Design and Analysis of Engine Fins

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Abstract— **Heat transfer is a process variant in most heat generation methods, applying two wheeler heat conduction fins. IC engine fins Assemblies with in a reacting power transmission Mechanisms in this engine Assembly, which requires heat removal to ensure proper operation. The aim of this project investigates alternative cooling methods for an engine fins Assembly. IC engine fins Assembly temperatures by worth of conduction cooling are needed for operating pressure. Enhanced design Stack Assembly designs which utilize fins, straight fins and internal cooling cavities are required to reduce or eliminate cooling. Steady state heat transfer finite element analyses are performed using ANSYS Workbench™ Version 14.5, utilizing 3-D models and heat transfer material properties of current engine fins Assemblies. ANSYS results from modified fins Assembly designs are compared to baseline geometry ANSYS results. Baseline cooling analyses are performed to validate the FEA models. The baseline results show the average temperature at the inner surface of the heat during normal operating conditions is approximately 23°C above the maximum technical limit of 423K. The baseline results are considered acceptable based on the conservative boundary conditions used in the FEA model. Fins Stack Assemblies which utilize fin optimization varies of cross section with internal grooves like half circle, Triangular, Trapezoidal, Square cross section with sliding taper cut-out arrays are also analyzed. Then comparing constant natural materials to take AL 6061, AL 200, CE17, CE17M it's considering take thermal distribution analysis in transient conditions to solving problems it's defined. An average temperature reduction of 150°C at the inner surfaces of the fins is achieved using fin arrays with a total additional surface area of 0.16 m 2per Fins Stack Assembly. To consider forced convection to solving heat flux with distribution along the distance with respect to time to be calculating with result and discussed.**

Keywords— AL 6061, IC engines, Fins Assembly

I. INTRODUCTION

Fins are basically mechanical structures which are used to cool various structures via the process of convection. Most part of their design is basically limited by the design of the system. But still certain parameters and geometry could be modified to better heat transfer. In most of the cases simple fin geometry is preferred such as rectangular fins and circular fins. Many experimental works has been done to improve the heat release of the internal combustion engine cylinder and fin efficiency. A numerical investigation has been carried for a finned metal cylinder using CFD and is validated against the experiments carried out.

A transient numerical analysis is carried out with wall cylinder temperature of 423 K initially and the heat release from the cylinder is analyzed for zero wind velocity. The heat release from the cylinder which is calculated numerically is validated with the experimental results. In the present paper an effort is made to study the effect of fin parameters on fin array performance which includes variation in pitch and fin material. In addition, the current paper considers the effect of air flow velocity on different fin pitch. With the help of the available numerical results, the design of the internal combustion engine cooling fins can be altered for better efficiency [1]. In this study, the effective thermal conductivity of aluminium filled high-density polyethylene composites is investigated numerically as a function of filler concentration. The obtained values are compared with experimental results and the existing theoretical and empirical models. The thermal conductivity is measured by a modified hot-wire technique. For numerical study, the effective thermal conductivity of particle-filled composite was calculated numerically using the micro structural images of them. By identifying each pixel with a finite difference equation and accompanying appropriate image processing, the effective thermal conductivity of composite material is determined numerically. As a result of this study, numerical results, experimental values and all the models are close to each other at low particle content. For particle content greater than 10%, the effective thermal conductivity is exponentially formed. All the models fail to predict thermal conductivity in this region. But, numerical results give satisfactory values in the whole range of aluminium particle content.

This study aims at investigating package materials based on polymer matrix for microelectronics. The next generation package materials are expected to possess high heat dissipation capability in addition to low coefficient of thermal expansion (CTE) as the accumulated heat from high performance electronic devices should be removed for proper operation. In this study, various inorganic fillers including aluminium nitride (AlN), wollastonite, silicon carbide whisker (SiC) and boron nitride (BN) with different shape and size were used alone or in combination to prepare thermally conductive polymer composites. In case of AlN, titanate coupling agent was used for the surface treatment of fillers. The use of hybrid filler was found to be effective in increasing thermal conductivity of the composite probably due to the enhanced connectivity offered by structuring filler with high aspect ratio in hybrid filler. For given filler loading, the use of larger particle and surface treated filler resulted in composite materials with enhanced thermal conductivity. The surface treatment of filler also allowed producing the composites with lower CTE. Enthalpy exchangers have been used as an efficient means to recover both sensible heat and moisture from exhaust ventilation air. A cross-flow plate-fin structure is the most popular arrangement for the exchanger core due to its compactness and high mechanical strength even with very small channel wall thickness. Traditionally, hygroscopic paper is selected as the plate and fin materials. Though the sensible effectiveness with this material is satisfactorily high, the latent effectiveness is disappointingly low due to the low moisture diffusivity in paper. To solve this problem, in this study, a novel concept is proposed to augment moisture transfer in the exchanger. Plates and fins are made with different materials. A novel membrane – the composite supported liquid membrane (CSLM) is used as the plate material. Paper is still used as the fin material for its cheapness and high support strength. To make comparisons, two cores, one is paper-fin and paper-plate, and another one is paper-fin and membrane-plate, are constructed and tested for heat and moisture recovery. Simultaneous heat and moisture transfer in the plate-fin core is studied. Mathematical model governing the heat and moisture transfer in the cores is set up and numerically solved. Both the experimental data and numerical results indicate that the latent effectiveness of the paper-fin and membrane-plate core is 60% higher than the traditional paper-fin and paper-plate core, due to the high moisture diffusivity in the CSLM.

A numerical analysis is carried out to study efficiency and temperature distribution of annular fins of different fin profiles (constant and variable cross-sectional area) when subjected to simultaneous heat and mass transfer mechanisms. The temperature and humidity ratio differences are driving forces for heat and mass transfer, respectively. Actual psychometric relations are used in the present work instead of a linear model between humidity ratio and temperature that has been used in the literature. A non-linear model representing heat and mass transfer mechanisms was solved using a finite difference successive over-relaxation method. Solutions are obtained for temperature distribution over the fin surface in addition to fin efficiency for both fully wet and partially wet fin surfaces. The numerical results are compared with those of previous studies. It was found that one of the linear models for the relation between the humidity ratio and temperature is a reasonable approximation. The absorber of a collector receives solar energy which is delivered to the transport medium to be carried away as useful energy. During this process, temperature of the absorber plate increases and therefore, thermo physical parameters engaged to determine the thermal performance of an absorber plate varies with temperature of the plate. The present study demonstrates analytically to determine the performance of an absorber plate fin with temperature dependent both thermal conductivity and overall heat loss coefficient. The decomposition method is proposed for the solution methodology. An optimum design analysis has also been carried out. A comparative study has been executed among the present results and that of existed in the published work, and a notable difference in results has been found. Finally, unlike published work, dependency parameters on the performances and optimum design have been highlighted.

Centrifugal pump are a class of machinery intended to increase the power of turbine. This is accomplished by increasing the pressure of intake air, allowing more fuel to be flow coition. In the late 19th century, Rudolf Diesel and Gottlieb Daimler experimented with pre-compressing air to increase the power output and fuel efficiency. The first exhaust gas turbocharger was completed in 1925 by the Swiss turbine Alfred Buchi who introduced a prototype to Increase the power of a compressor by a reported 76%. The idea of salary coition at that time was not widely accepted. However, in the last few decades, it has become essential in almost all diesel compressors with the exception of very small diesel turbo charger. Their limited use in gasoline compressors has also resulted in a substantial boost in power output and efficiency. Their total design, as in other turbo machines, involves several analyses including: mechanical, aerodynamic, thermal, and acoustic. Turbo chargers and researchers still seek ways to improve their designs while governed by rules of cost and manufacturing capabilities. At first, scientists simply attempted to develop the conceptual designs into reliable products for end users.

II. Problem Identification

The heat that is generated produced (or) developed in the system that conducts through the walls or boundaries is to be continuously dissipated to the surroundings or environment to keep the system in steady state condition. Large quantities of heat have to be dissipated from small area as heat transfer by convection between a surface and the fluid surroundings. It can be increased by attaching thin strips of metals called fins to the surface of the system. In that case the design model of fin is to be changed in various model fin blades.

III. Methodology

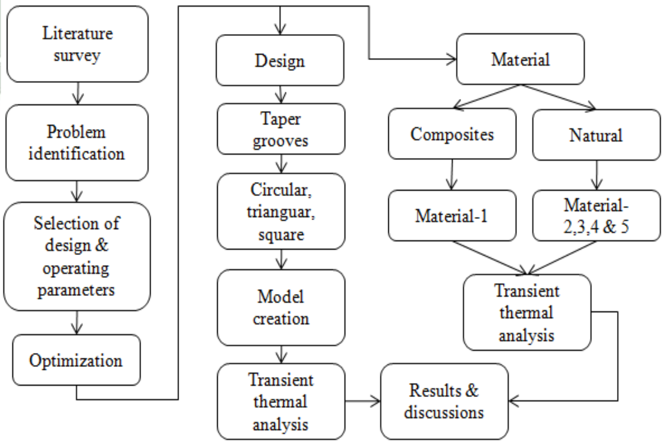

Fig. 1. System Flow Diagram.

IV. Materials

Any materials made up of iron with about 2% or more of carbon is considered to be cast iron. Most commercial alloys contain from about 2.5% to 3.8% carbon. There are four types of cast iron that are usually produced.

- Grey cast iron

- White cast iron
- Malleable iron
- Nodular iron.

V. Modeling

Fins improve heat transfer in two ways. One way is by creating turbulent flow through fin geometry, which reduces the thermal resistance (the inverse of the heat transfer coefficient) through the nearly stagnant film that forms when a fluid flows parallel to a solid surface. A second way is by increasing the fin density, which increases the heat transfer area that comes in contact with the fluid. Fin geometries and densities that create turbulent flow and improve performance also increase pressure drop, which is a critical requirement in most high performance applications. The optimum fin geometry and fin density combination is then a compromise of performance, pressure drop, weight, and size. A figure-of-merit comparison based on performance, pressure drop, weight, and size among common fin types is described in “Air Cooled Compact Heat Exchanger Design for Electronics Cooling.” Aside from fin geometry, parameters such as thickness, height, pitch, and spacing can also be altered to improve performance. Typically, fin thicknesses vary from 0.004 in (0.1 mm) to 0.012 in (0.3 mm), heights vary from 0.035 in (0.89 mm) to 0.6 in (15.24 mm), and densities vary from 8 to 30 FPI (Fins per Inch).

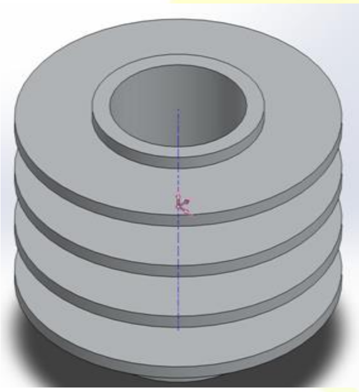

Fig. 2. Isometric Model.

VI. Analysis

A. Meshing

The Engine Fins models are analyzed using ANSYS Workbench Version 14.5 as outlined in Section 2.0. The models are meshed using the ANSYS default settings for path conforming volume with a relevance of 0.5 on a scale of -100 to 100. The resulting mesh is shown in Figure 6.Similar setting the mesh relevance to a maximum of 100 refines the mesh to 185237 nodes and 95422 elements, an almost three-fold increase in number of mesh nodes. The refined mesh is shown in Figure 7. Introducing the Half circle, Triangular, Square, and Trapezoidal. While the default mesh parameters are acceptable, the maximum mesh refinement Table no elements of the different shapes of component. Parameters are used when possible in order to produce more accurate results. In the convection cooling analyses involving assembly fins, complex model geometries and computing resources available require the models to be reduced to a quarter section of the original geometry. This is acceptable due to the ax symmetric nature of the IC engine Fins -assemblies. The model is conservatively sectioned so that the quarter geometry contains the least cooling surface area of the four quarters possible. Figure 8 shows the plan view of the meshed quarter section model. In all ANSYS cases, the model is first meshed, boundary conditions are applied and then the analysis is performed.

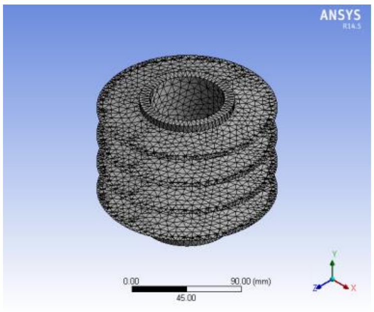

Fig. 3. Volume mesh of concave shape.

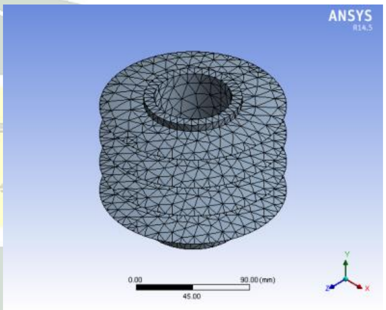

Fig. 4. Volume mesh of half circular shape.

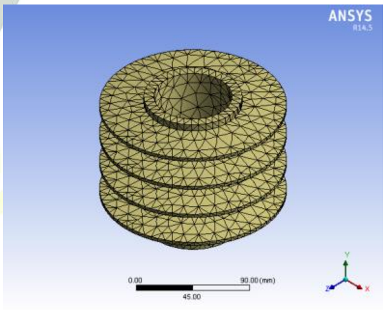

Fig. 5. Volume mesh of trapezoidal shape.

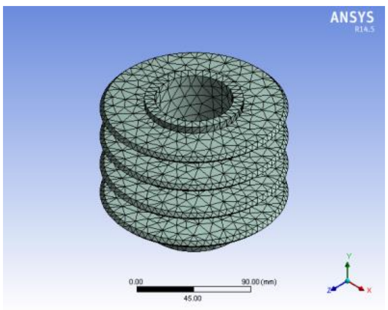

Fig. 6. Volume mesh of triangular shape.

B. FEA model inputs

The FEA model boundary conditions, are calculated in Sections 3.1.1 and 3.1.2 based upon empirical. The intent is to mimic those boundary conditions experienced by the Engine Fins during normal plant operation. It is important to note that heat transfer coefficients are calculated for the regions shown in Figure 5: (1) the internal surfaces of the Pressure Housing, (2) the external surfaces of the Pressure Housing below the Engine Fins, (3) the external surfaces of the Engine Fins and (4) the external surfaces of the Pressure Housing above the Engine Fins. The Engine Fins heat transfer coefficient is calculated by treating the Engine Fins as a flat plate; therefore all four Engine Fins surfaces have the same heat transfer coefficient. Additionally, testing and operating plant data have shown an approximate 210K temperature increase in the cooling air temperature as it passes over the height of the Engine Fins. This 50 °F temperature increase is assumed to occur in a linear fashion such that it is incorporated into the FEA models in 10 °F increments.

C. Baseline cooling analysis

The baseline cooling analysis of the Engine Fins is performed by simply applying the loads in to the various components of the FEA model, as shown in Figure 9. The heat loads are what the Pressure Housing and Engine Fins experience during normal stepping operations.

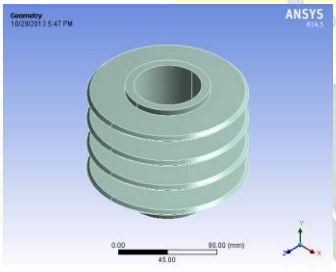

Fig. 7. Heat loads applied to FEA model for baseline run.

D. Conductive Cooling Analyses

The conductive cooling analyses are performed by first applying the heat loads on the Pressure Housing and Engine Fins components. However, instead of applying the cooling convection loads to the Pressure Housing and ENGINE FINS exteriors, specific Engine Fins surfaces are held at a fixed temperature of 100 °F. Holding the surfaces at a fixed temperature simulates a conductive apparatus removing heat from the Engine Fins. Normal component cooling water is typically available on site at 70 °F nominal, however a water temperature value of 100 °F is assumed for these analyses, to account for potential heat loads imposed on the cooling water as it travels through the reactor containment building to each of the Engine Fins. The flow rate of the component cooling water is assumed to be sufficient to maintain the conductive cooling apparatus at a constant temperature despite potentially high heat fluxes. The thermal conductivities of individual Engine fins components that make up the different internal grooves system are defined as input to the heat transfer analyses. For conservatism, all thermal conductivities are taken at the maximum allowable fin temperature of 392 °F.

TABLE I. ENGINE FINS MATERIAL PROPERTIES

Material	**Thermal Conductivity (W/mm^2)**
AL6061	180
AL200	226
CE17	178
CE17M	147

Conductive cooling Case 1 assumes that only the flat sides of the Engine Fins housings are held at constant temperature, which correlates to a straight-sided apparatus that could be utilized on existing Engine Fins. Figure 10 shows the typical areas (highlighted in dark green) of the Engine Fins housings which are selected within the FEA model for this analysis. Conductive cooling Case 2 assumes that both the flat sides and the angled surfaces of the Engine Fins housings are conductively cooled. This correlates to an apparatus which is profiled to both the flat sides and the inward-angled surfaces of the Engine Fins. This profiled apparatus could be utilized on existing Engine Fins. Figure 11 shows the typical areas (highlighted in dark green) of the Engine Fins housing which are selected within the FEA model for this analysis.

E. Conductive Cooling Analyses – fins with optimization shapes in different material

The convective cooling analyses of engine fin cooling effects are performed by applying the heat loads and convective cooling loads on the quarter section ANSYS model Pressure Housing and Engine Fins components including the added engine fins. Since the amount of convective cooling is dependent on surface area, it is expected that the cooling convective heat transfer will increase as the area increases due to the addition of Engine fins. An increase in cooling convection will result in lower Engine Fins component temperatures. The Engine fin sizes and spacing are shown in Figure 12. The cooling air flow over the external Pressure Housing and Engine Fins surfaces is to be turbulent. It is assumed that the air flow acts on all external surfaces of the Engine Fins.

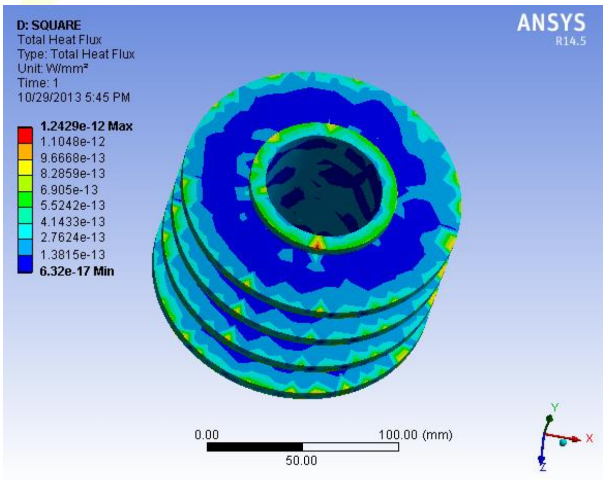

Fig. 8. Conduction analysis surfaces of straight fins.

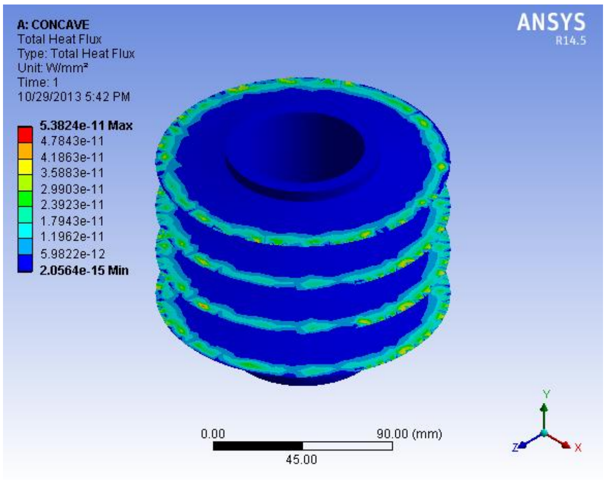

Fig. 9. Conduction analysis surfaces of straight fins.

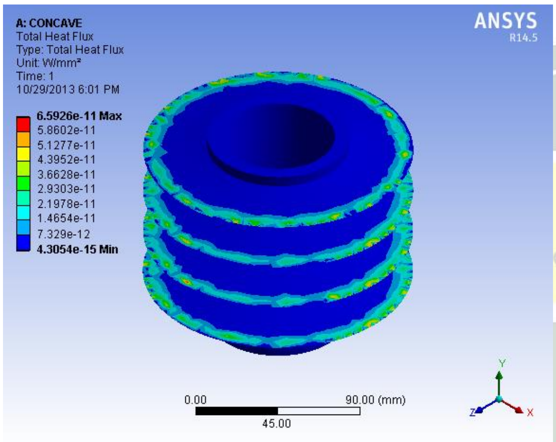

Fig. 10. Temperature distribution in AL6061.

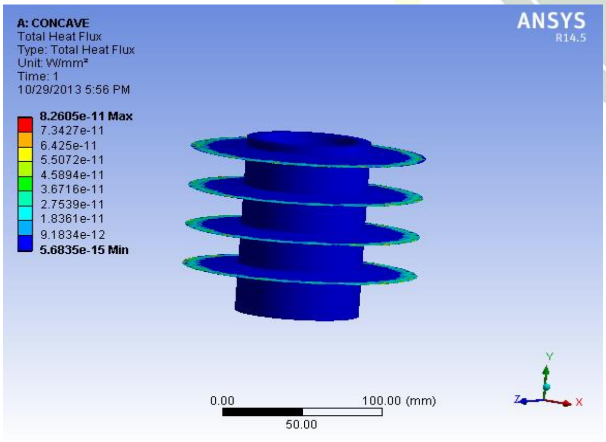

Fig. 11. Temperature distribution in AL200.

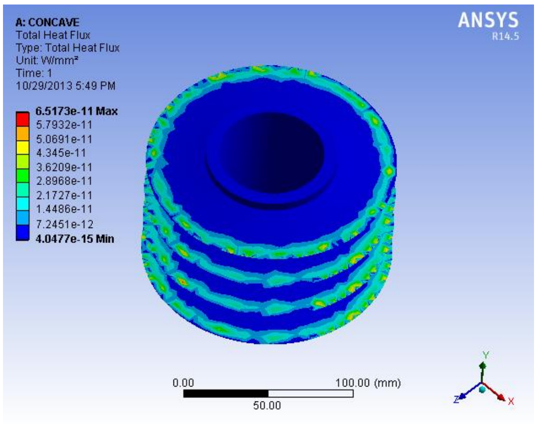

Fig. 12. Temperature distribution in CE17.

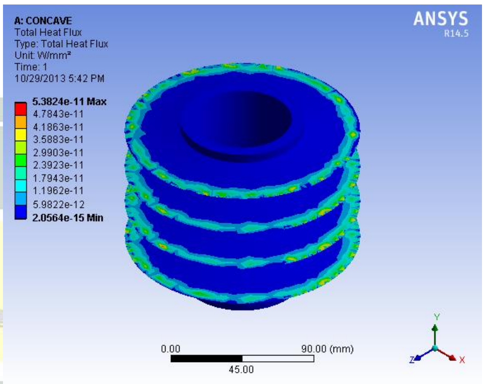

Fig. 13. Temperature distribution in CE17M.

VII. Results and Discussion

From the following tabulation the following graphs are drawn and the comparison is carried out for different cross section with shapes on materials. The comparison is carried out for, factor of safety and heat transfer rate.

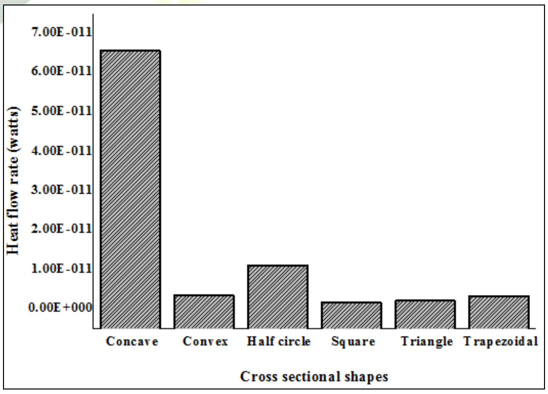

Fig. 14. Heat flow rates of AL6061 material for different shapes.

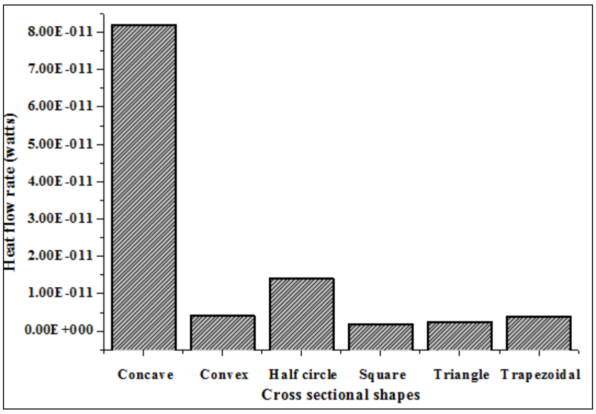

Fig. 15. Heat flow rates of AL200 material for different shapes.

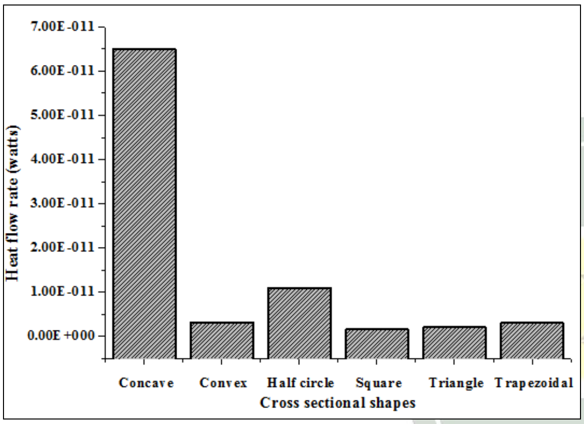

Fig. 16. Heat flow rates of CE17 material for different shapes.

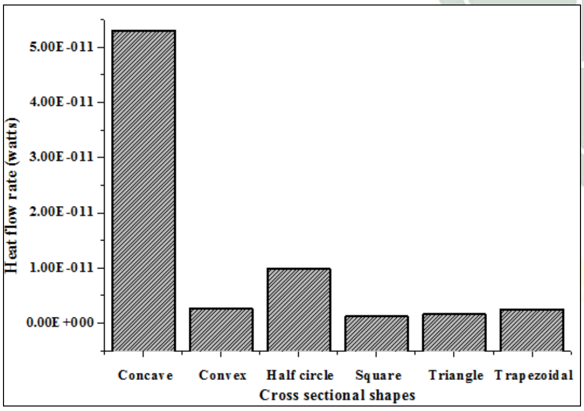

Fig. 17. Heat flow rates of CE17M material for different shapes.

CONCLUSION

Engine Fins assembly the positions of straight within a reactor core and are vital to the operation of medium air. In order to ensure reliable operation the of the Engine fins system, a significant amount of heat must be removed from the IC engine fins. This project evaluated several different shape with material optimization heat removal methods for the using it. IC engine s through utilization of ANSYS finite element analysis software. First, a baseline analysis was performed to verify the FEA model and calculated boundary conditions. Next, conductive cooling apparatuses were analyzed by holding specified surfaces at a constant temperature within the FEA model. Conductive cooling analyses were performed for two cases: a simple apparatus which fit along the flat surfaces of the fins walls and a second case in which the apparatus conformed to the external surface profiles of the walls surface. Enhanced convective cooling analyses were then performed to determine the effect of various shapes fin arrays and straight fin arrays on fins coil temperatures. Lastly, an analysis was performed to determine the effect of internal cooling cavities on IC engine coil temperatures. From the analysis the materials it's best comparing its AL200 compared to AL6061 produces the better thermal behaviour than the existing material. Then the best optimization of the shape its find out concave on the best cross section.

REFERENCES

[1] Mishra A.K., Nawal S. and Thundil Karuppa Raj R;Heat Transfer Augmentation of Air Cooled Internal Combustion Engine Using Fins through Numerical Techniques; ISSN 2278 – 9472.