

Thermal Analysis of Heat Sink with Perforation Techniques Using Ansys

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Abstract- The engine chamber is one of the essential engine components that is subjected to high temperatures and heat stress. Particles on the cylinder surface enhance convection heat exchange. The heat produced by gasoline burning inside a vehicle engine. The friction between moving components often generates more heat. The air-cooled I.C. engine has fins in the shape of expanded surfaces surrounding the motor cylinders to improve heat transfer. Fin analysis is an important endeavour in order to increase the heat transfer rate. This study looks at past work on fine heat transfer rate enhancements, looking at changes in the form and composition of cylinder fins. The ANSYS programme was utilised in this study to examine the impact of fin shape and size on heat exchange within various fin geometries, including pin fin morphologies, tube fin geometries, hole geometries, and plate fin geometries. Temperature changes in fins have been investigated utilizing experiments. One of the studies was to assess temperature changes in exact field performance models and compare them to experimental data in Ansys. We're looking at methods to make the most of the wind to help with heat dissipation. The study's goal is to improve thermal properties via modifications in form, material, and small-scale design.

Keywords- heat transfer, Extended surfaces, Thermal analysis, FEM, Analysis and Heat transfer enhancement

I. INTRODUCTION

In many cases, the main components of an engine would be exposed to the elements. When a car's engine fails, heat escapes via the exhaust at a certain velocity and volume. This method is known as natural air cooling since the heat is transported via the air. Natural-inspired two-wheelers have engines that are constantly recharged with fresh air. To reduce engine heat generation, the area where the engine interacts with the air must be extended. The engine, which has a bigger diameter, is taller, and its output is less powerful when evaluated by weight. The fin design allows for a different arrangement to improve the engine's frontal cross-section.

The cylinders and cylinder heads are adorned with large fins (or ribs). To avoid overheating, any heat supplied to the component must be quickly evacuated into the air. You may aid in the transmission of heat from a surface to the environment by improving the heat exchange coefficient between the surface and its surroundings. Enlarging the heat exchange zone on the surface, or both, may also aid in heat transmission to the environment. Extensive surfaces are often utilised to increase the area of heat exchange, which balances the fins linked to walls and surfaces. Heat exchange is enhanced in heat-exchanging devices with expanded surfaces (fins) because these fins enable more of the required surface to come into contact with the surrounding liquid. Intricate geometric patterns, ranging

from simple forms to complex motifs, have been utilised. Regular fin shape variants include rectangular, triangular, cylindrical, trapezoidal, and other shapes. To improve performance, a fin design for a more efficient heat exchange was created. Heat exchange is improved by warming the fin and surroundings, or by altering the surface area or size of the object. Heat dissipation will aid in getting there faster. The use of fins (extended surfaces) may enhance heat transfer from the engine cylinder. This is critical for comprehending the heat transfer rate of the fins. Because each shape, size, and material combination has its own unique degree of heat transmission, determining the most effective set of designs may offer greater heat transfer rates and higher levels of engine efficiency. A significant portion of the cylinder's surfaces are utilised to make greater contact with the fluid flowing through it.

II. EXTENDED SURFACES (FINS)

In heat exchange research, a fin is extruded from a base. Heat is distributed using fins, which enhance heat transmission through convection. The rate of heat transfer is determined by whether the item is dominated by convection, conduction, or radiation. It rises in steps depending on the temperature difference between the object and its surroundings, and it also includes the heat transfer coefficient and surface area. While increasing the size increases heat flow resistance, a smaller base surface area results in a lower coefficient of heat transfer. Fins of

various shapes and sizes are used in engineering applications to increase heat transfer rates, such as

- Rectangular fins
- Triangular fins
- Trapezium fins
- Circular segmental fins.

Different shape and designs of fins are used in different situations.

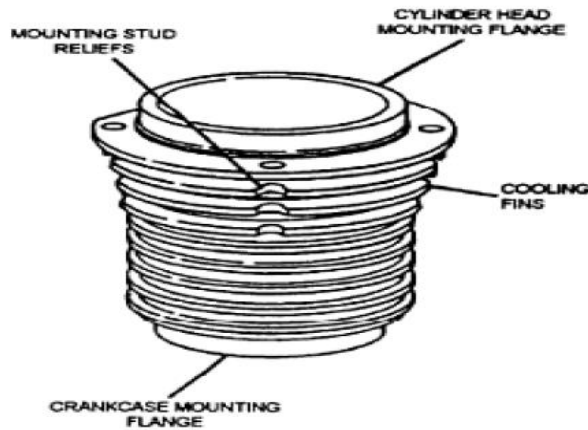


Figure 1: Cylinder with fins
(Source: Ahirwar et al. 2018).

II. Material properties of Fins material

The thermal study of Fins was carried out utilising the Fins material's Aluminum alloy. Table 1 shows the chemical composition of aluminium alloy.

Table 1: Material properties of Fins Model.

Parameters	Unit	Aluminum alloy (1060)
Density	(Kg/m ³)	2700
Young's Modulus	(MPa)	69000
Coefficient of thermal expansion	(1/K)	2.3×10^{-5}
Poisson's Ratio	-	0.33
Elastic modulus	(GPa)	70
Ultimate Tensile Strength	(MPa)	310
Thermal conductivity	(W/m ² C)	200

III. DESIGN AND ANALYSIS OF FINS

1. Modeling of Fins Model

Plate Fins, Circular Pin Fins, and Rectangular Pin Fins are three fins types created here using aluminium alloy 1060 as the material option. Fins model includes plate fins and pin fins in the shape of circular and rectangular apertures pin fins for air passage. Ansys was used to conduct the FEM analysis. The practical application of finite element modelling is known as FEA, and it is best understood while addressing real-world problems. The automobile industry has made extensive use of FEA. In the product

development process, it is a very popular tool for configuring builds. To make FEA a successful design tool, it is critical to understand the fundamentals of FEA and design techniques, as well as showing systems, inherent errors, and their effects on the nature of the results. Engineering issue studies are also carried out using FEA as a computer technique.

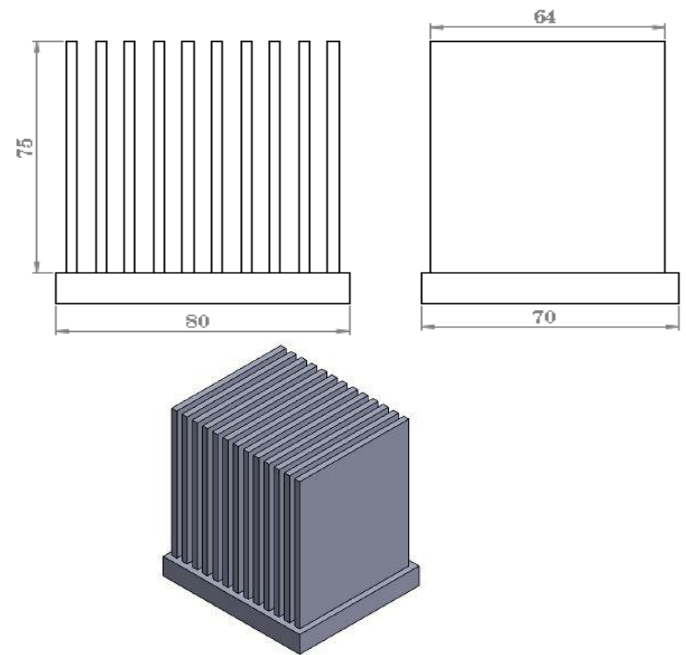


Figure 2: Plate Fins Designed Model in Ansys

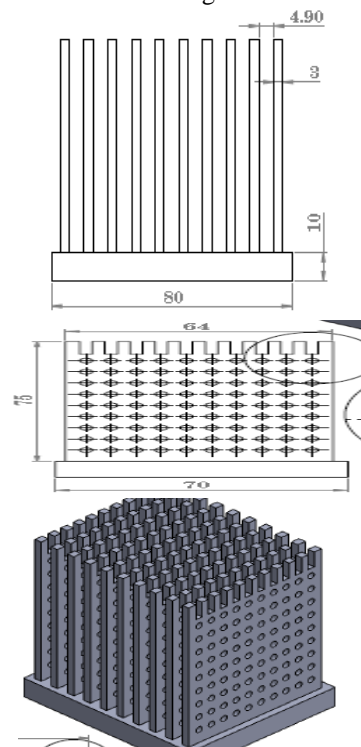


Figure 3: Circular perforation Fins Designed Model in Ansys

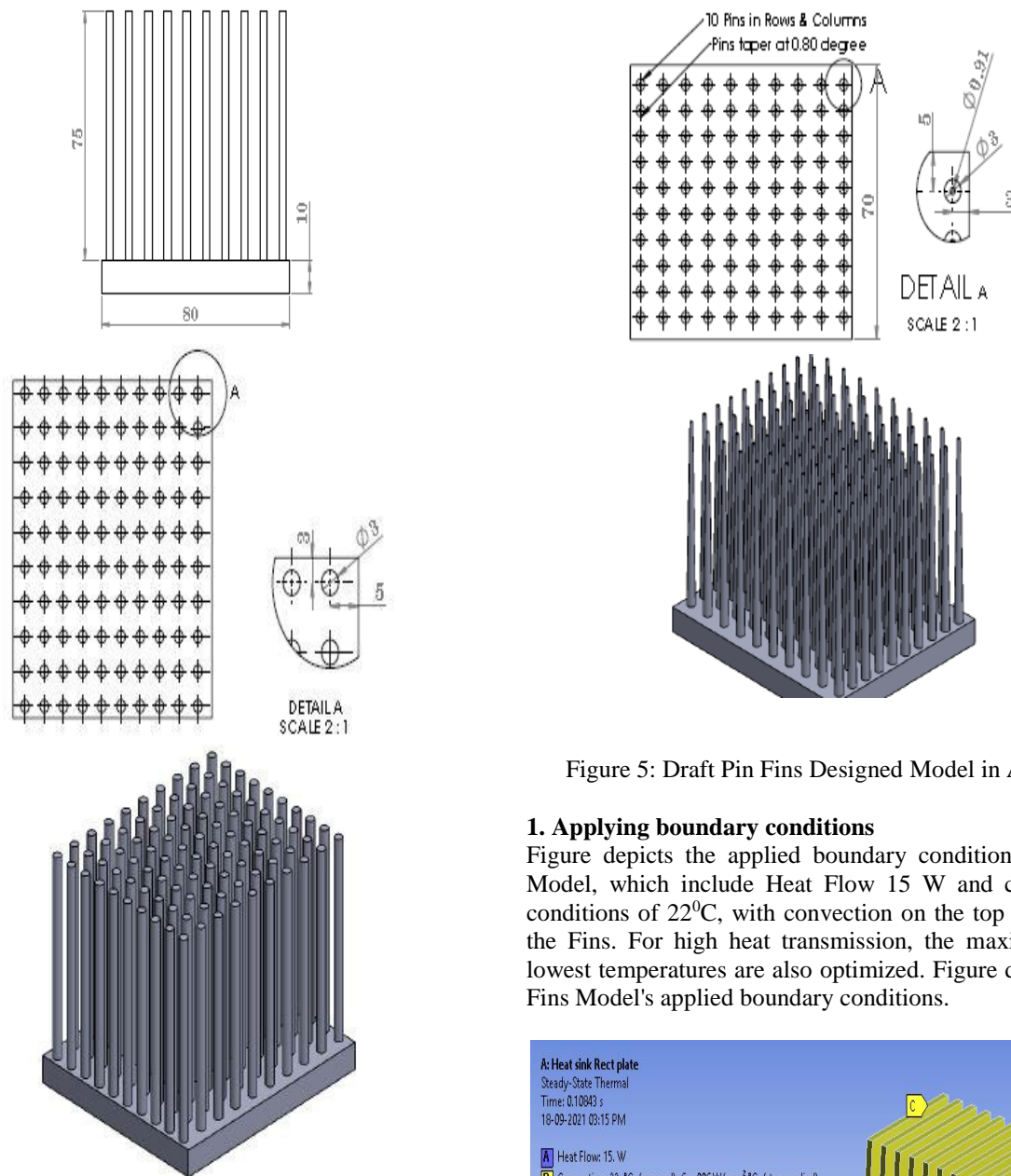


Figure 4: Circular Pin Fins Designed Model in Ansys

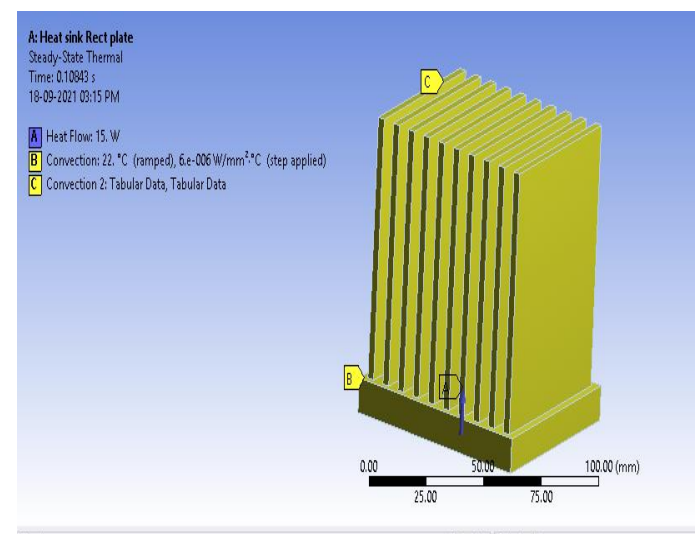
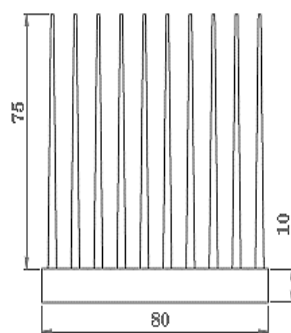


Figure 6: Applied Boundary conditions on Plate Fins.

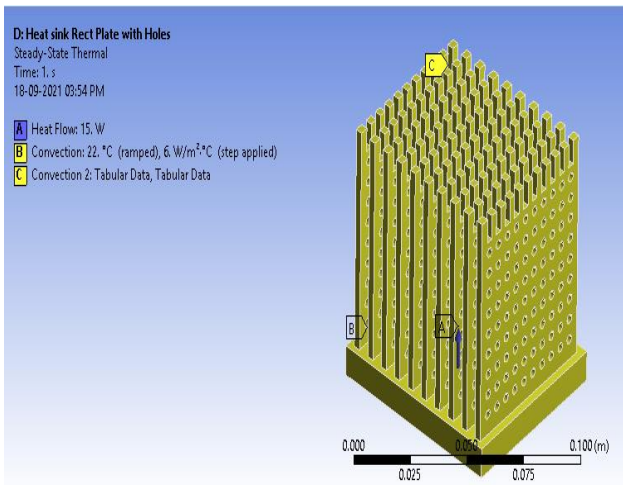


Figure 7: Applied Boundary conditions on Rectangular plate Fins with holes

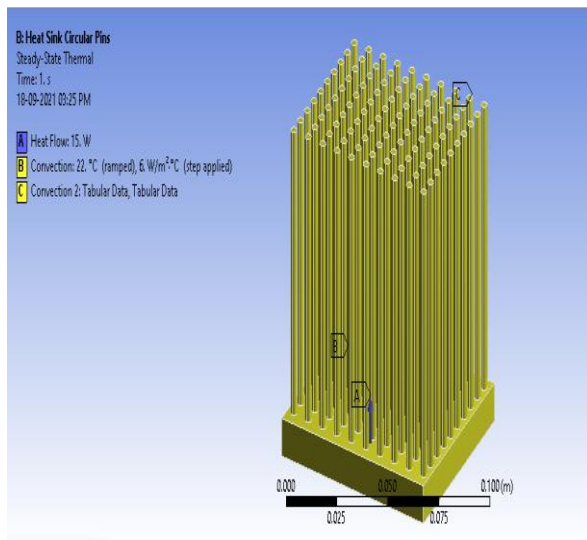


Figure 8: Applied Boundary conditions on Circular Pin Fins

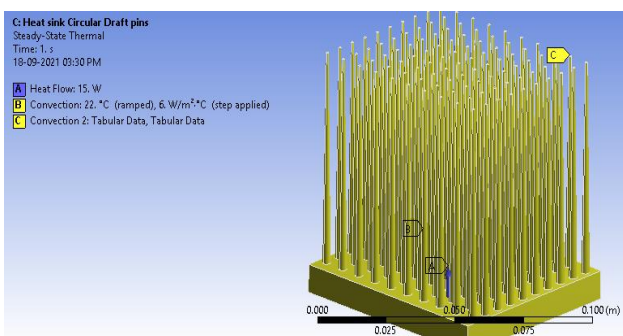


Figure 9: Applied Boundary conditions on Draft conical Pin Fins.

III. RESULTS AND DISCUSSION

The Fins model is split into a mesh of restricted measured fundamental frame components for study. Basic polynomial profile capacity and nodal Temperature are considered to calculate the displacement difference throughout each segment. As far as the hidden nodal temperature is concerned, conditions for strains and stresses are generated. The balancing conditions are then gathered in a grid form that may be readily modified. Figures illustrate temperature variations among different Fins models under steady-state circumstances, as well as boundary conditions imposed. At the summit, the temperature reaches its maximum. The temperature and total heat flux in thermal analysis were compared to plate fins, circular pin fins, plate fins with holes, and draught Pin fins after processing solution. These findings are achieved for all three circumstances, namely plate Fins, Circular Pin Fins, Plate Fins with Holes, and Draft Pin Fins, as part of structural and thermal study. The simulation research in Ansys of Fins models is shown in the figures.

1. Temperature distribution analysis of Fins Models

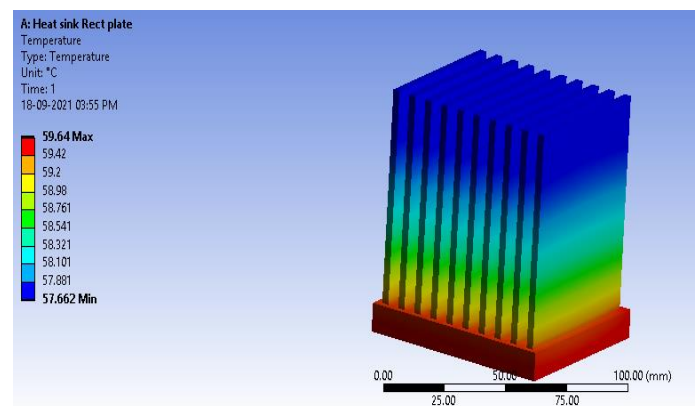


Figure 10: Temperature Distribution of Plate Fins.

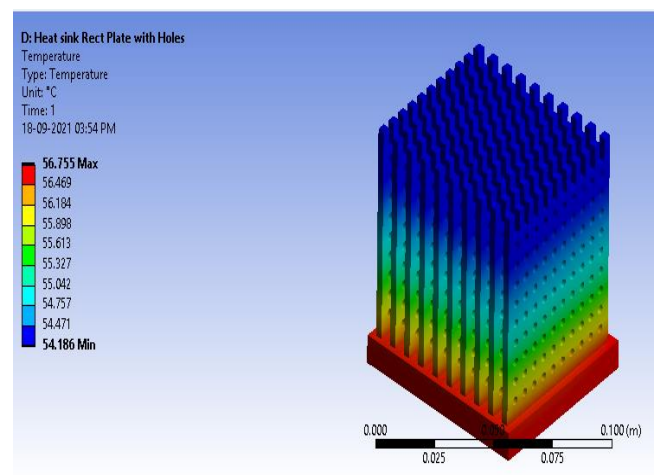


Figure 11: Temperature Distribution of Rectangular plate Fins with holes

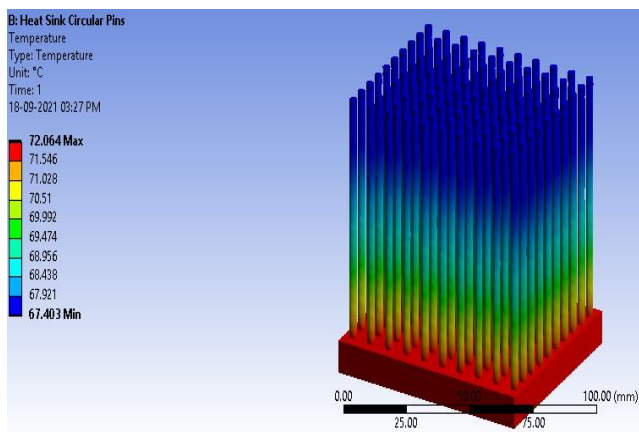


Figure 12: Temperature Distribution of Circular Pin Fins.

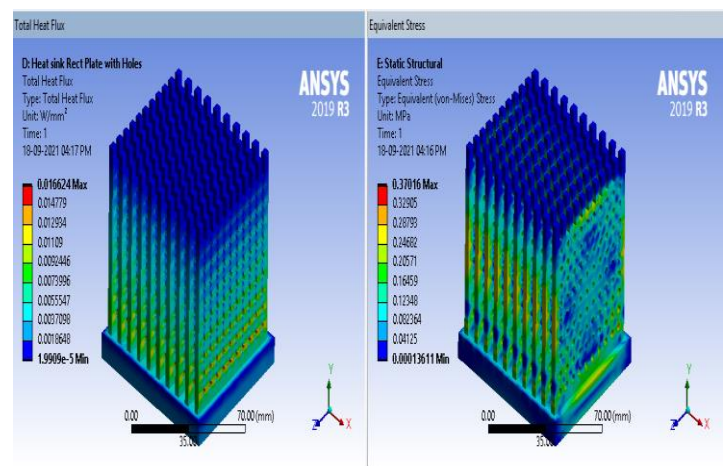


Figure 15: Heat flux of Rectangular plate Fins with holes.

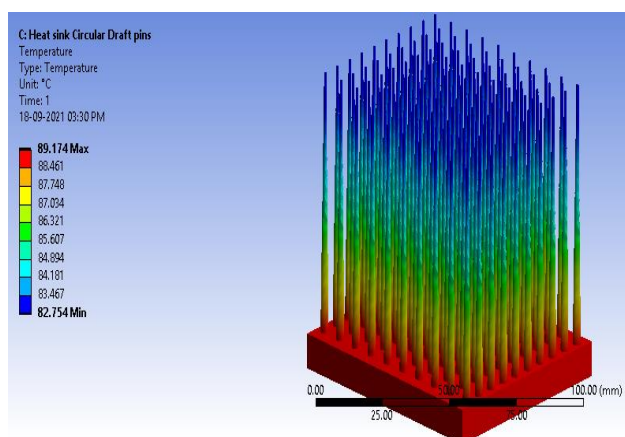


Figure 13: Temperature Distribution of draft conical Pin Fins

2.Heat Flux and stress analysis of Fins Models

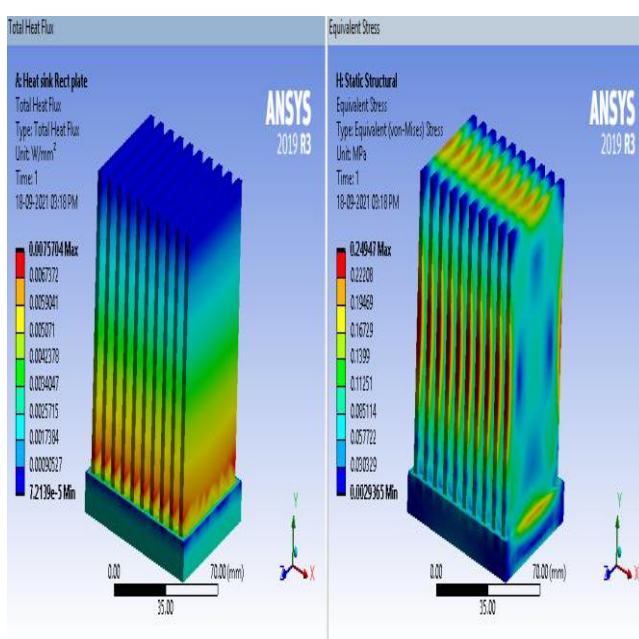


Figure 14: Heat Flux and Stress of Plate Fins

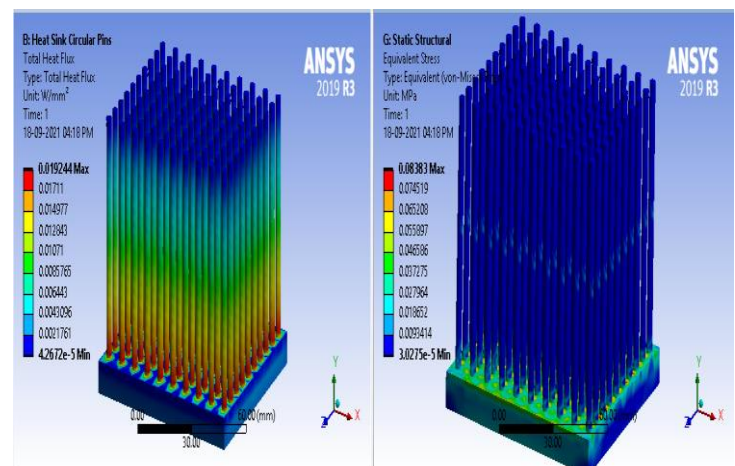


Figure 16: Heat flux and Stress of Circular Pin Fins

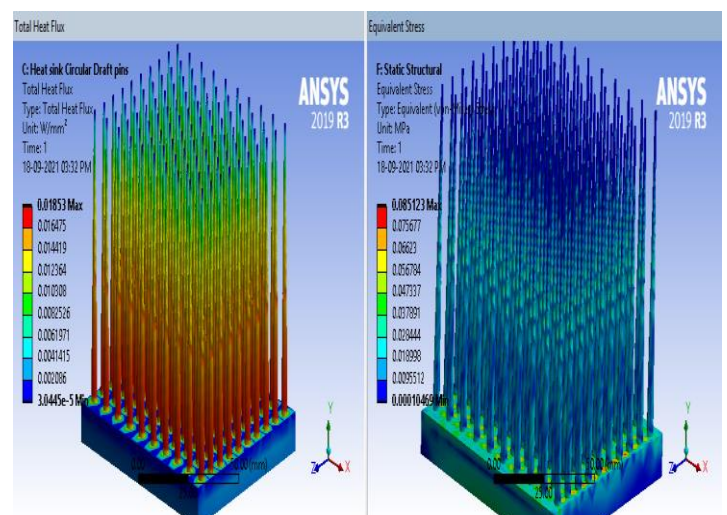


Figure 17: Heat flux and Stress of Circular Pin Fins

Table 2: Temperature Variations of Fins Models.

Geometry Condition	Heat Flow(watt)	Max Temperature (°C)	Min Temperature (°C)	Temperature drop(°C)
fins with rectangular plate	15	59.64	57.66	1.98
Circular pin fins	15	72.06	67.40	4.66
Conical draft pin fins	15	89.17	82.75	6.42
Rectangular plate fins with holes	15	56.75	54.18	2.57

Table 3: Heat Flux Found on All conditions of Fin Models.

Geometry Condition	Heat Flux	Thermal Stress (MPa)	Weight(kg)
fins with rectangular plate	0.0075	0.249	0.554
Circular pin fins	0.019	0.083	0.301
Conical draft pin fins	0.018	0.085	0.223
Rectangular plate fins with holes	0.016	0.370	0.48

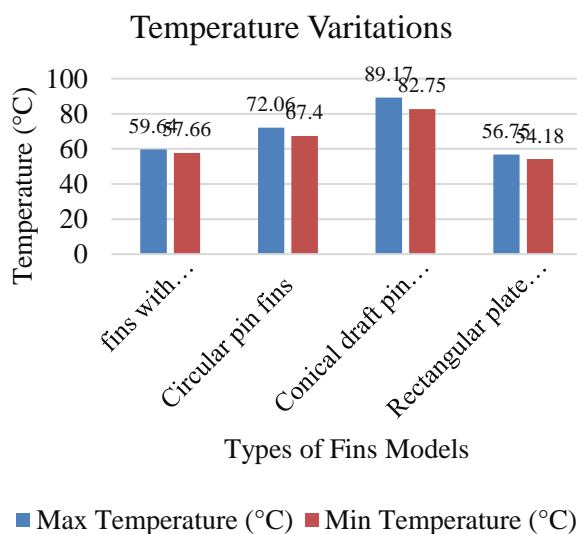


Figure 18: Temperature Variations in Models of Fins

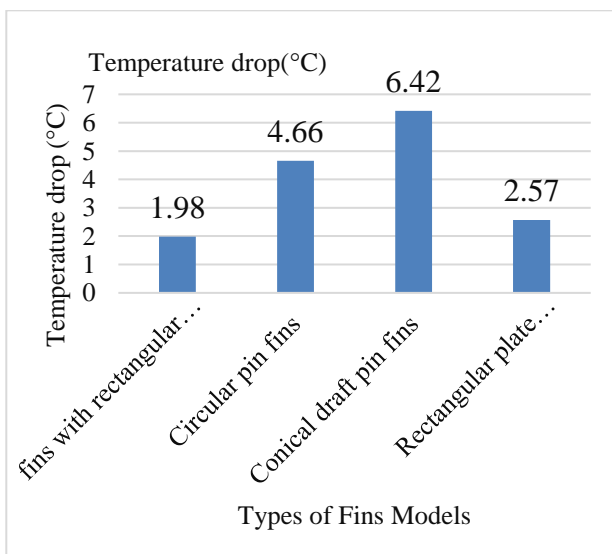


Figure 19: Total Temperature Drop in Fins Models

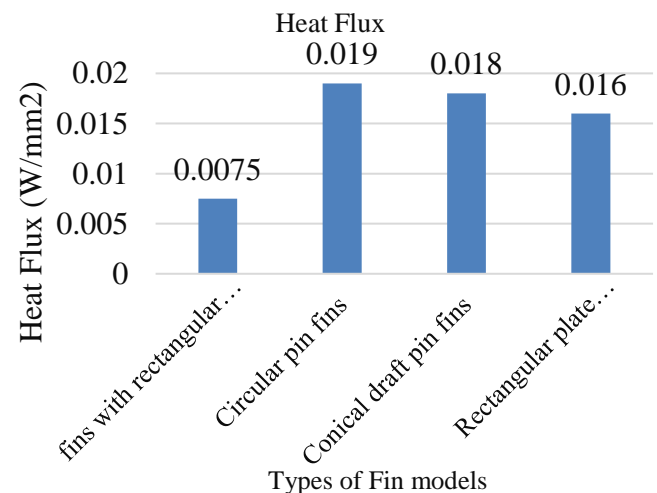


Figure 20: Comparison of Heat flux of Fin Models.

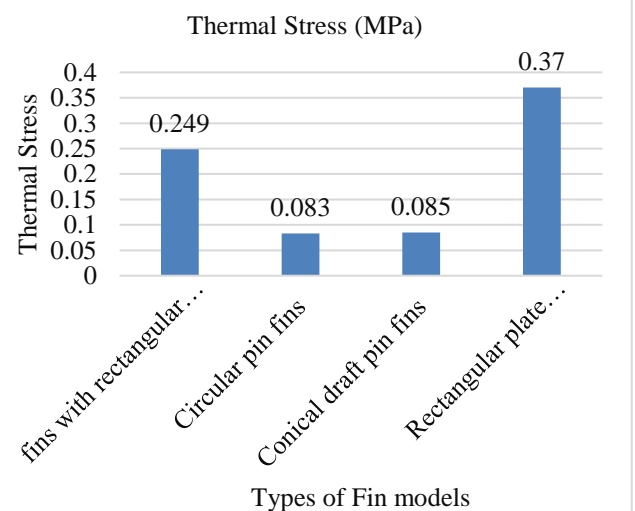


Figure 21: Comparison of Thermal Stresses of Fin Models.

III. CONCLUSION

From the comparative analysis of plate Fins, Circular Pin fins, plate fins with holes, and draft Pin fins study conclusion is that the Total heat flux found maximum

0.019 W/mm² in Circular Pin fins. Maximum temperature found in Conical draft Pin Fins is 89.170C and Minimum Temperature found in Plate Fins is 57.66 0C. Maximum Temperature drop found on Conical draft pin fin 6.42 °C and minimum temperature drop found on plate fin is 1.98°C. so, it is concluded that Pin Fins with Conical draft Pin Fins is shows better Heat transfer properties in this analysis. Thus, better heat transfer for fins or an experimental result show that Conical draft Pin Fins having better than plate Fins. The overall analysis is performed on ANSYS FEM analysis Tool. Thus, further research can be carried with the advance materials and different designing, analysis tools. From the above study work the following conclusions are made:

- Thermal analysis for fins has been completed by adjusting other parameters, including geometry, platform fins and pin fins.
- While looking at the results of the experiment, one can easily say that using Conical Pin Fins with aluminum alloy 1060 is much easier because of the dropping temperature and the heat transfer rate in Conical Pin Fins compared with Plate Pins.

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