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Design Modification And Thermal Analysis of IC Engine Fin

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Abstract :- Cooling fins in IC engines remove excess heat from it to protect its components from thermal damages. These fins work on the principle of convection heat transfer. The cooling efficiency of the engine fins can be improvised by changing geometry, thermal conductivity and the material of the cooling fins. Computational fluid dynamics is the technique used to determine thermal stresses and temperature distribution through the fins. CFD analysis gives accurate and realistic results in comparison with physical analysis processes. This project is based on designing more efficient cooling fins for a 150 cc (Honda Unicorn) bike engine by improvising the design and the material of the fin. Where the modelling of the fin is performed on Creo modelling software and the CFD analysis is performed on ANSYS 15.0 Workbench software.

Keywords: - Creo 3.0, ANSYS 15.0, CFD Analysis, Steady State, Transient State Heat Transfer**.**

I. INTRODUCTION

Internal combustion engines are those in which the combustion takes place inside the engine cylinder, this chemical process of combustion generates very high amount of thermal energy up to 2500ºC. This high temperature is unbearable by the fluid film between various moving parts of the engine and the fluid film may evaporate. This temperature may also cause severe damage to various parts of the engine like piton, valves etc, as it generates very high rates of thermal stresses, to protect them from the damages the temperature should be reduced up to required working condition temperature of the engine. The reduction in the temperature is only permissible up to a limit, after the limit this temperature cannot be reduced further otherwise it may affect thermal efficiency of the engine. About 25-35% of the total generated thermal energy could be used into useful mechanical work and rest is rejected into the atmosphere. In this present work Honda unicorn 150cc bike is selected for thermal analysis. The Honda engine is having rectangular fins on the circumference of the cylinder and on engine head. This engine is made by aluminium alloy material. This engine design is modified by using holes of different sizes on the surfaces of the fin, different shape of holes having different effects on the heat dissipation capacity of the fin. To increase the heat transfer rate than the existing engine model the Aluminium alloy material has replaced by AL 6063 and Aluminium Nitride (ALN) and comparing the both used materials.

II. LITERATURE REVIEW

Related work is has been done on the Honda unicorn (150cc) bike model IC engine. There is continuous work going on for increasing the thermal efficiency and reducing the temperature of the engine.
A research has been performed by KM Sajesh et al. Which shows the results that:-

1. Turbulence of flow of air increased between the fins of hole.
2. Temperature of fin can be reduced by creating holes on it.
3. On increasing the surface area or increasing the diameter of the holes the cooling efficiency increases.

A research has been performed by B N Niroop Kumar Gowd et al. and they concluded that:-

Aluminum Alloy 204 with three other materials are considered which have more thermal conductivities than Aluminum Alloy 204 used, 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. The shape of the fin can be modified to improve the heat transfer rate and can be analyzed.

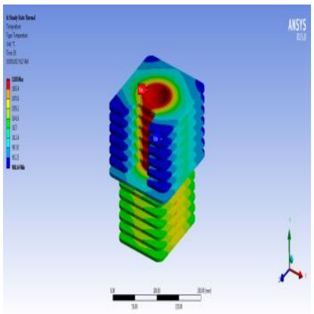
Deepak Gupta et al. have designed a cylinder fin body used in a 100cc Hero Honda Motorcycle and modeled in parametric 3D modeling software Pro/Engineer. Presently used material for fin body is aluminum alloy fins and internal core with grey cast iron replaced with Aluminum alloy 6063 and Grey cast iron separately for entire body. The shape of the fin is rectangular; we have changed the shape with circular shaped. The default thickness of fin is 3mm; we are reducing it to 2.5mm. They have done thermal analysis on the fin body by varying materials, geometry and thickness. By observing the analysis results, using circular fin, material Aluminum alloy 6063 and thickness of 2.5mm is better since heat transfer rate is better. But by using circular fins the weight of the fin body increases. So if we consider weight, using circular fins is better than other geometries. So they say Aluminum alloy 6063 is better, reducing thickness to 2.5mm is better and using fin shape circular by analysis and fin shape curved by weight is better. By observing the results, using circular fins the heat lost is more, efficiency and effectiveness is also more..

III. MODELLING

The modelling of Honda unicorn 150cc bike engine is done on the CREO 3.0 software. CREO 3.0 is the latest PTC software used to design and modelling machine or machine parts more accurately then the previous PTC softwares. The modelling is done by putting the geometrical values by physical measurements of actual unicorn bike engine. Fig. 1 shows the model of Honda Unicorn (150cc) bike engine.

IV. FIGURES AND TABLES

It is clear from above literature that a lot of research work is going on thermal analysis and design modification of cooling fins of IC engines and still the future scope is available. In this research paper the thermal analysis is carried out on ANASYS 15.0 workbench and a comparative study is done between Aluminium 6063 and ALN materials for various diameter holes on the fins of 2mm, 6mm, 10mm and without hole. Figures show the results of thermal analysis of 150 cc Honda unicorn bike engine. Figures show results in all states with both designing materials which are Aluminium 6063 and Aluminium Nitride. Figure 1 and 2 shows results about steady state and transient states of Aluminium 6063 and figure 3 and 4 shows results about steady and transient states of Aluminium Nitride material.



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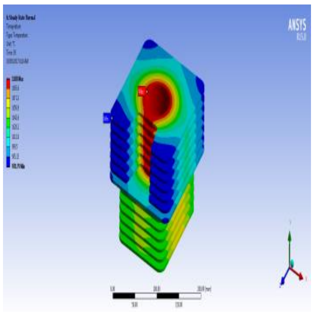

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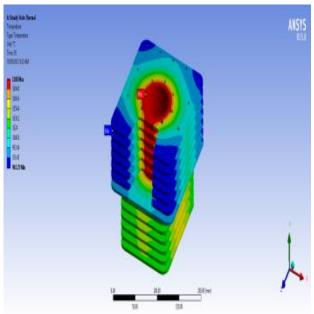

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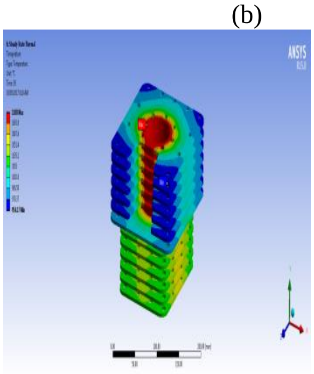

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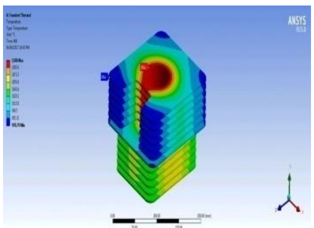
Fig.1. Aluminium 6063 Steady State (a) No Hole (b) 2mm Hole (c) 6 mm Hole (d) 10 mm Hole



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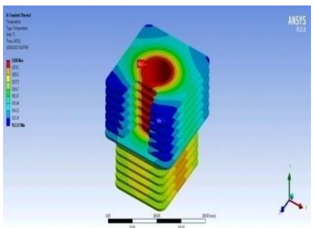

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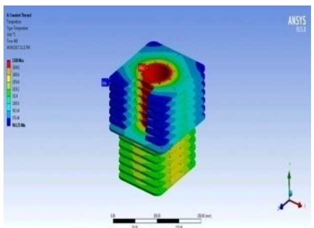

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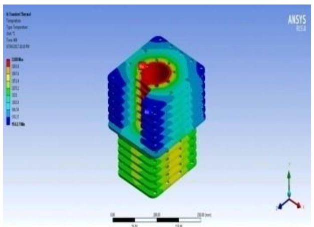

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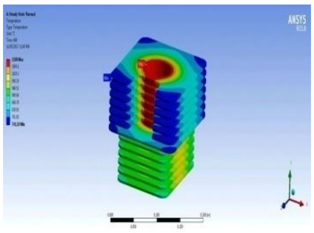
Fig. 2 Aluminium 6063 Transient State (a) No Hole (b) 2mm Hole (c) 6 mm Hole (d) 10 mm Hole



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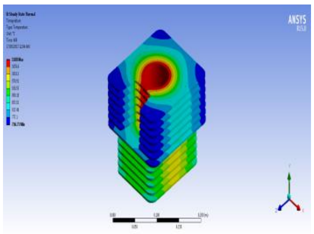

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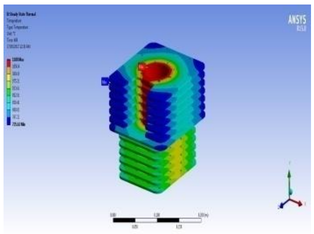

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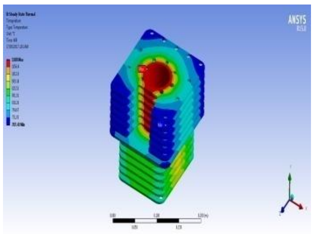

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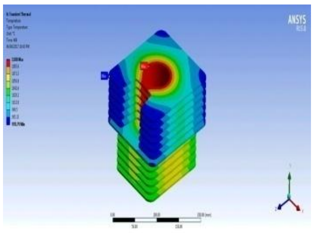
Fig. 3 Aluminium Nitride Steady State (a) No Hole (b) 2mm Hole (c) 6 mm Hole (d) 10 mm Hole



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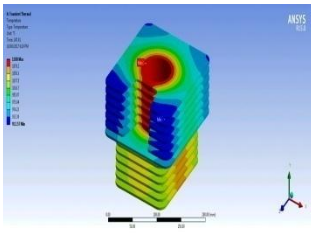

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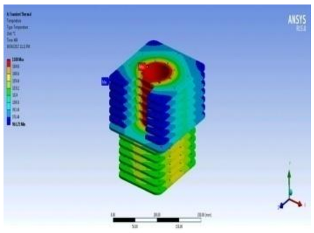

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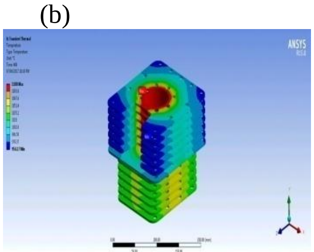

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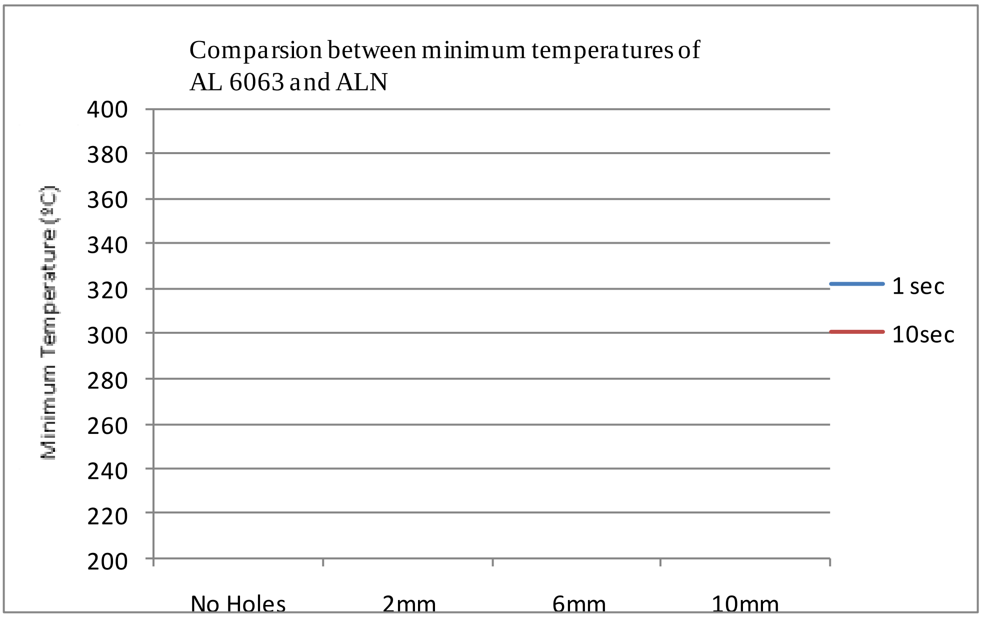
Fig. 4 Aluminium Nitride Transient State (a) No Hole (b) 2mm Hole (c) 6 mm Hole (d) 10 mm Hole

Hole Diameter	Minimum Temperature (ºC) in AL 6063	Minimum Temperature (ºC) in ALN (Aluminium Nitride)
No hole	970.79	741.18
2 mm Hole	968.64	736.73
6 mm Hole	963.25	725.62
10 mm Hole	954.17	707.43

Table 1:- Comparison between the Minimum Temperatures of Al 6063 and ALN.

Table 1 is prepared after the thermal analysis/ CFD analysis of the varying geometries of cooling fins. Here a maximum temperature as a load of 1100ºC is applied on the engine and the minimum temperatures are analysed to find out the most efficient performance of the cooling fins. In which 707.43º C is founded minimum temperature among all the geometries of fins



Graph 1:- Minimum Temperature v/s Size of The Holes between Al 6063 and ALN

From table 1 the difference in temperature is clearly explained between AL6063 and ALN materials and from the graph it is clear that the ALN material is showing better cooling results than previously used AL 6063 material. So that it is clear as per the design prospective the ALN material should be used to achieve better heat dissipating properties, with results better than previously used materials as Aluminium 6061, 6063 and other Aluminium alloy materials.

V. CONCLUSION

We have implemented that the minimum temperature of the engine reduces on increasing the cross section area of the fins which is done by implanting holes on the fin surface. As the hole area increases the fin efficiency also increases. We also implemented the reduction in minimum temperature of the engine by implementing the material from AL 6063 to Aluminium Nitride (ALN) which is showing better and more efficient results than AL 6063. It has been seen that the implementation results in reduction in minimum temperature of the engine up to 20% in Aluminium nitride after improvising from Aluminium 6063. It is clear from CFD analysis that, to achieve better cooling results Aluminium Nitride is a better option than Aluminium 6063 alloy material. It is also proved from experimental results that, on increasing the diameter of the hole the dissipated heat also gets increased. Fin with hole diameter 10mm has decreases the minimum temperature of 741.18ºc for an imperforated fin to a minimum temperature of 707.43ºc

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