INVESTIGATION AND ANALYSIS OF PISTON BY USING COMPOSITE MATERIAL

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ABSTRACT

An Internal Combustion Engine is that kind of prime mover that converts chemical energy into mechanical energy. The fuel on burning changes into gas which impinges on the piston and pushes it to cause reciprocating motion. The reciprocating motion of the piston is then converted into rotary motion of the crankshaft with the help of connecting rod. Metal Matrix Composites (MMCs) have evoked a keen interest in recent times for potential applications in Aerospace and automotive industries owing to their superior Strength to weight ratio and high temperature resistance.

Composite materials are gaining importance for their advantages including low cost, ease and simplicity of operation. Composites containing hard oxides (like SiC) are preferred for high wear resistance along with increased hardness, improved corrosion resistance and high temperature oxidation resistance as compared to alloy and pure metal. Composite coating is used for the purpose of wear resistance. With increasing availability of micron-sized particles of SiC, there is growing interest in the electrolytic and electro less co-deposition of these particles. In this work, material composition test, hardness test, of such composite coatings are carried out. The effect of particle size and number of particles suspended is reported. SiC Composites have been deposited on Aluminium by casting process. The resulting castings are studied using scanning electron microscopy and hardness tests. The piston is modeling using Pro-E modeling and analyzing using ANSYS simulation software for Aluminium (Pure) and Aluminium-SiC and the results were discussed.

Keyword: - *Engine, Mechanical Energy, Piston, Connecting rod, Metal matrix composite*

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1. INTRODUCTION

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and/or connecting rod. In a pump, the function is reversed and force is transferred from the crankshaft to the piston for the purpose of compressing or ejecting the fluid in the cylinder. In some engines, the piston also acts as a valve by covering and uncovering ports in the cylinder wall.

2. PISTON DESIGN

Creo Elements/Pro offers a range of tools to enable the generation of a complete digital representation of the product being designed. In addition to the general geometry tools there is also the ability to generate geometry of other integrated design disciplines such as industrial and standard pipe work and complete wiring definitions. Tools are also available to support collaborative development. A number of concept design tools that provide up-front Industrial Design concepts can then be used in the downstream process of engineering the product. These range from conceptual Industrial design sketches, reverse engineering with point cloud data and comprehensive free-form surface tools.The created model Connecting Rod using CREO software. The models are shown below.

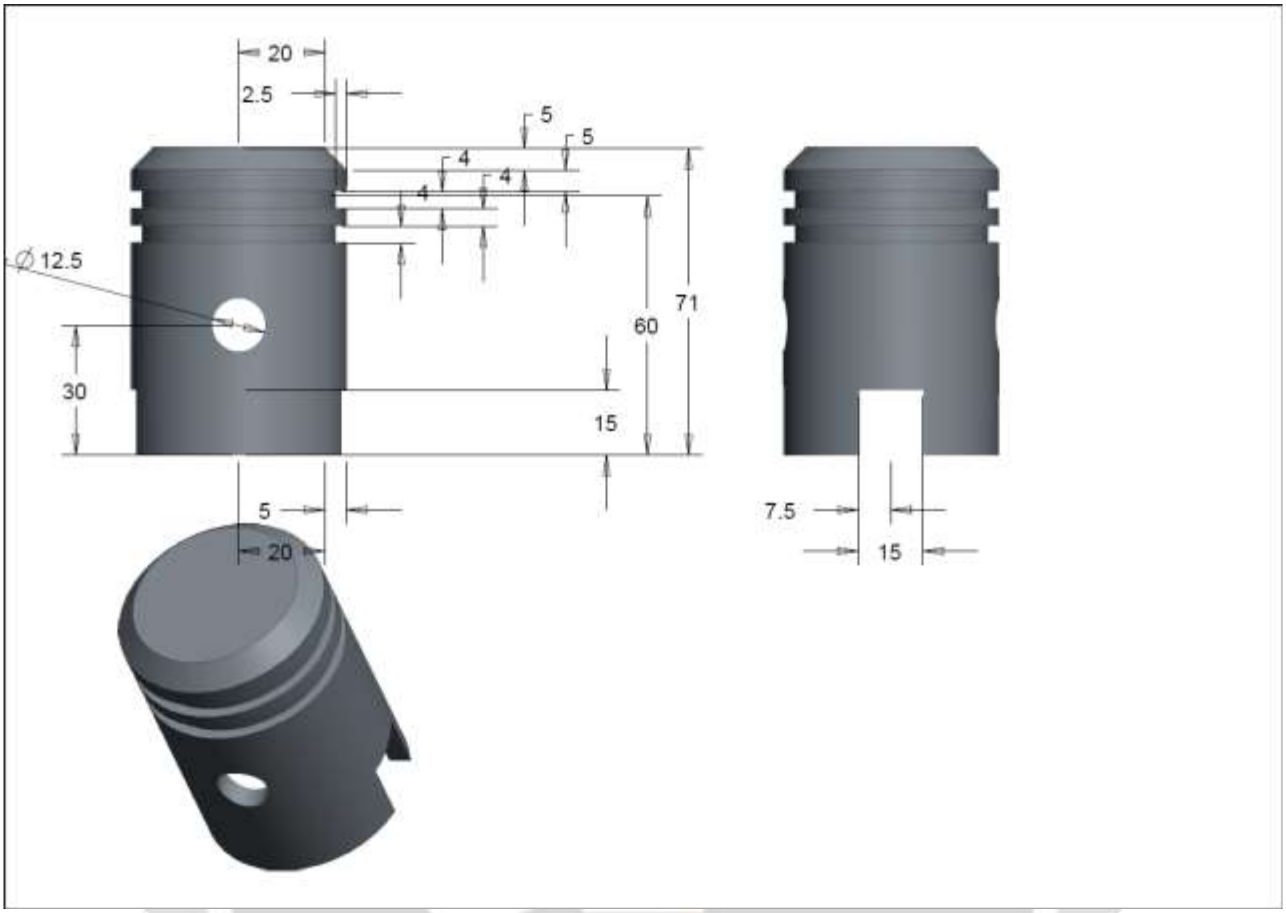

Fig 2.1 Detailed Views

3. THERMAL ANALYSIS BY USING ANSYS SOFTWARE

ANSYS is capable of both steady state and transient analysis of any solid with thermal boundary conditions. Steady – state thermal analyses calculate the effects of steady thermal loads on a system or component. Users often perform a steady – state analysis before doing a transient thermal analysis, to help establish initial conditions. a steady -state analysis also can be the last step of a transient thermal analysis; performed after all transient effects have diminished. ANSYS can be used to determine temperatures, thermal gradients, heat flow rates, and heat fluxes in an object that are caused by thermal loads that do not vary over time. Such loads include the following

i. Convection
ii. Radiation
iii. Heat flow rates
iv. Heat fluxes (heat flow per unit area)
v. Heat generation rate (heat flow per unit volume)
vi. Constant temperature boundaries
vii. Explicit Dynamics Analysis

A steady –state thermal analysis may be either linear, with constant material properties; or nonlinear, with material properties that depend on temperature. The thermal properties of most material very with temperature. This temperature dependency being appreciable, the analysis becomes nonlinear. Radiation boundary conditions also make the analysis nonlinear. Transient calculations are time dependent and ANSYS can both solve distributions as well as create video for time incremental displays of models

4. STRUCTURAL STATIC ANALYSIS OF AL WITH 10% Sic

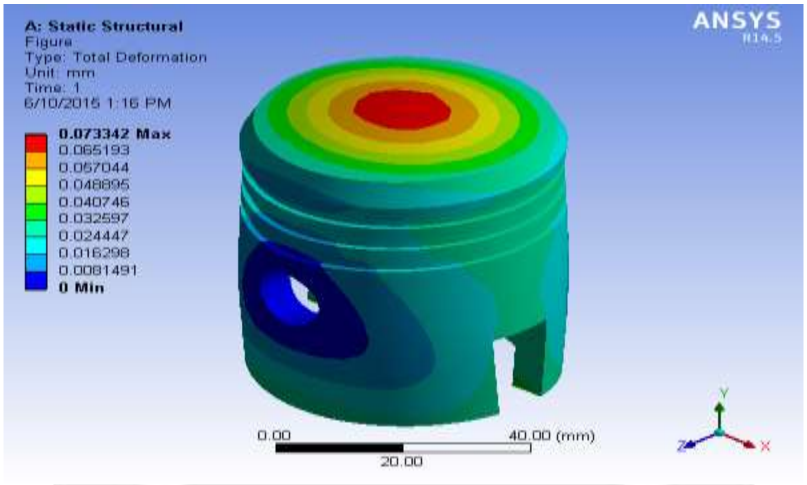

Fig.4.1 Total deformation of Al with 10%Sic

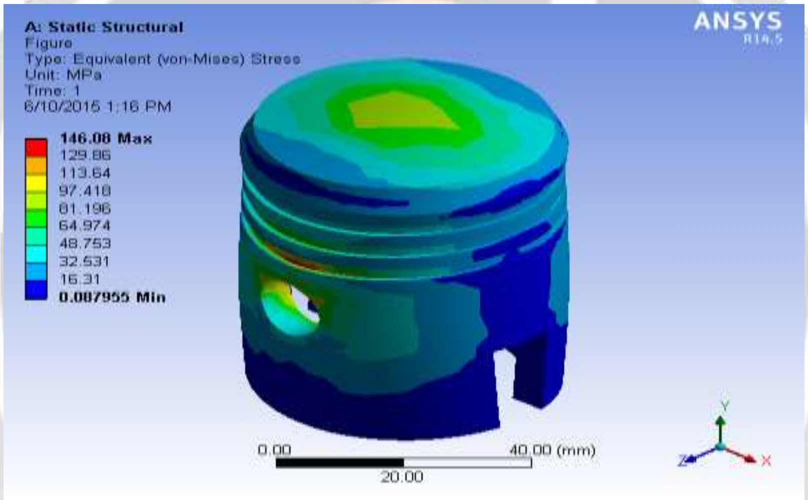

Fig.4.2 Von-Mises stress distribution of Al with 10%Sic

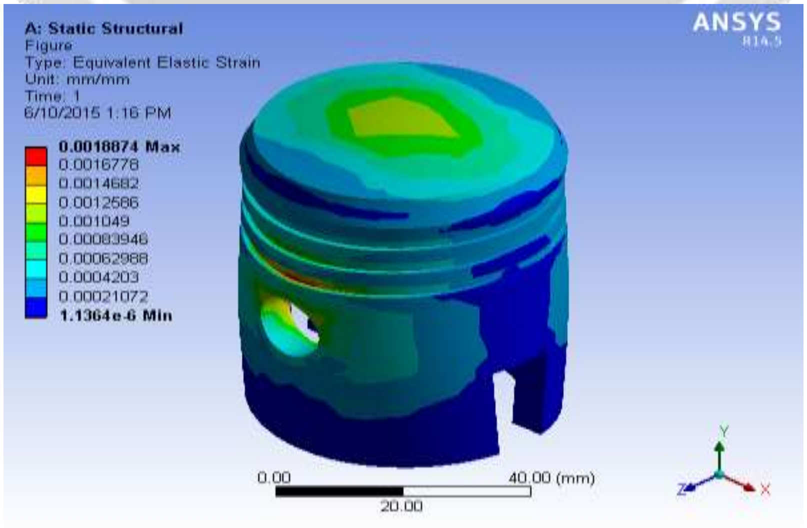

Fig.4.3 Equivalent Elastic Strain of Al with 10%Sic

4.1 STEADY STATE THERMAL ANALYSIS OF AL WITH 10% Sic

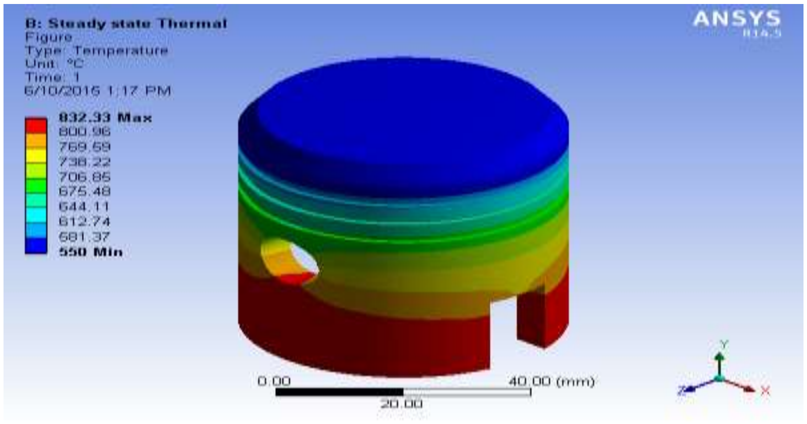

Fig.4.4 Temperature distribution of Al with 10%Sic (Steady state)

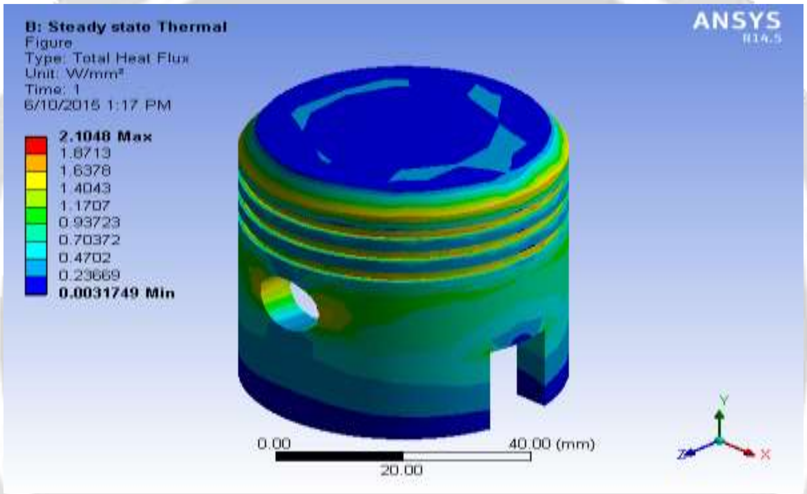

Fig.4.5 Total heat flux of Al with 10%Sic

4.2 TRANSIENT THERMAL ANALYSIS OF AL WITH 10% Sic

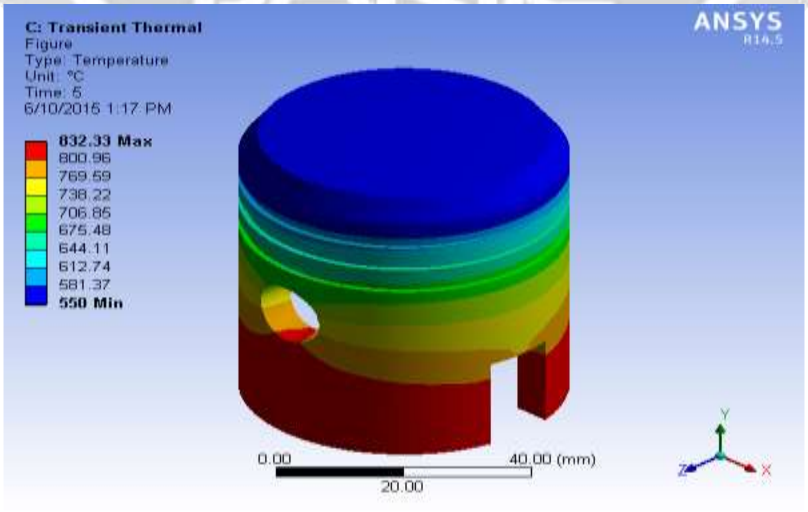

Fig.4.6 Temperature distribution of Al with 10%Sic (Transient Thermal)

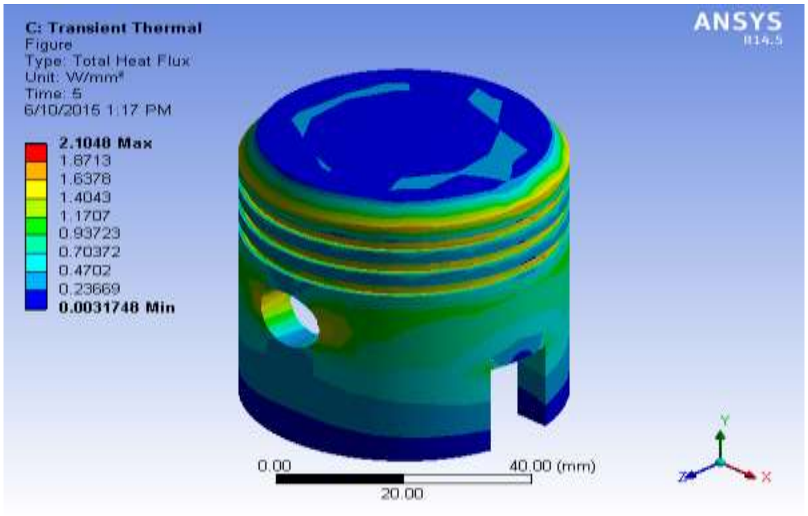

Fig 4.7 Total Heat flux of Al with 10%Sic (Transient Thermal)

4.3 STRUCTURAL STATIC ANALYSIS OF AL WITH 20%Sic

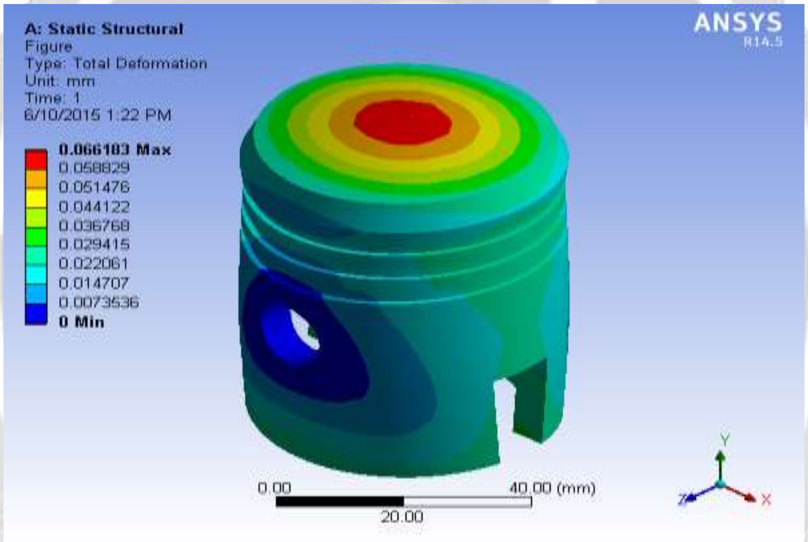

Fig.4.8 Total deformation of Al with 20%Sic

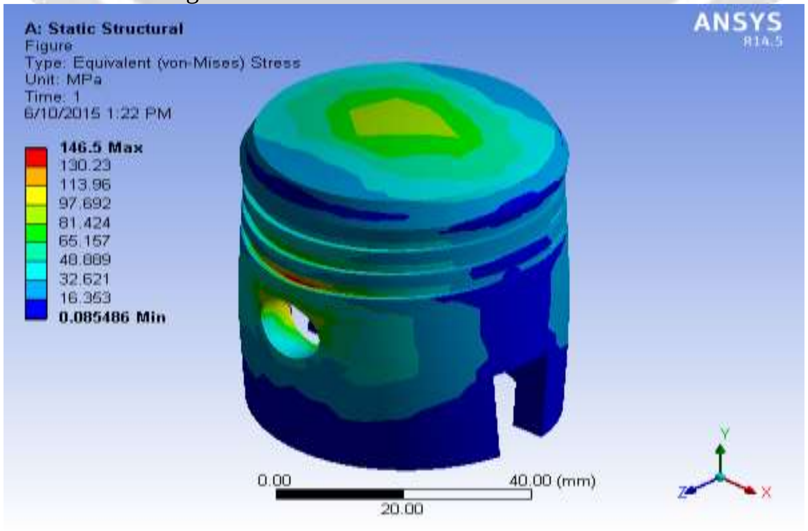

Fig.4.9 Von-Mises stress distribution of Al with 20%Sic

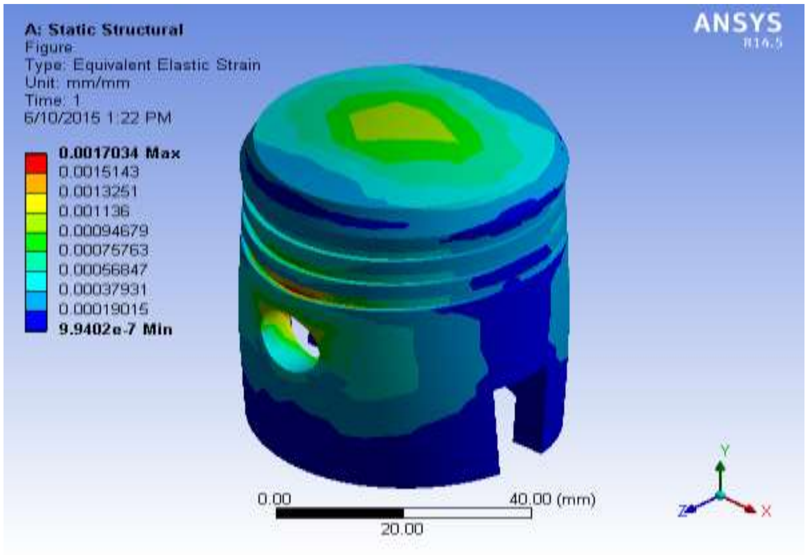

Fig.4.10 Equivalent Elastic Strain of Al with 20%Sic

4.4 STEADY STATE THERMAL ANALYSIS OF AL WITH 20% Sic

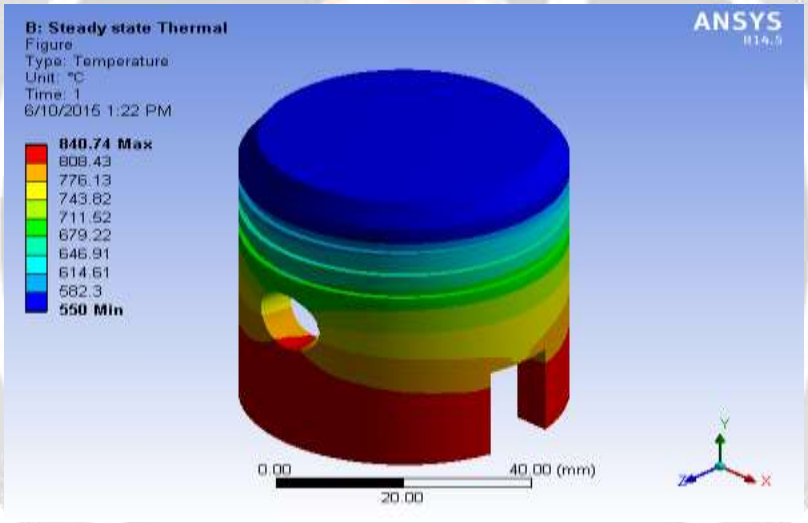

Fig.4.11 Temperature difference of Al with 20% Sic (Steady state)

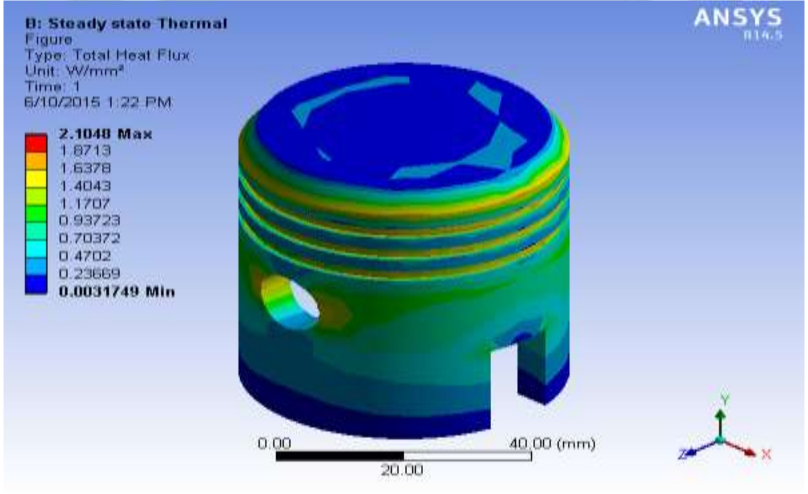

Fig.4.12 Total Heat Flux of Al with 20%Sic

4.6 TRANSIENT THERMAL ANALYSIS OF AL WITH 20% Sic

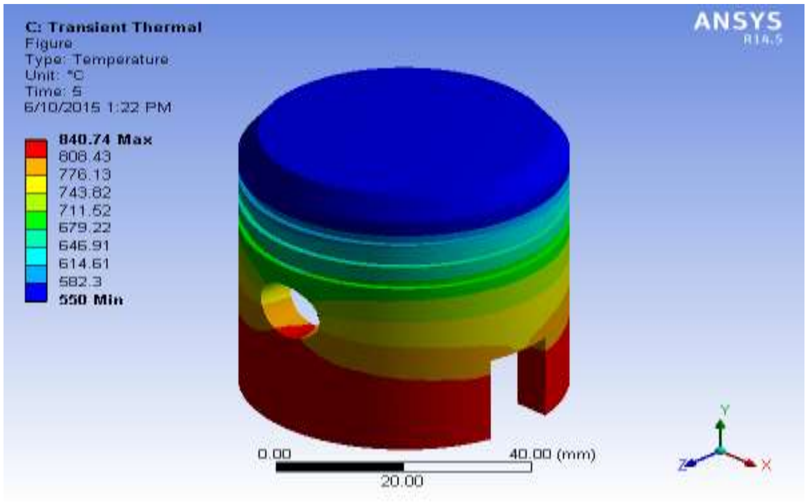

Fig.4.13 Temperature distribution of Al with 20%Sic (Transient Thermal)

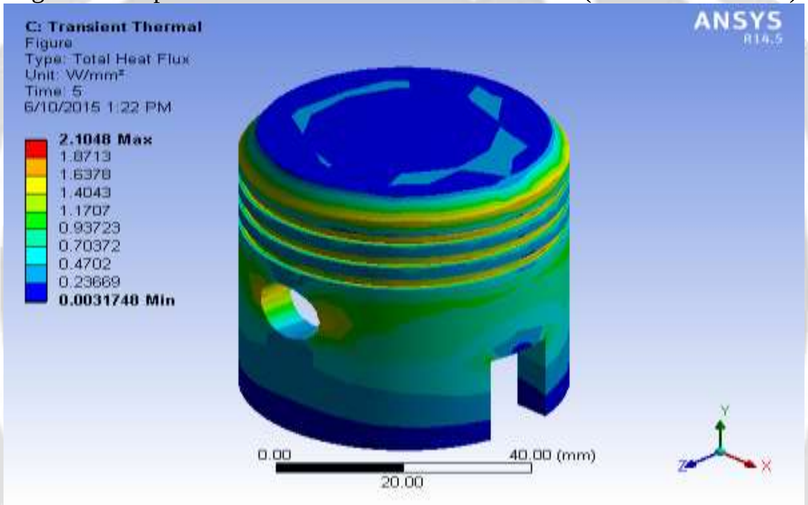

Fig 4.14 Total Heat flux of Al with 10%Sic (Transient Thermal)

5. RESULTS

5.1 THERMAL ANALYSIS FOR PISTON

Table 5.1 Steady State Thermal Analysis

Materials	**Temperature (°C)**	**Total Heat Flux (W/mm^2)**
Al with 10% SiC	832.33	2.10
Al with 20% SiC	840.74	2.10
Al with 30% SiC	847.83	2.10
Existing Material (Al alloy)	863.1	2.10

Table 5.2 Transient State Thermal Analysis

Materials	**Temperature (°C)**	**Total Heat Flux (W/mm^2)**
Al with 10% SiC	832.33	2.10
Al with 20% SiC	840.74	2.10
Al with 30% SiC	847.83	2.10
Existing Material (Al alloy)	863.1	2.10

5.2 STRUCTURAL ANALYSIS FOR PISTON

For structural static analysis of piston the minimum deformation and elastic strain value obtained for the Al with 30% SiC and the minimum equivalent stress value is obtained for the Al with 10% SiC.

Table 5.3 Structural Static Analysis of Piston

Materials	**Deformation (mm)**	**Equivalent (von mises) stress (N/mm^2)**	**Equivalent Elastic Strain**
Al with 10% SiC	0.073	146.08	0.0018
Al with 20% SiC	0.066	146.5	0.0017
Al with 30% SiC	0.062	146.9	0.0015
Existing Material (Al alloy)	0.079	146.08	0.0020

6. CONCLUSION

In this project, 3D Model is prepared in CREO and then CAE analysis is performed by Ansys 14.5 and three different materials (Al with 10% SiC, AL with 20% SiC and AL With 30% SiC) for piston are taken into thermal analysis. From the result obtained from Ansys, It Seems that the Aluminium with 10% SiC material having better temperature distribution in both steady state thermal analysis as well as transient state thermal analysis hence aluminium with 10% SiC Material is better than Aluminium alloy Material therefore Aluminium with 10% SiC Material is most suitable for piston.

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