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EFFECT OF HEAT TRANSFER IN A CYLINDRICAL FIN BODY BY VARYING ITS GEOMETRY & MATERIAL

D. MERWIN RAJESH
PG Student
Dept. of Mechanical Engineering
K.S.R.M College of Engineering
Kadapa, Andhra Pradesh -516003

K. SURESH KUMAR
ASSOSCIATE PROFESSOR
Dept. of Mechanical Engineering
K.S.R.M College of Engineering
Kadapa, Andhra Pradesh -516003

Abstract - The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside cylinder. The principle implemented in this project is to increase the heat dissipation rate by using the invisible working fluid, is air. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main purpose of using these cooling fins is to cool the engine cylinder by any air. A parametric model of piston bore fins has been developed to predict the transient thermal behavior. The parametric model is created in 3D modeling software Pro/Engineer. Thermal analysis is done on the fins to determine variation temperature distribution overtime. The analysis is done using ANSYS. Analysis is conducted by varying material .In this thesis, Presently Material used for manufacturing cylinder fin body is Aluminum Alloy 204 which has thermal conductivity of 150W/mk. In this thesis, it is replaced with Aluminum alloy 7075, Magnesium and beryllium

Keywords: heat dissipation, thermal gradient, nodal temperature, heat flux.

I. Introduction

A. **Cooling System for I.C. Engines:** Internal combustion engines at best can transform about 25 to 35 percentage of the chemical energy in the fuel in to mechanical energy. About 35 percent of the heat generated is lost in to the surroundings of combustion space, remainder being dissipated
through exhaust' and radiation from the engine. The temperature of the burning gases in the engine cylinder is about 2000 to 2500° C. The engine components like cylinder head, cylinder wall piston and the valve absorb this heat.

Necessity for Engine Cooling

1. Engine valves warp (twist) due to overheating.
2. Damage to the materials of cylinder body and piston.
3. Lubricating oil decomposes to form gummy and carbon particles
.4 Thermal stresses are set up in the engine parts and
Causes distortion (twist or change shape) and cracking of components.
5. Pre – ignition occurs (i.e. ignition occurs before it is required to igniter due to the overheating of spark plug.
6. Reduces the strength of the materials used for piston and piston rings.
7. Overheating also reduces the efficiency

A typical distribution for the fuel energy is given below:

Useful work at the crank shaft = 25 per cent
Loss to the cylinders walls = 30 per cent
Loss in exhaust gases = 35 per cent
Loss in friction = 10 per cent
Here we used air cooling system in the engine which uses fins, it is a extended surface used to transfer the heat

Though cooling improves the volumetric efficiency, but over cooling result in the decrease of overall efficiency

II. AIM OF THE PROJECT

The main aim of the project is to design and analyze cylinder with fins, by changing the thickness of the fins, and geometry of the fin. Analyzation is also done by varying the materials of fins. Present used material for cylinder fin body is Aluminum alloy 204 which has thermal conductivity of 110 – 150 w/mk. Our aim is to change the material for fin body by analyzing the fin body with other materials and also by changing the thickness.

Geometry of fins – Rectangular, Circular and Curve Shaped

Thickness of fins – 3mm and 2.5mm

Materials – Aluminum Alloy A204, Aluminum Alloy 7075, Magnesium alloy and Beryllium.

STEPS INVOLVED IN THE PROJECT

1. MODELING
2. TRANSIENT THERMAL ANALYSIS

For modeling of the fin body, we have used **Pro-Engineer** which is parametric 3D modeling software. For analysis we have used ANSYS, which is FEA software

III. MODELLING

In this a cylinder fin body for hero 100cc motorcycle is modeled using parametric software Pro/Engineer. The thickness of the original model is 3mm, in this thesis it is reduced to 2.5mm.

Original Fin Body Design

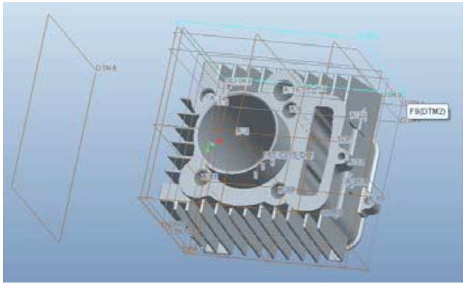

Fig. 1: 3mm Thickness Fin Body

B. Modification of Fin Body

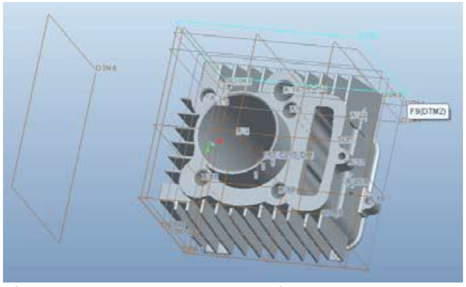

fig 2: 2.5 mm thickness fin body

IV. Experimental Procedure

A. Analysis

Transient thermal analysis determines temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as with cooling

B. Build Geometry

Construct a two or three dimensional representation of the object to be modeled and tested using the work plane co-ordinate system within ANSYS.

C. Define Material Properties

Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties

.D. Generate Mesh

At this point ANSYS understands the makeup of the part. Now define how the modeled system should be broken down into finite pieces.

E. Apply Loads

Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

F. Obtain Solution

This is actually a step, because ANSYS needs to understand within what state (steady state, transient… etc.) the problem must be solved.

Figure

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In this , we have taken four types of metals having different properties. The tabular column gives the values of thermal conductivity, specific heat, density For these metals

Properties Metals	*Thermal Conductivity*	*Specific Heat*	*Density*
Aluminum Alloy A204	*120 w/mk*	*0.963 J/g °C*	*2.8 g/cc*
Aluminum Alloy 7075	*173 w/m k*	*0.960 J/g °C*	*2.7 g/cc*
Magnesium	*159 w/m k*	*1.45 J/g °C*	*2.48 g/cc*
Beryllium	*216 w/m k*	*0.927 J/g °C*	*1.87 g/cc*

.

LOADS APPLIED:

The loads applied are

Apply Thermal-Temperature- on Area-Select inside area 585K

Convections – on Areas (select Remaining areas-Film Co-efficient – 25 W/mm K

Bulk Temperature – 313 K

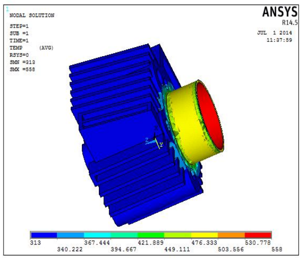
The given loads are applied on meshed models of aluminum alloy 7075, aluminum A204,
Magnesium, beryllium

Now we calculated Nodal temperature, thermal gradient, thermal flux for all the metals taken of 2.5 and 3mm thickness by using ansys software

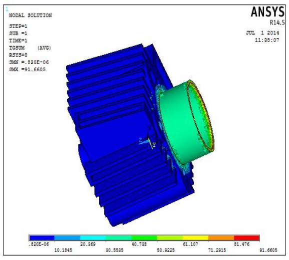
Here for convenience sake we have shown only ansys models of Aluminum alloy 204 of 3mm and2.5mm Thickness

ALUMINUM ALLOY 204 : RECTANGULAR FIN

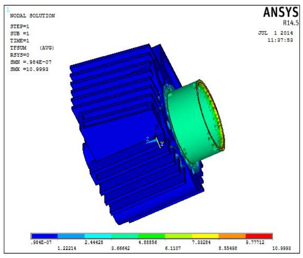
3mm THICKNESS



Nodal temperature

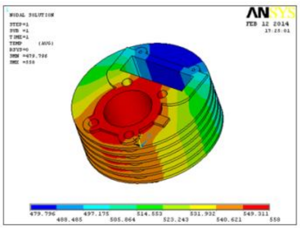


Thermal gradient

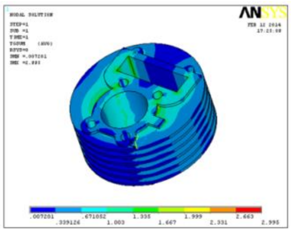


Thermal flux

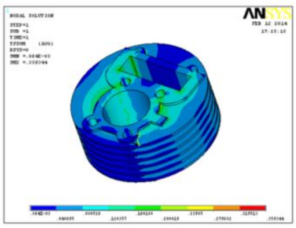
3mm THICKNESS ;



Nodal Temperature

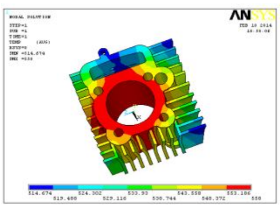


Thermal Gradient

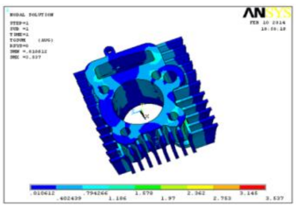


Thermal Flux

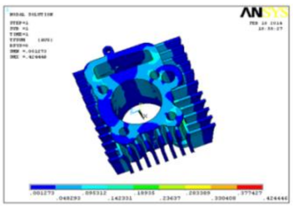
CURVED FIN:



Nodal temperature



Thermal Gradient



Thermal Flux

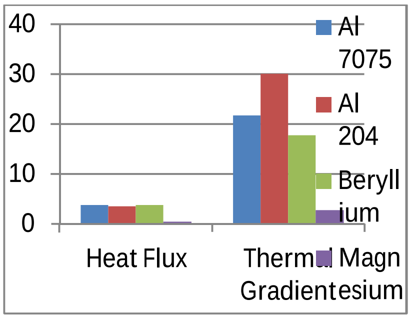
IV RESULTS AND DISCUSSION

FIN THICKNESS	TYPE	MATERIALS	RESULTS		
			NODAL TEMPERATURE	THERMAL GRADIENT	HEAT FLUX
2.5mm	Curved	Al 7075	558	21.7453	3.76193
		Al 204	558	30.034	3.604
		beryllium	558	17.7891	3.84244
		magnesium	558	2.73671	0.435137
	Circular	Al 7075	558	2.16593	0.467841
		Al 204	558	3.354	0.40253
		beryllium	558	2.62442	0.454025
		magnesium	558	2.663	0.423381
	Rectangular	Al 7075	558	182.998	23.0087
		Al 204	558	170.122	20.4146
		beryllium	558	132.021	28.5166
		magnesium	558	140.767	22.3819
3mm	Curved	Al 7075	558	2.39	0.413
		Al 204	558	3.537	0.424496
		beryllium	558	1.96731	0.42278
		magnesium	558	2.763	0.439357
	Circular	Al 7075	558	2.12	0.366
		Al 204	558	2.99	0.359345
		beryllium	558	1.74111	0.377375
		magnesium	558	2.3772	0.377
	Rectangular	Al 7075	558	70.7334	12.234
		Al 204	558	91.6605	10.9993
		beryllium	558	59.747	12.9054
		magnesium	558	75.254	11.9634

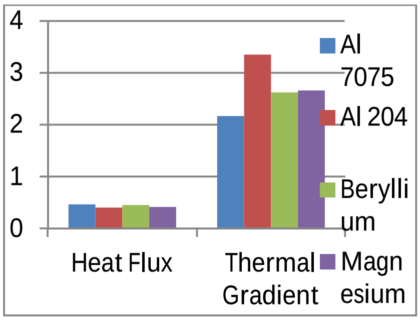
GRAPHICAL REPRESENTATION:

Thickness of 2.5 mm

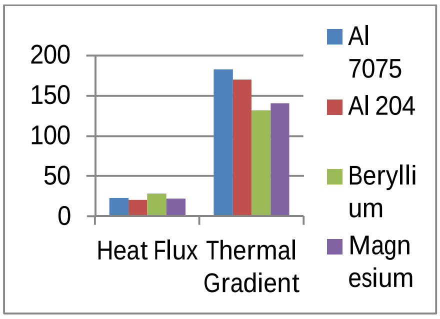
CURVED FIN:



CIRCULAR FIN:



RECTANGULAR FIN:



By observing the graphs, the heat flux is more for Beryllium and Aluminum alloy 7075.

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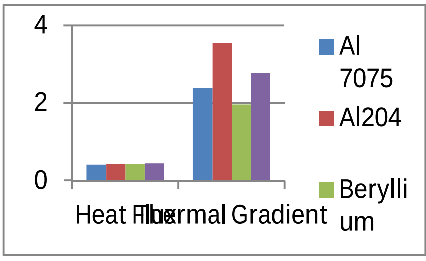

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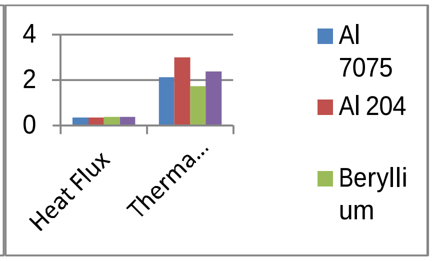

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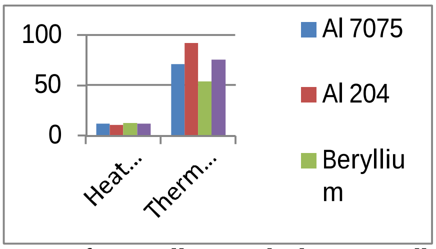
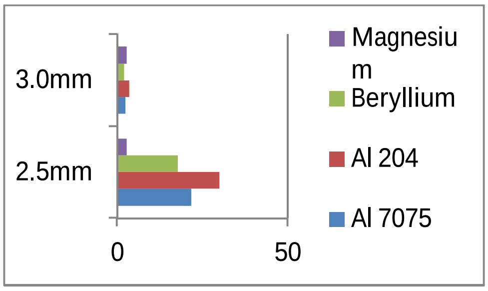
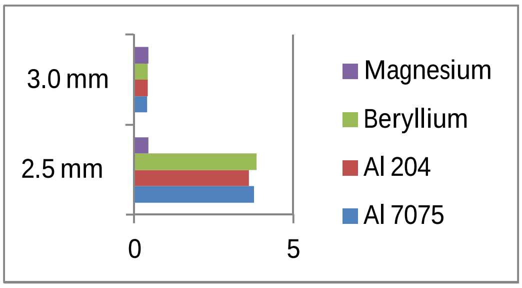


By observing the graphs, the heat flux is more for Beryllium and Aluminum alloy 7075

Comparison of Thickness 2.5 mm and 3 mm

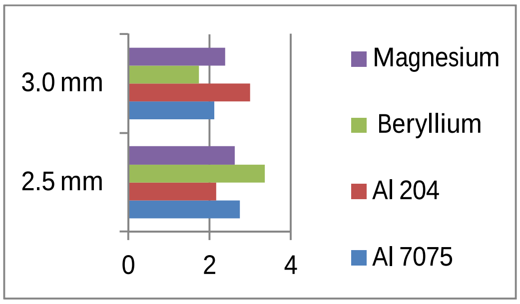
CURVED: THERMAL GRADIENT **THERMAL FLUX**

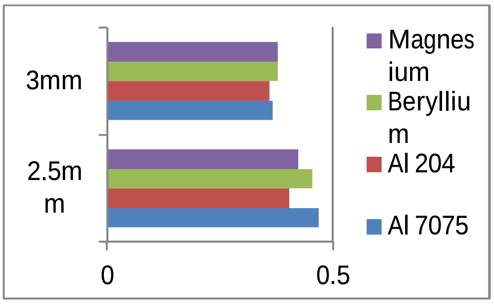




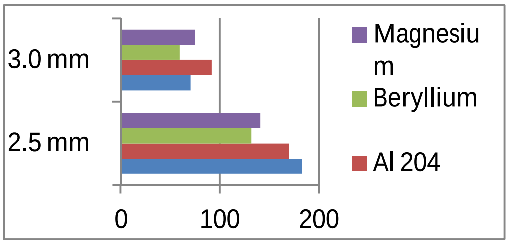
By observing the graphs, the heat flux is more for 2.5mm

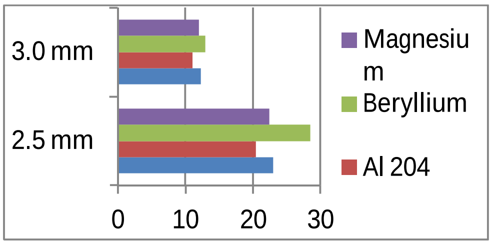
CIRCULAR FIN: THERMAL GRADIENT **THERMAL FLUX**





RECTANGULAR FIN THERMAL GRADIENT **THERMAL FLUX**





V. CONCLUSION

In this Project, a cylinder fin body for a 180cc motorcycle is modeled using parametric software Pro/Engineer. The original model is changed by changing thickness of the fins. The thickness of original model is 3mm, it has been reduced to 2.5mm. By reducing the thickness of the fins, the overall weight is reduced.

Present used material for fin body is Aluminum Alloy 204. In this thesis, three other materials are considered which have more thermal conductivities than Aluminum Alloy 204. The materials are Aluminum alloy 7075, Magnesium Alloy and Beryllium. Thermal analysis is done for all the three materials. The material for the original model is changed by taking the consideration of their densities and thermal conductivity.

By observing the thermal analysis results, thermal flux is more for Beryllium than other materials and also by reducing the thickness of the fin 2.5mm, the heat transfer rate is increased.

IV. FUTURE SCOPE

The shape of the fin can be modified to improve the heat transfer rate and can be analyzed. The use of Aluminum alloy 6061 as per the manufacturing aspect is to be considered. By changing the thickness of the fin, the total manufacturing cost is extra to prepare the new component

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