THERMAL ANALYSIS OF FINS.

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Abstract— *The main component of an automobile is its engine cylinder which is subjected to high thermal stresses. In order to relieve the thermal stresses and to cool the engine cylinder to its optimum temperature fins are provided on the surface of the cylinder to increase the heat transfer rate by increasing its surface area. The aim of this paper presentation is to analyze the thermal properties of fin by varying its fin geometry such as rectangular, curved and taper fin along with variable fin material using SOLIDWORKS to design 3D model and ANSYS workbench for carrying out thermal analysis. The variation of temperature gradient over time is of interest in many applications such as in cooling. The accuracy of thermal simulation could permit critical design parameters to be identified for improved life. Aluminium Alloy 2014 & 6061 are the recent material used for manufacturing cylinder fin body which has thermal conductivity of 110 & 170 W/mk respectively and presently analysis is carried out for cylinder fins using this material.*

Keywords— Dissipation, Thermal conductivity, cylinder, fins, Thermal flux, Aluminium Alloy 2014, Aluminium Alloy 6061.

1. INTRODUCTION

In an internal combustion engine heat is released during the combustion of air and fuel mixture, this explosion delivers the power stroke. Less than half the heat energy released is converted into useful work usually 30% and the rest is to be removed in order to prevent the melting of engine components. The temperature of the hot gases after combustion may be around 500 – 1500°C and this can burn the oil film between the moving parts and may also result in welding or complete breakdown of engine. Therefore for efficient functioning of engine it is desired to reduce the temperature to 150 - 300°C without affecting its thermal efficiency. Therefore extended surfaces called fins are provided at the periphery of air cooled engine cylinder to increase heat transfer rate. Hence analysis of fin is important to increase the heat transfer rate.

ENGINE FINS- In present times the internal combustion engines are liquid cooled by a closed circuit carrying liquid coolant through channels in the engine block and cylinder head, where the coolant carries away the heat through heat exchanger or radiator where the coolant releases heat into the air. While the heat generated by an air-cooled engine is released directly into the air known as Direct Cooled Engine. Direct Cooled Engine with metal fins on the outside periphery of the Cylinder Head and cylinders which increase the surface area that air can act on. Air may be fed though force convection with the use of a fan to achieve efficient cooling with high volumes of air or simply by natural air flow with efficiently designed and angled fins. In internal combustion engines, a huge percentage of the heat generated escapes through the exhaust (approx. 44%), and the rest through either a liquid coolant or through fins of an air-cooled engine (12%). A small amount of the heat energy finds its way into the oil, which carries away the heat although primarily meant for lubrication, also plays a role in heat dissipation via cooler.

1.1 Classification of Fins

Based on the geometry of fins. Fins can be classified into three type .They are

1. Longitudinal fins
2. Annular fins
3. Pin- fin or spine fins

Longitudinal fins: It is a straight rectangular fin attached to a plane wall. It may be of uniform cross-sectional area, or its area may vary along its length to form a triangular, parabolic or trapezoidal shape

Fig -1.1 longitudinal fin

Annular fins: An angular fin is a fin that is circumferentially attached to a cylinder and its cross-section varies with radius from center line of cylinder.

Fig -1.2 Annular Fin

Spine or pin-fin: A pin-fin or spine is an extended surface of circular cross-section whose diameter is much smaller than its length. The pin fins may also be uniform or non-uniform cross-section.

Fig -1.3 spine or pin-fin

1.2 Applications of Fins

1. It is Mounted on engine cylinder to cool the engine
2. It is also used in refrigeration system
3. It is used in car radiators
4. It is also used in electrical transformers and motors

2. FIN MATERIALS

Aluminum alloy 2014 and Aluminum alloy 6061 is used material for manufacturing of fins

Chemical Composition Aluminum Alloy 2014

Following Table is the Chemical composition for Aluminium alloy 2014

Table -2.1 Chemical composition of AL alloy 2014

Element	Weight %
Aluminum	Balance
Chromium	0.1
Copper	3.9 - 5
Iron	0.5
Magnesium	0.2 - 0.8
Manganese	0.4 - 1.2
Silicon	0.5 - 0.9
Titanium	0.15
Zinc	0.25

Chemical Composition of Aluminum Alloy 6061

Following Table is the chemical composition of Aluminium alloy 6061

Table -2.2 Chemical composition of Aluminium 6061

Element	Weight %
Aluminum	Balance
Chromium	0.04 - 0.35
Copper	0.15 - 0.4
Iron	0 - 0.7
Magnesium	0.8 - 1.2
Manganese	0 - 0.15
Silicon	0.4 - 0.8
Titanium	0 - 0.15
Zinc	0 - 0.25

Properties of Materials

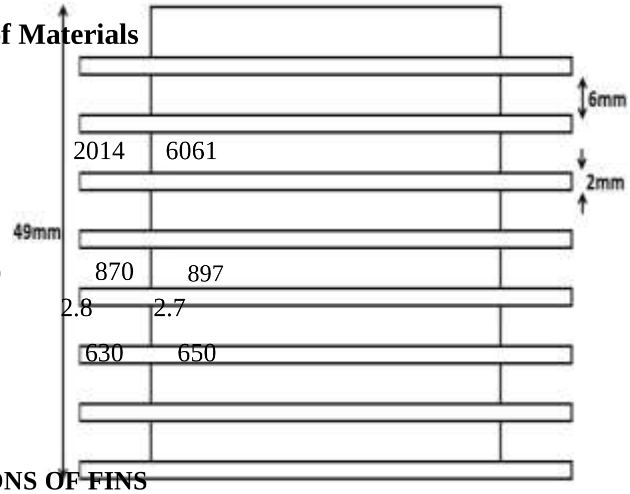


Table -2.4 Properties of selected Materials

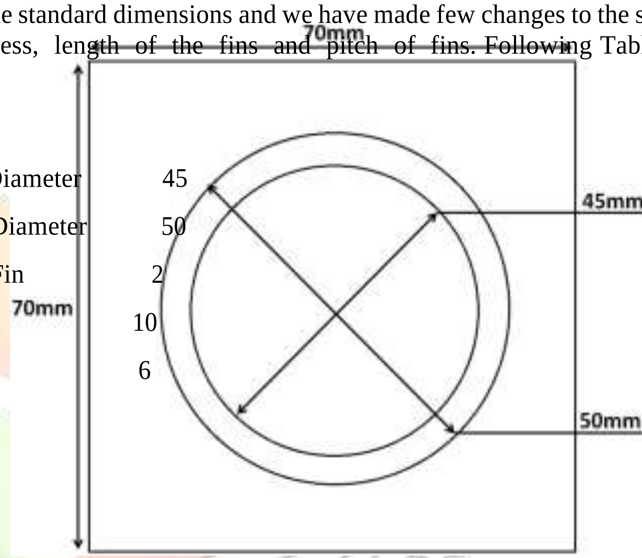
	Aluminium alloy 2014	6061
Tensile Strength (Mpa)	331	330
Thermal conductivity (w/m-k)	110	170
Specific heat (J/kg·K)	870	897
Density	2.8	2.7
Melting point (^{0}C)	630	650

3. DIMENSIONS OF FINS

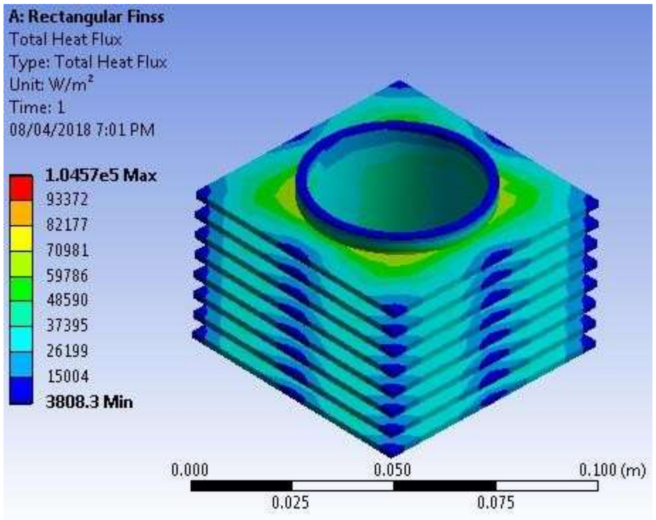
The dimensions for engine fins and cylinder have been taken from the standard dimensions and we have made few changes to the standard dimensions according to our project. We have changed the thickness, length of the fins and pitch of fins. Following Table is the considered dimensions for design. All Dimensions are in mm.

Table -3.1 Selected Dimensions

Cylinder Inner Diameter	45
Cylinder Outer Diameter	50
Thickness of Fin	2
Length of Fin	10
Pitch of Fin	6
Length of Cylinder	49

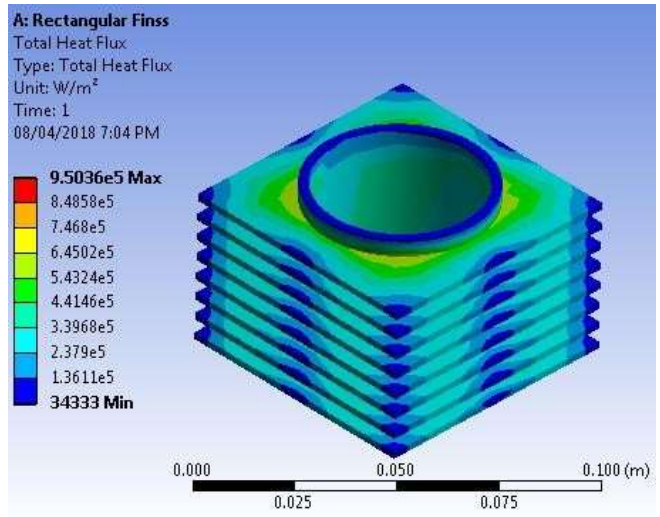


4. RESULTS ANALYSIS AND DISCUSSION



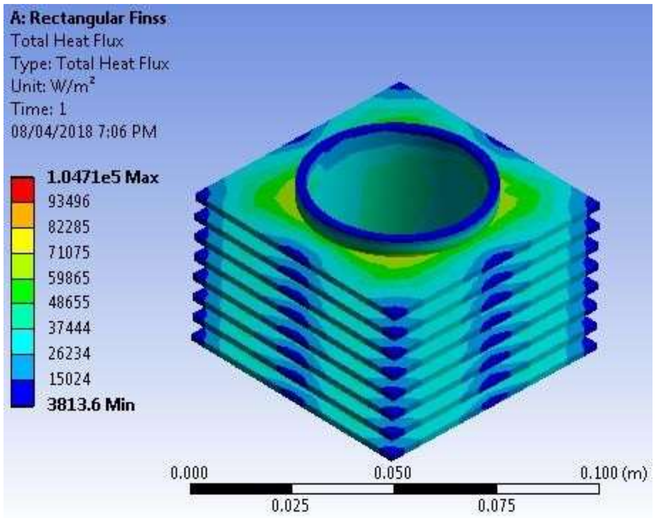
Aluminium alloy 2014

Properties	Natural convection		
	Rectangular fin	Curved fin	Taper fin
Nodal Temperature (K)	500	500	500
Temperature at Fin end (K)	491.31	492.64	490.45
Thermal Flux (W/mm^2)	104570	91748	96376

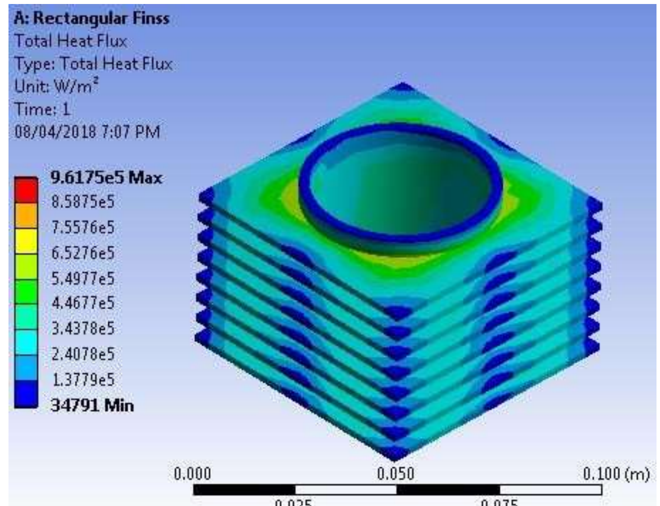


Aluminium alloy 2014

Properties	Forced convection		
	Rectangular fin	Curved fin	Taper fin
Nodal Temperature (K)	500	500	500
Temperature at Fin end (K)	422.65	433.3	415.43
Thermal Flux (W/mm^2)	950360	846290	880520



Aluminium alloy 6061



Aluminium alloy 6061

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Natural convection			
Rectangular fin		Curved fin	Taper Properties fin
Nodal Temperature (K)	500	500	500
Temperature at Fin end (K)	492.32	493.49	491.56
Thermal Flux (W/mm^2)	104710	91850	96496

Forced convection			
Rectangular fin		Curved fin	Taper fin
Nodal Temperature (K)	500	500	500
Temperature at Fin end (K)	430.75	440.41	424.24
Thermal Flux (W/mm^2)	961750	854910	890490

5. CONCLUSION

By observing thermal analysis results, we can clearly conclude that Rectangular shaped fins made from Aluminium alloy 6061 is most efficient from selected materials in natural & forced convection and is most effective in terms of rate of heat flux & effectiveness.

6. REFRENCES

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