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27.

THERMAL ANALYSIS ON CARBON GRAPHITE AND CAST IRON PISTONS APPLIED HEAT POWER VALUE OF 200 WATT ON THE TOP OF PISTON HEAD USING SOLIDWORKS SIMULATION TECHNIQUE

Jatender Datta* & Dr. Sahib Sartaj Singh**
*Research Scholar,PhD (Mechanical Engg.), Desh Bhagat University, Mandi Gobindgarh
**Workshop Suptt. , Punjabi University, Patiala (India)

Abstract- *This paper was designed to find the temperature distribution and resultant temperature gradient value after applied thermal load as heat power value of 100 watt on the top of the pistons made of Gray Cast Iron and Carbon Graphite. The Piston of 100cc bike and drawn in solidworks software. The drawn model was meshed and analyzed using solidworks simulation software for better results. The main motive is to find the thermal load results from both the pistons and to find the best suitable piston for IC engine to increase the efficiency of the engine.*

Keywords: heat power analysis, gray cast iron analysis, thermal load analysis, temperature gradient, heat transfer, meshing, thermal conductivity.

I INTRODUCTION:

A piston is a cylindrical engine component that slides back and forth in the cylinder bore by forces produced during the combustion process. The piston acts as a movable end of the combustion chamber. The stationary end of the combustion chamber is the cylinder head. Piston features include the piston head, piston pin bore, piston pin, skirt, ring grooves, ring lands, and piston rings. The piston head is the top surface (closest to the cylinder head) of the piston which is subjected to tremendous forces and heat during normal engine operation.

II FEM:

The finite element method (FEM) is a numerical method for solving problems of engineering and mathematical physics. It is also referred to as finite elementanalysis (FEA). ... To solve the problem, it subdivides a large problem into smaller, simpler parts that are called finite elements.Finite Element Analysis (FEA) is a computer based method of simulating/analyzing the behavior of engineering structures and components under a variety of conditions. It is an advanced engineering tool that is used in design and to augment/replace experimental testing.

III. VOLUMETRIC PROPERTIES:

Table 1: Grey Cast Iron

S NO	PROPERTIES	VALUE
1	MASS	0.196 kg
2	VOLUME	2.72e-005m^3
3	DENSITY	7200 kg/m^3
4	WEIGHT	1.92 N

Table 2: Carbon Graphite

S NO	PROPERTIES	VALUE
1	MASS	0.060 kg
2	VOLUME	2.72e-005m^3
3	DENSITY	2240 kg/m^3
4	WEIGHT	0.59 N

IV. MECHANICAL PROPERTIES:

S NO	PROPERTIES	VALUE
1	POISSONS RATIO	0.27
2	THERMAL EXPANSION COEFFICIENT	1.2e-005/K
3	DENSITY	7200 kg/m^3
4	THERMAL CONDUCTIVITY	45 W/(m-K)
5	SPECIFIC HEAT	510 J (kg-K)

Table 3: Grey Cast Iron

S NO	PROPERTIES	VALUE
1	POISSONS RATIO	0.28
2	THERMAL EXPANSION COEFFICIENT	1.3e-005/K
3	DENSITY	2240 kg/m^3
4	THERMAL CONDUCTIVITY	168 W/(m-K)
5	SPECIFIC HEAT	44 J (kg-K)

Table 4: Carbon Graphite

IV. ENGINE SPECIFICATIONS:

Type	Air cooled, 4 - stroke single cylinder OHC
Displacement	97.2 cc
Max. Power	6.15kW (8.36 Ps) @8000 rpm
Max. Torque	0.82kg - m (8.05 N-m) @5000 rpm
Max. Speed	87 Kmph
Bore x Stroke	50.0 mm x 49.5 mm
Carburetor	Side Draft , Variable Venturi Type with TCIS
Compression Ratio	9.9 : 1
Starting	Kick / Self Start
Ignition	DC - Digital CDI
Oil Grade	SAE 10 W 30 SJ Grade , JASO MA Grade

Air Filtration	Dry , Pleated Paper Filter
Fuel System	Carburetor
Fuel Metering	Carburetion

V. REVERSE ENGINEERING THE PISTON:

With the help of measuring instruments like vernier caliper etc. the dimensions of the model piston were measured. By using this measurement 3D model of the piston were drawn using Solidworks 3D modeling software as below:

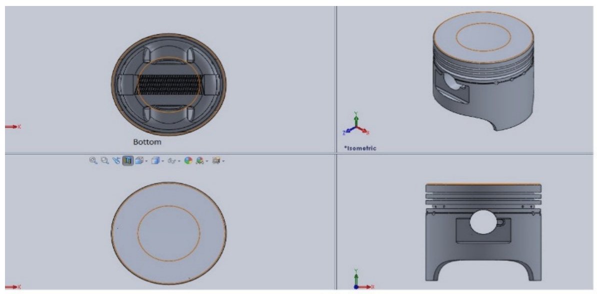

Figure 1. Model of Piston

VI. BOUNDARY CONDITIONS AND LOADS:

Applied Thermal Load as Heat power value of 200 Watt on the top of the piston head.

Note: Units, boundary conditions and loads will be same in both tests.

VII. MESHING OF PISTON:

Mesh Information

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	2.94563 mm
Tolerance	0.147281 mm
Mesh Quality	High

Mesh Information - Details

Total Nodes	26221
Total Elements	14224
Maximum Aspect Ratio	90.342
% of elements with Aspect Ratio < 3	84
% of elements with Aspect Ratio > 10	0.443

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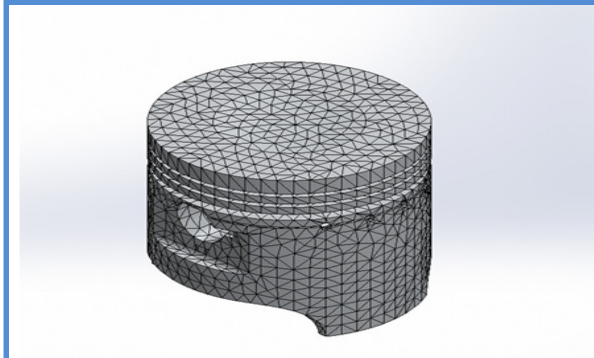
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:07
	Figure 2: Meshed Model

VIII. Study Properties:

Study name	Study 1
Analysis type	Thermal(Transient)
Mesh type	Solid Mesh
Solver type	Direct sparse solver
Solution type	Transient
Total time	1 Seconds
Time increment	0.1 Seconds
Contact resistance defined?	No
Result folder	DEFAULT

IX .Units:

Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m^2

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X. RESULTS AND DISCUSSION:

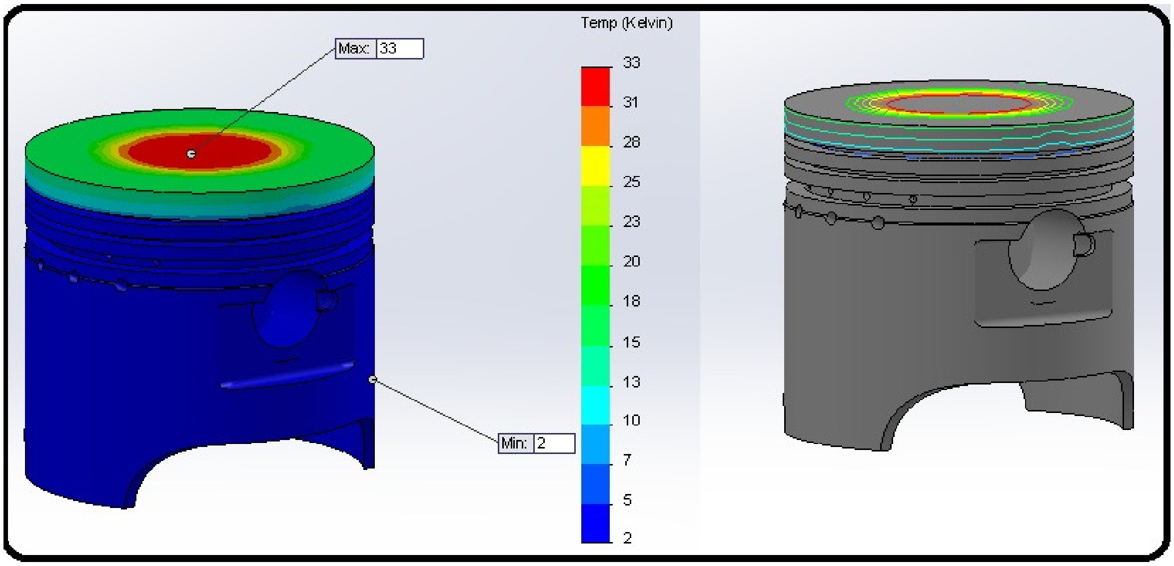

Figure 3.Result of Temperature distribution for Gray Cast Iron

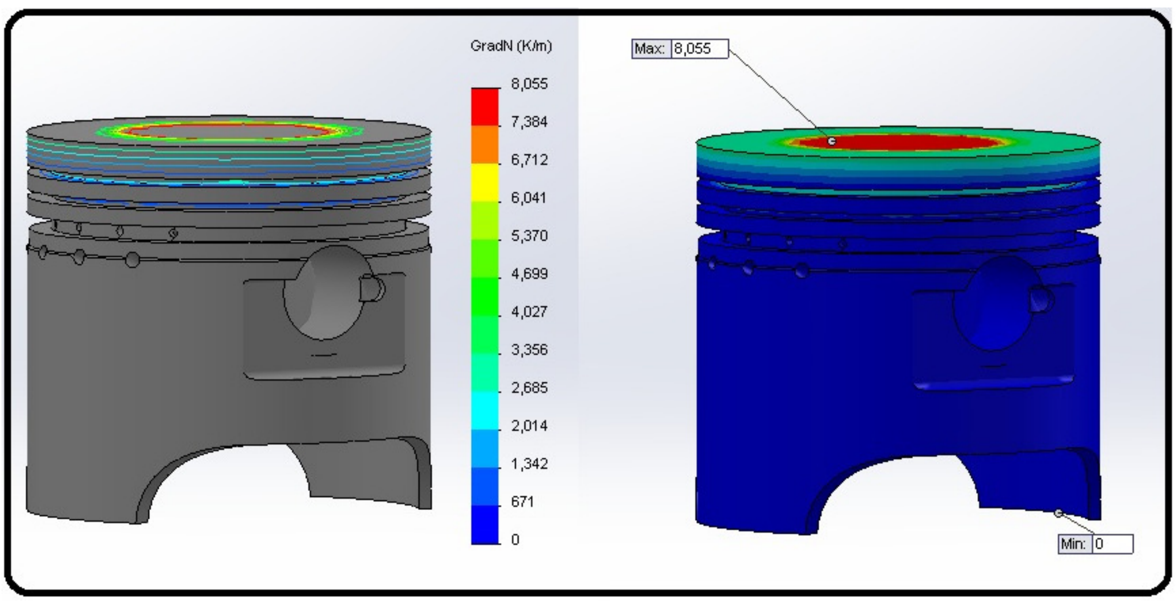

Figure 4. Resultant Temperature Gradient for Gray Cast Iron

Figure 3: The maximum temperature shown on the top of the piston head and properly distributed till just below the piston pin hole due to heat produced by the gases in the combustion chamber.

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Figure 4: In this study maximum temperature absorbed on the top of the piston head and heat transfer properly shows till the 2nd groovedue to the gases in the chamber.

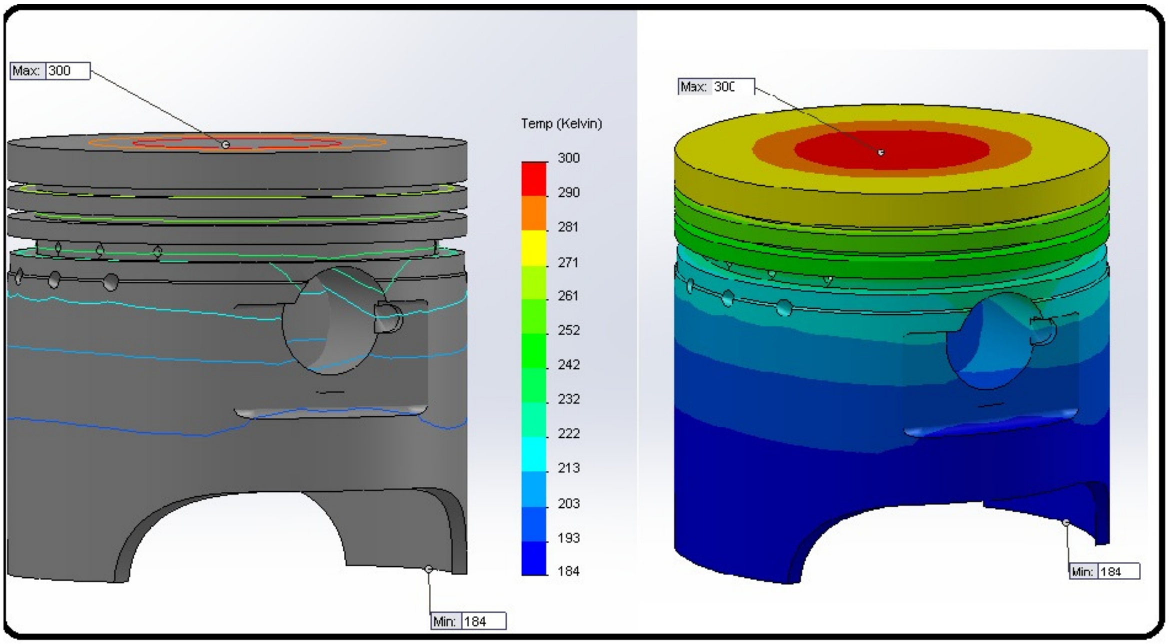

Figure 5. Temperature distribution result for Carbon Graphite material

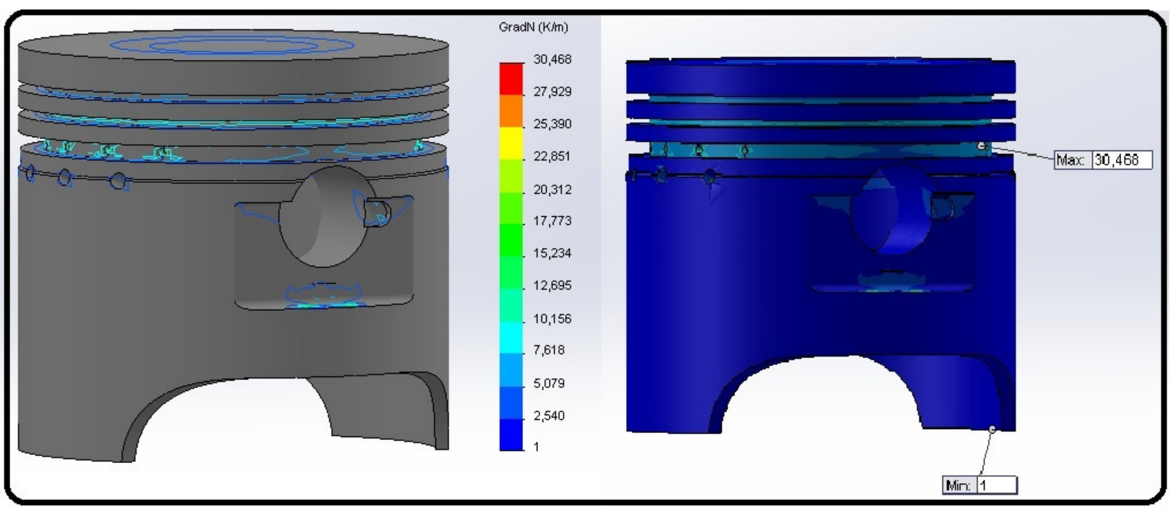

Figure 6 . Resultant Temperature Gradient for Carbon Graphite

Figure 5: The maximum Temperature occur on the top of the piston and excellent distributed till last as shown in image due to heat in the combustion chamber.

Figure6: Here the result shows the maximum value of resultant temperature gradient occur till last end of the piston and heat transfer shows till just below the piston pin hole properly

shown in the image due to heat generated by the gases at the time of combustion in the chamber.

XI. CONCLUSION:

In the conclusion , result shows in the favor of piston made of Carbon Graphite as compared to piston made of Gray cast Iron due to the higher thermal conductivity of carbon graphite.

Carbon Graphite is much lighter in weight as compared to cast iron. On the other hand, Carbon graphite has a self-lubricant properties and its mechanical strength increases while temperature rise, which is not in other metals.

At last, Carbon Graphite material is most suggested material as compared to Cast iron for piston in this paper for best performance of engine.

REFERENCES:

[1]SreckoManasijevic, RadomirRadisa, SrdjanMarkovic, ZagorkaAcimovic- PavlovicKarloRaic, "Thermal analysis and microscopic characterization of the piston alloy AlSi13Cu4Ni2Mg",Intermetallics 19 (2011) 486 – 492.

[2]Gudimetal P, Gopinath C.V, "Finite Element analysis of Reverse Engineered Internal Combustion Engine Piston", AIJSTPME (2009) 2(4): 85-92.

[3]Esfahanian, A. Javaheri, M. Ghaffarpour, "Thermal analysis of an SI engine piston using different combustion boundary condition treatments", Applied Thermal Engineering 26 (2006)277.

[4]C.H. Li., Piston thermal deformation and friction considerations, SAE Paper 820086, 1982.

[5]Y. Liu. and R.D. Reitz, Multidimensional modeling of combustion chamber surface temperatures, SAE Paper 971539, 1997.

[6] Handbook of Internal Combustion Engines, SAE International.

[7]. NunnaDurgaPrasanth ,Dr.BVenkataraman – "EXPERIMENTAL INVESTIGATION AND ANALYSIS OF PISTON BY USING HYBRID METAL MATRIX" [Nunna, 4(3): March, 2015] ISSN: 2277-9655 Scientific Journal Impact Factor: 3.449 (ISRA), Impact Factor: 2.114.

[8]..Kethavath Vishal, Dinesh Bajaj, A.Sai Kumar –" Design and Structural Analysis of Composite Piston" Volume No: 2 (2015), Issue No: 10 (October) October 2015.

[9]. M.Srinadh , K. RajasekharaBabu – "Static and Thermal Analysis of Piston and Piston Rings" August 2015, Volume 3, Issue 8, ISSN 2349-4476.

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