Thermal Analysis of Fins with Varying Geometry of Different Materials

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Abstract— The heat dissipation from surface is always been a hot topic of all time considering fins. Experimenting with various geometry in order to enhance the heat dissipation is been a constant research interest. In almost every field, increasing the heat dissipation capacity of the fins has been great challenge for all engineers. With the evolution of various shapes and sizes with different materials has helped our researchers and manufactures a lot. In this paper we have taken 3 different shapes such as circular, square, tapper which are modeled and analyzed in SOLID WORKS 2015 .The objective of this paper is to observe and analyses the heat dissipation of different material with respect to different geometry (circular, square, tapper).A comparison is shown between two different materials Alloy Steel and Aluminum alloy 1060.

Key words: Solid Works, Heat Dissipation, Fin

I. INTRODUCTION

In Internal Combustion engines, combustion takes place inside the engine and hot gases are generated, of temperature around 2300-2500°C.And this high temperature may burn the lubrication between parts and may also seize or weld. So, this temperature needs to be reduced up to 150-200°C at which the engine will work efficiently. So in order to get better efficiency from the engine it needed to be cooled by down. Many several ways of cooling have been suggested by our engineers. And one of the finest way to cool the engine is to use fin.

Fins are extended surfaces that are generally use to enhance the rate of heat transfer by increasing HEAT convection. As greater the convection, the greater will be the heat dissipation. As general application of fins in automobile sector is to dissipate the heat of an engine or any other component to the environment. As more the dissipation greater the efficiency. Thus, adding a fin to an object or any component, will certainly increases the surface area and heat transfer rate. P. Sai Chaitanya et.al [1] presented Thermal Analysis of Engine Cylinder Fin by Varying Its Geometry and Material, carried out the analysis for cylinder fins using this material and also using Aluminum alloy 6061 which have higher thermal conductivities. K. Pavan Kumar et.al[2] presented Thermal and Structural Analysis of Tree Shaped Fin Array discusses the possibility of using a variant of tree fin array as a heat sink for a processor in a computer terminal and an array of Tree fins with and without slots were modelled and tested for different materials. By observing the structural deformation material is suggested. Deepak Gupta et.al [3] presented Design and Analysis of Cooling Fins and analyzed the designed models by taking the thermal temperature of 11000C.

II. MODEL OF FIN

The fin is modeled with the base dimensions 100*50*10 (mm^3). Tapper fin dimensions 50mm height for both Alloy steel and aluminum alloy 6061.Circluar fin with radius of 2.5mm and square fin with side 5mm and both have height of 50mm.

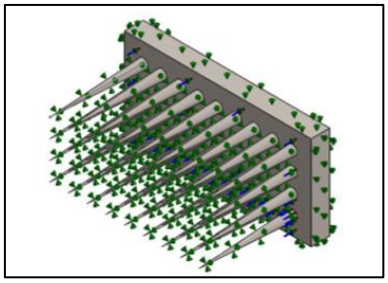

Fig. 1: Tapper –fin

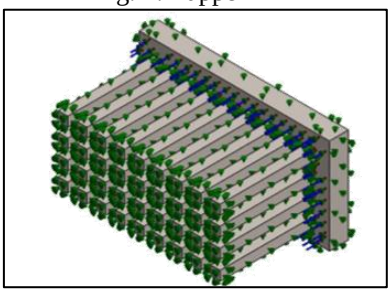

Fig. 2: Square-Fin

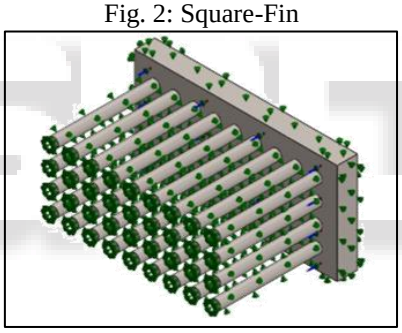

Fig. 3: Circular-fin

A. *Finite Element Analysis*

The finite element analysis [FEA] has become most useful tool for many problems in the field of engineering and non-engineering. FEA is one of the best tool ever to get better results. In this step it defines the analysis type and options, then mesh generation followed by applying material and properties apply loads (if required) and initiate the finite element solution. This involves three phases: Pre-processor phase, Solution phase, Post-processor phase. The Solid works, provides one of the best working environment with all relative and required CAE information on the bar. This environment provides enhanced interoperability and control over the flow of information between these task modules. Various tools and techniques are incorporated for efficiently manage to large models. First 3D model was built in solid works and then transferred to the simulation environment for required analysis.

B. *Meshing Details*

Meshing in Solid works is generally provided durable and easy specifications which makes it easy for user to work. The model using must be divided into a "n" number of small

pieces known as finite elements. Here we have used "Fine" mesh. A finite element mesh model generated is shown in fig.4, 5, 6.The mesh results are as shown in table No 1.

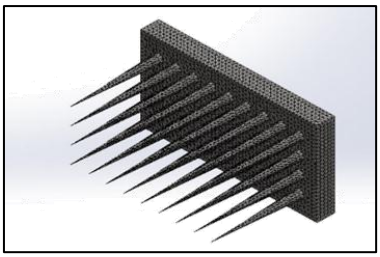

Fig. 4: Mesh Generation (Tapper- Fin)

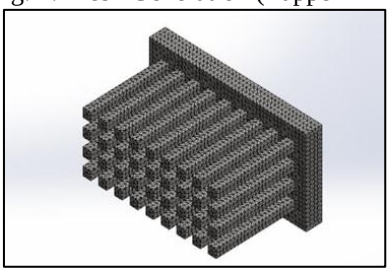

Fig. 5: Mesh Generation (Square Fin)

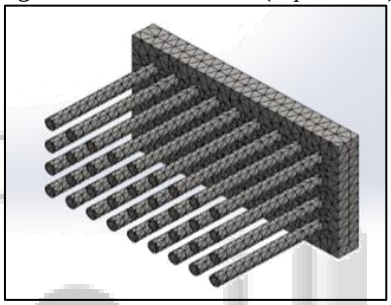

Fig. 6: Mesh Generation (Circular Fin)

Shapes	Alloy Steel		Aluminum Alloy 1060	
	No. of mesh	No. of nodes	No. of mesh	No. of nodes
Tapper	64950	106075	64950	106075
Square	50709	87300	50709	87300
Circular	15166	28442	15166	28442

Table 1: Elements and Nodes

Material properties of Alloy Steel and Aluminum Alloy 6061 in tabular form

Material Properties	Alloy Steel	Aluminum Alloy 1060
Young modulus (GPa)	210	69
Poisson ratio	.28	.33
Tensile ultimate strength(N/mm^2)	723.83	68.94
Tensile yield strength(N/mm^2)	620.42	27.57
Density ($Kg/m^{3)}$	7700	2700

Table 2: Material Properties

III. RESULTS AND DISCUSSION

Comparing both alloy structural steel and aluminum alloy 1060 and their properties by applying the same convection coefficient of 22W/m2k and maximum temperature 573 kelvin.

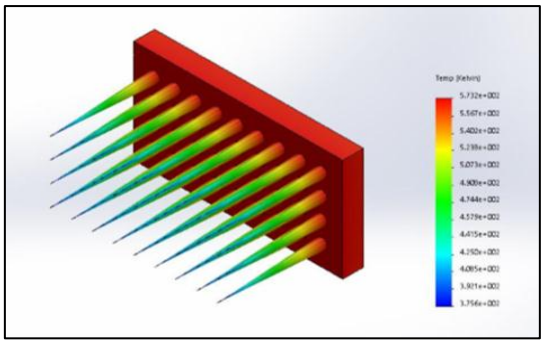

Fig. 7: Tapper fin(Alloy Steel)

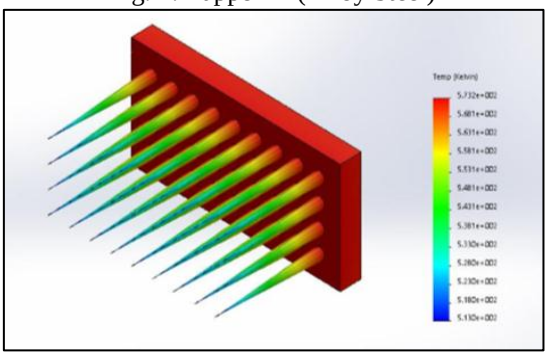

Fig. 8: Tapper Fin (Aluminiumn Alloy 1060)

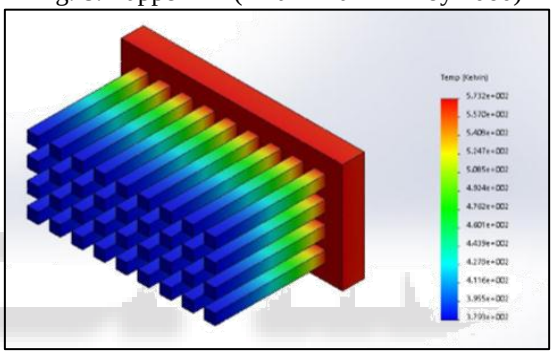

Fig. 9: Square Fin (Alloy Steel)

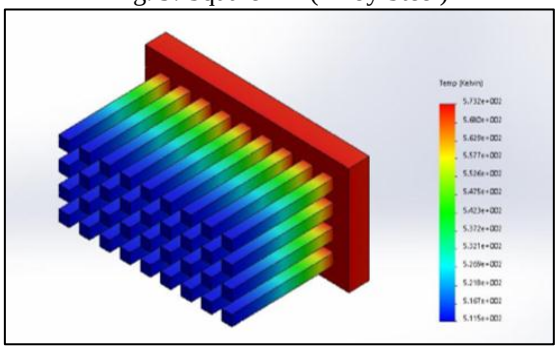

Fig. 10: Square Fin (Aluminum Alloy1060)

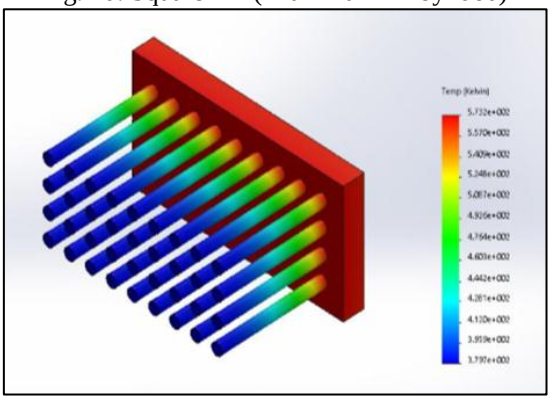

Fig. 11: Circular Fin (Alloy Steel)

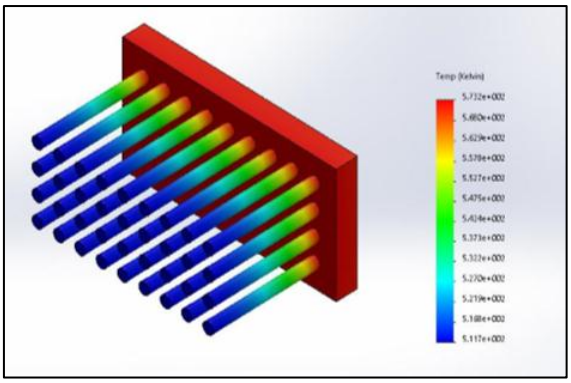

Fig. 12: Circular Fin (Aluminum Alloy 1060)

Material	Tapper fin		Square fin		Circular fin	
	Temperature (Kelvin)					
	Min	Max	Min	Max	Min	Max
Alloy Steel	375.6	573	379.15	573	379.745	573
Aluminum alloy 1060	512.9	573	511.53	573	511.68	573

Table 3: Results

IV. Conclusion

After comparing and observing all the above analysis, we come to know that both alloy steel and aluminum alloy 1060 show different minimum temperature with different geometry. As we all know more the temperature difference more will be the heat dissipation. As from above results it is cleared that Alloy steel is quite better than aluminum alloy because of the large temperature difference and can be better replacement.

Also, temperature difference varies with the geometry and tapper fin shows the large temperature difference among other geometry. So it is concluded that Tapper fin of alloy steel should be used for better heat dissipation.

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