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Modeling and simulation of engine cylinder Fins by using fea

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Abstract: In this design the single cylinder air cooled engine to be analysis with different profile fins such as triangular, rectangular, elliptical, trapezoidal profile and compare the existing profile of the engine .Comparative thermal tests will be carried out using Aluminum two stroke S.I engine made with triangular fin, with rectangular, elliptical, trapezoidal profile without varying material properties of engine block. A cylinder with a single fin mounted on it to be tested. The numerical simulation of the same setup was done using ansys. The main of aim of this work is to study various researches done in past to improve heat transfer rate of cooling fins by changing cylinder block fin profiles.

Keywords: Heat transfer, Fins, Air Cooling, ANSYS, Cylinder block, Engine Performance.

1. INTRODUCTION:

Heat transfer enhancement in fins can be increased by using the porous fins Experimental studies were conducted to analyze the natural convection heat transfer of from solid and permeable fins [1].Numerical simulations were carried out to determine the heat transfer characteristics of different fin parameters namely, number of fins, fin thickness at varying air velocities[2]. work is to study various researches done in past to improve heat transfer rate of cooling fins by changing cylinder block fin geometry, climate condition and material[3].In This study, heat release of an IC engine cylinder cooling fins with six numbers of fins having pitch of 10 mm and 20 mm are calculated numerically using commercially available CFD tool Ansys Fluent[4].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 surface of the cylinder to increase the rate of heat transfer. Innovative Thermal designs but also to push the limits of the available technology Finite element analysis (FEA) can also be useful in determining Performance, especially conductivity gradients. The principle implemented in the project is to increase the heat dissipation rate by using the invisible working fluid, nothing but air.Analyzing this profile with same boundary condition. The results of the exist profile rectangular fin will be also compared with all profile using finite element analysis program developed on Ansys software .In addition to the temperature measurements, the Thermal stress distribution will be investigation. As the amount of heat that needs to be removed from two stroke spark ignition engine constantly increases, thermal engineers are faced with never-ending challenges not only to Provide innovative thermal designs but also to push the limits of the available technology Finite element analysis (FEA) can also be useful in determining performance, especially conductivity gradients. The heat transfer coefficient can be determined using advanced FEA codes which incorporate fluid mechanics. These simplified terms represent a combination of several factors, such as material conductivity, lateral fin conduction, boundary layer formation, and effective surface area; however, pin fin geometry cannot easily be modeled by using either method. Each pin must be individually discredited, increasing the modeling time substantially. A simulation program will be developed for predicting and optimizing thermal performance of bi-directional circular Fins with a) triangular, b)rectangular, c)elliptical, d)trapezoidal profile.

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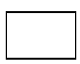
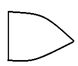
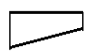
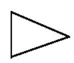
2. MODEL GEOMETRIC AND MATERIAL SPECIFICATIONS:

2.1 FIN PROFILES:

Types of radial fin profiles	Rectangle	Elliptical	Trapezoidal	Triangle
Diagram				

2.2 ENGINE SPECIFICATION:

No of cylinders	1
Bore	61.5 mm
Stroke	58 mm
Piston displacement	173 cc
Compression ratio	6.6 : 1
Fuel used	Petrol
Engine position	Vertical

3. MATERIALS AND METHODS

3.1 work piece material:

Aluminium is a very light metal with a specific weight. the use of Al in vehicles reduces dead weight and energy consumption while increasing load capacity. aluminium naturally generates a protective one side coating and is highly corrosion resistance.surface treatment like painting, the anodizing improve this property.aluminium is an excellent heat and electricity conductor. This has made aluminium most commonly used.water in major power transmission lines. Aluminium is a good reflector of visible light as well as heat.

Aluminium properties better corrosion resistance, thermal conductivity, reflectivity, ductility, odourless, recyclability.

Table-1: Chemical composition (wt %) of Aluminum alloy

Al	Si	Fe	Cu	Impurities
99.8	0.08	0.1	Less than 150ppm	0.01 to 0.06

3.2. Modeling and simulation:

FEA simulates how solid materials (including rubber) will deform under stress, including applied forces, pressures and temperatures. FEA for applications involving silicone materials is not straightforward. But Dow Corning has experience in performing these complex analyses. Analyses that can be performed include. Static stress/displacement analysis, Dynamic stress/displacement analysis, Transient or steady-state heat transfer analysis.

- Transient or steady-state mass diffusion analysis
- Steady-state transport analysis
- Coupled thermo-mechanical
- Coupled thermo-electrical

The finite element method of analysis is not a new technique. In the late 1940s, the method started as a structural analysis tool that was used for helping aerospace engineers design better aircraft structures. Since then, aided by the rapid increase of computer power, the method has continually developed until it became a very sophisticated generic tool for accomplishing a wide array of engineering tasks. Its development and success is not paralleled by any other numerical analysis technique. The technique is based on the premise that an approximate solution to any complex

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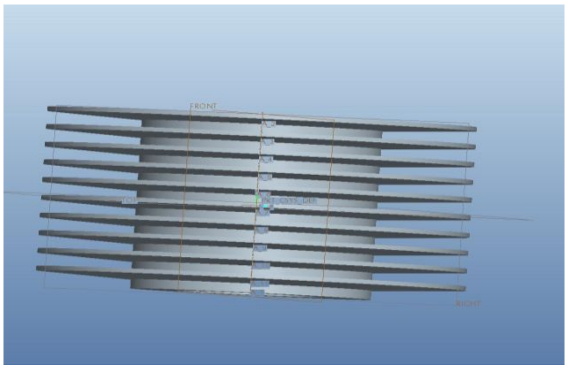
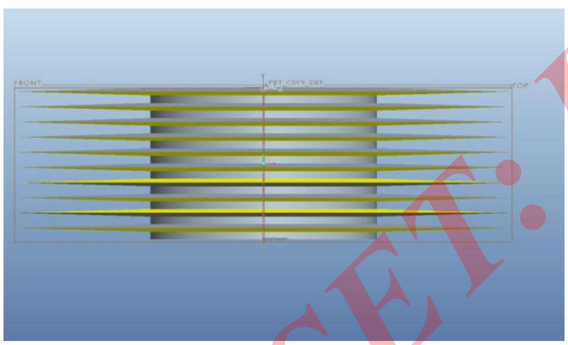
engineering problem can be reached by subdividing the problem into smaller more manageable (finite) elements. Using finite elements, solving complex partial differential equations that describe the behavior of certain structures can be reduced to a set of linear equations that can easily be solved using the standard techniques of matrix algebra.

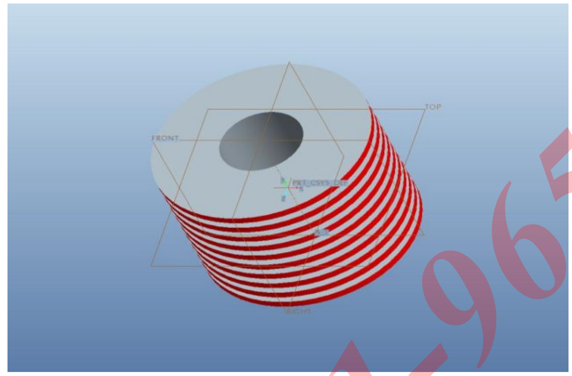
3.3 Modeling profiles:



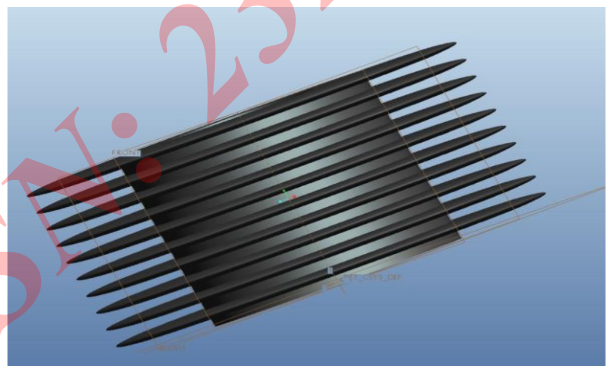
3.3.1. Trapezoidal Profile



3.3.2.Triangle Profile



3.3.3. Rectangle Profile



3.3.4. Elliptical Profile

3.4 Six Steps in the Finite Element Method:

- Step 1 - Discretization: The problem domain is discretized into a collection of simple shapes, or elements.
- Step 2 - Develop Element Equations: Developed using the physics of the problem, and typically Galerkin's Method or variational principles.
- Step 3 - Assembly: The element equations for each element in the FEM mesh are assembled into a set of global equations that model the properties of the entire system.

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- Step 4 - Application of Boundary Conditions: Solution cannot be obtained unless boundary conditions are applied. They reflect the known values for certain primary unknowns. Imposing the boundary conditions modifies the global equations.

- Step 5 - Solve for Primary Unknowns: The modified global equations are solved for the primary unknowns at the nodes.

- Step 6 - Calculate Derived Variables: Calculated using the nodal values of the primary variables.

4. ANALYSIS DIAGRAM:

4.1. RECTANGLE PROFILE:

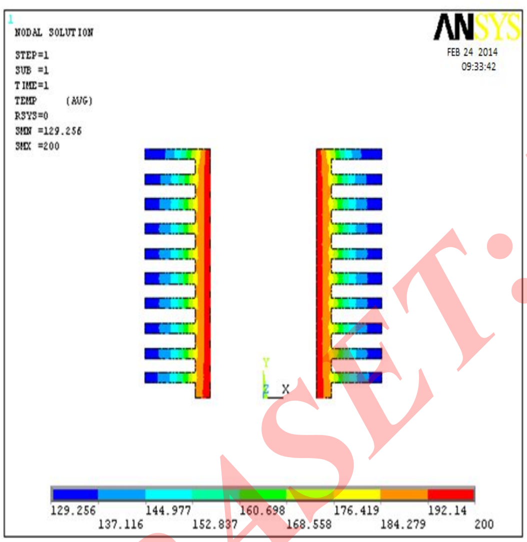


Fig.1.Rectangle profile in 2D

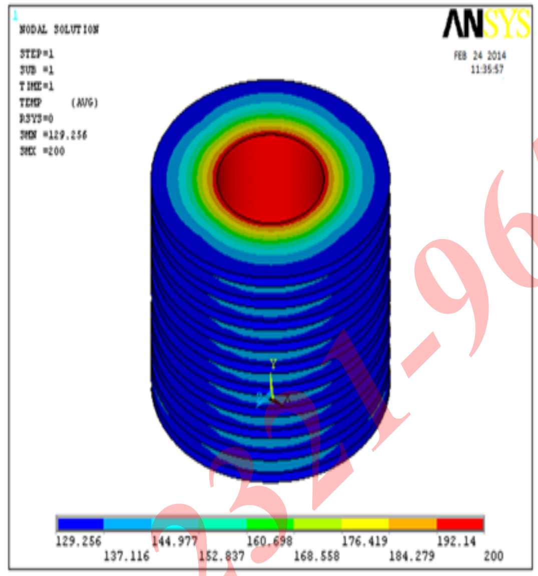
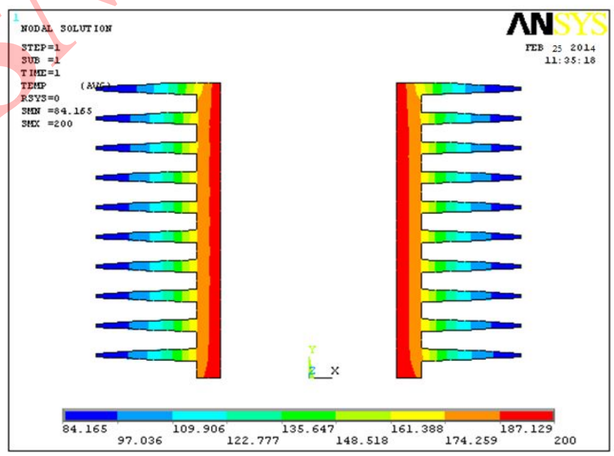


Fig.2.Rectangle profile in 3D



4.2. ELLIPTICAL PROFILE:

Fig.3.Elliptical profile in 2D

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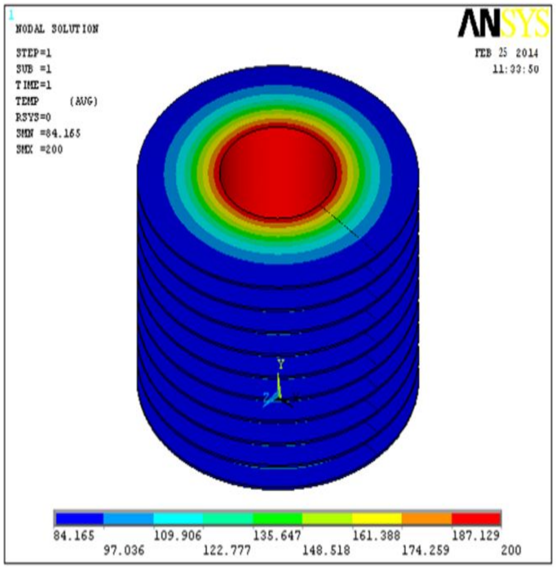

Fig.4.Elliptical profile in 3D

4.3. TRAPEZOIDAL PROFILE:

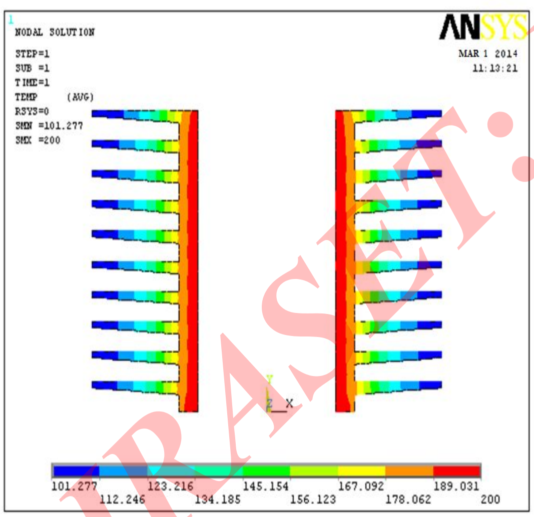

Fig.5.Trapezoidal profile in 2D

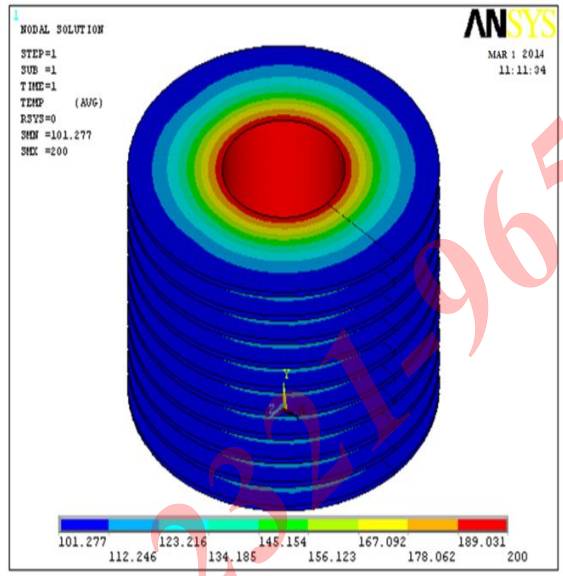

Fig.6.Trapezoidal profile in 3D

4.4. TRIANGLE PROFILE:

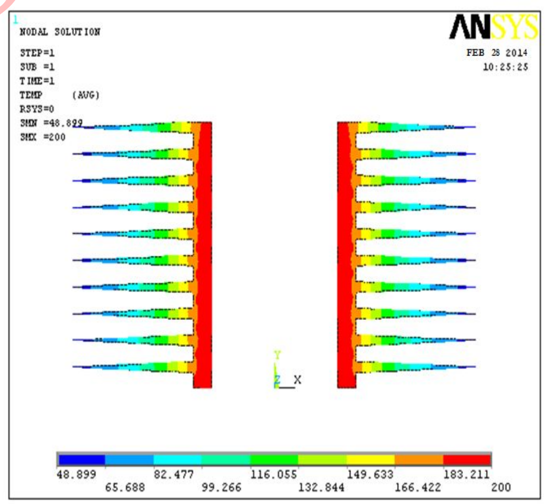

Fig.7.Triangle profile in 2D

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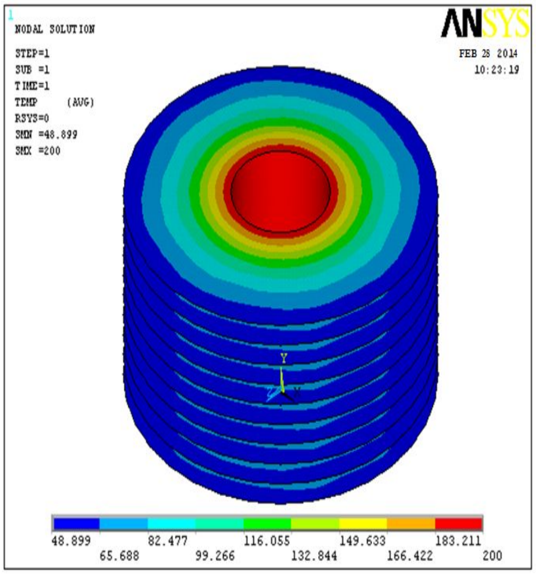
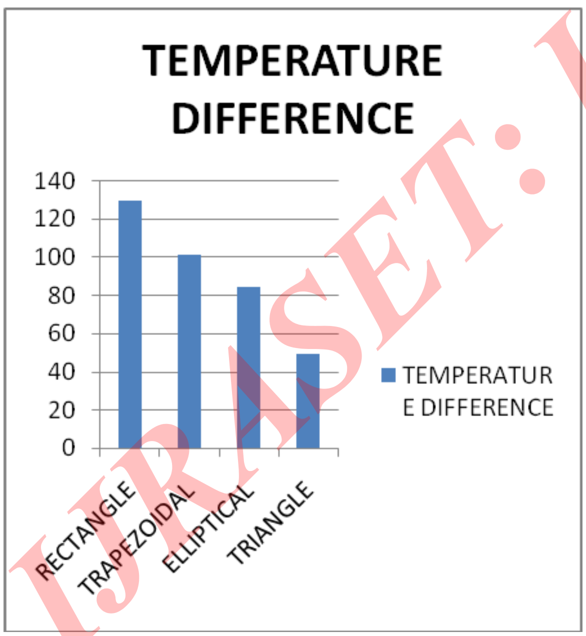


Fig.8.Triangle profile in 3D

5. RESULT:



The analysis described in this project incorporates several possible performance factors. These simplified terms represent a combination of several factors, such as material conductivity, lateral fin conduction, boundary layer formation, and effective cross section area. In comparing the circular fin of trapezoidal cross section (real sample) , the rectangular fin ,triangle fin ,elliptical Profile fin (keep the fin gap and no of section constant for all) it was found that , the triangle profile fins yield a lower tip temperature distribution than other as shown in the table comparing with the length of the fin and space optimization elliptical fin can give better output than the real sample.

6. CONCLUSION:

The results of the exist profile rectangular fin will be also compared with all profile using finite element analysis program developed on Ansys software .In addition to the temperature measurements, the Thermal stress distribution will be investigation.

The fin heat transfer analysis represents only one set of design parameters relating to shape based upon the cross section of fins. the exist profile tip temperature value(rectangle)129.25°c,trapezoidal tip temperature 101.27°c,elliptical tip temperature 84.16°c,triangle tip temperature 48.89°c.. There may exist other designs which produce better results in overall thermal performance.

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