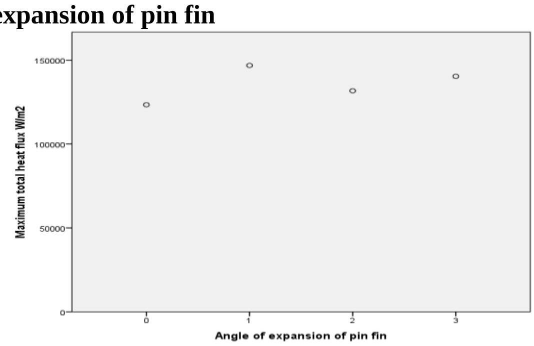
Graph.1.(a) minimum temperature and angle of expansion of pin fin



Graph.1.(b) maximum temperature and angle of expansion of pin fin



Graph.1.(c) minimum total heat flux and angle of expansion of pin fin



Graph.1.(d) minimum temperature and angle of expansion of pin fin

VIII. CONCLUSION

The graph 1 show the variation of temperature and heat flux with change of angle of expansion of pin fin. The minimum temperature 159.89 0C has noticed at 3 degree of expansion of pin fin and highest temperature 198.56 0c is found at 0 degree of expansion of conventional pin fin. The largest angle of expansion of modified pin fin is responsible to bring down the temperature of heat sink. There is significantly drop in minimum total heat flux 2250.3W/m2 with increasing the degree of expansion outward 2 of modified pin fin but suddenly rise of 2748.5 W/m2 appeared at 3 degree of expansion of modified pin fin. In the case of maximum total heat flux initially there is drop in maximum total heat flux and then rise at one degree expansion of modified pin fin and then again there is downfall in maximum total heat flux and at last 3 degree of expansion there is again rise in maximum total heat flux.

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