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Thermaal Invistigation of Single Cylinder 4-Strock Engine With Different Fin Profile Using Various Alluminium Alloys

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ABSTRACT

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. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult.

The main aim of the present paper is to analyze the thermal properties by varying geometry, material and thickness of cylinder fins using ANSYS. Transient thermal analysis determines temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life. Presently Material used for manufacturing cylinder fin body is Aluminum Alloy A204.

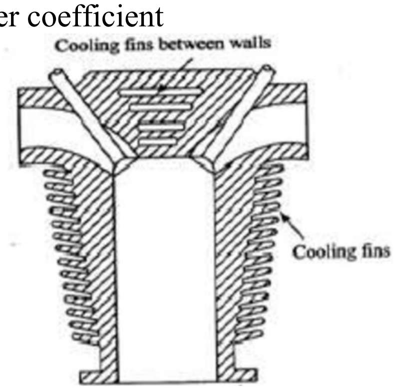
Presently analysis is carried out for cylinder fins using this material and also using Aluminum alloy 6061 and Al 7075 which have higher thermal conductivities and by varying the fins geometry from straight to variable leads to increase the area.

INTRODUCTION

Most modern internal combustion engines are cooled by a closed circuit carrying liquid coolant through channels in the engine block and cylinder head, where the coolant absorbs heat, to a heat exchanger or radiator where the coolant releases heat into the air (or raw water, in the case of marine engines). Thus, while they are not ultimately cooled by the liquid, because of the liquid-coolant circuit they are known as water-cooled. In contrast, heat generated by an air-cooled engine is released directly into the air. (Direct Cooled Engine) Typically this is facilitated with metal fins covering the outside of the Cylinder Head and cylinders which increase the surface area that air can act on. Air may be force fed with the use of a fan and shroud to achieve efficient cooling with high volumes of air or simply by natural air flow with well-designed and angled fins.

In all combustion engines, a great percentage of the heat generated (around 44%) escapes through the exhaust, not through either a liquid cooling system nor through the metal fins of an air-cooled engine (12%). About 8% of the heat energy finds its way into the oil, which although primarily meant for lubrication, also plays a role in heat dissipation via a cooler.

Many engineering devices generate heat during their operation. If this generated heat is not dissipated rapidly to its surrounding atmosphere, this may cause rise in temperature of the system components. This cause overheating problems in device and may lead to the failure of component. Fins or extended surfaces are known for enhancing the heat transfer in a system. Liquid-cooling system enhances better heat transfer than air-cooling system, the construction of air cooling system is very simpler. Therefore it is imperative for an air-cooled engine to make use of the fins effectively to obtain uniform temperature in the cylinder periphery. The major heat transfer takes by two modes that is by conduction or by convection. Heat transfer through fin to the surface of the fin takes place through conduction whereas from surface of the fin to the surroundings, it takes place by convection. Further heat transfer may be by natural convection or by forced convection. Based upon the cross sectional area type, straight fins are of different types such as rectangular fin, triangular fin, trapezoidal fin parabolic fin or cylindrical fin. Fin performance can be measured by using the effectiveness of fin, thermal resistance and efficiency. Triangular fins have applications on cylinders of air cooled cylinders and compressors, outer space radiators and air conditioned systems in space craft. Fins must be designed to achieve maximum heat removal with minimum material expenditure, taking into account, however, the ease of manufacturing of the fin shape. Large number of studies has been conducted on optimizing fin shapes. Other studies have introduced shape modifications by cutting some material from fins to make cavities, holes, slots, grooves, or channels through the fin body to increase the heat transfer area and/or the heat transfer coefficient



Internal combustion engine cooling uses either air or a liquid to remove the waste heat from an internal combustion engine. For small or special purpose engines, air cooling makes for a lightweight and relatively simple system. The more complex circulating liquid-cooled engines also ultimately reject waste heat to the air, but circulating liquid improves heat transfer from internal parts of the engine. Engines for watercraft may use open-loop cooling, but air and surface vehicles must recirculate a fixed volume of liquid

Heat engines generate mechanical power by extracting energy from heat flows, much as a water wheel extracts mechanical power from a flow of mass falling through a distance. Engines are inefficient, so more heat energy enters the engine than comes out as mechanical power; the difference is waste heat which must be removed. Internal combustion engines remove waste heat through cool intake air, hot exhaust gases, and explicit engine cooling.

Engines with higher efficiency have more energy leave as mechanical motion and less as waste heat. Some waste heat is essential: it guides heat through the engine, much as a water wheel works only if there is some exit velocity (energy) in the waste water to carry it away and make room for more water. Thus, all heat engines need cooling to operate.

Some high-efficiency engines run without explicit cooling and with only incidental heat loss, a design called adiabatic. Such engines can achieve high efficiency but compromise power output, duty cycle, engine weight, durability, and emissions.

LITERATURE SURVEY

In the paper by **Fernando Illan** simulated the heat transfer from cylinder to air of a two-stroke internal combustion finned engine. The cylinder body, cylinder head (both provided with fins), and piston have been numerically analyzed and optimized in order to minimize engine dimensions. The maximum temperature admissible at the hottest point of the engine has been adopted as the limiting condition. Starting from a zero-dimensional combustion model developed in previous works, the cooling system geometry of a two-stroke air cooled internal combustion engine has been optimized in this paper by reducing the total volume occupied by the engine. A total reduction of 20.15% has been achieved by reducing the total engine diameter D from 90.62 mm to 75.22 mm and by increasing the total height H from 125.72 mm to 146.47 mm aspect ratio varies from 1.39 to 1.95. In parallel with the total volume reduction, a slight increase in engine efficiency has been achieved.

In the paper by **G. Babu and M. Lavakumar**analyzed the thermal properties by varying geometry, material and thickness of cylinder fins. The models were created by varying the geometry, rectangular, circular and curved shaped fins and also by varying thickness of the fins. Material used for manufacturing cylinder fin body was Aluminium Alloy 204 which has thermal conductivity of 110-150W/mk and also using Aluminium alloy 6061 and Magnesium alloy which have higher thermal conductivities. They concluded that by reducing the thickness and also by changing the shape of the fin to curve shaped, the weight of the fin body reduces thereby increasing the efficiency. The weight of the fin body is reduced when Magnesium alloy is used and using circular fin, material Aluminium alloy 6061 and thickness of 2.5mm is better since heat transfer rate is more and using circular fins the heat lost is more, efficiency and effectiveness is also more.

In the paper by **J. Ajay Paul et.al.**carried out Numerical Simulations to determine heat transfer characteristics of different fin parameters namely, number of fins, fin thickness at varying air velocities. A cylinder with a single fin mountedon it was tested experimentally. The numerical simulation of the same setup was done using CFD. Cylinders with fins of 4 mm and 6 mm thickness were simulated for 1, 3, 4 & 6 fin configurations. They concluded that 1. When fin thickness was increased, the reduced gap between the fins resulted in swirls being created which helped in increasing the heat transfer. 2. Large number of fins with less thickness can be preferred in high speed vehicles than thick fins with less numbers as it helps inducing greater turbulence and hence higher heat transfer.

In the paper by **N. Phani Raja Rao**et.al.analyzed the thermal properties by varying geometry, material and thickness of cylinder fins. Different material used for cylinder fin were Aluminium Alloy A204, Aluminium alloy 6061 and Magnesium alloy which have higher thermal conductivities and shown that by reducing the thickness and also by changing the shape of the fin to circular shaped, the weight of the fin body reduces thereby increasing the heat transfer rate and efficiency of the fin. The results shows, by using circular fin with material Aluminium Alloy 6061 is better since heat transfer rate, Efficiency and Effectiveness of the fin is more.

In the paper by **Young Researchers, Central Tehran Branch, Islamic Azad University, Tehran, Iran has stated that** heat transfer in a straight fin with a step change in thickness and variable thermal conductivity which is losing heat by convection to its surroundings is developed via differential transformation method (DTM) and variational iteration method (VIM). In this study, we compare DTM and VIM results, with those of homotopyperturbaion method (HPM) and an accurate numerical solution to verify the accuracy of the proposed methods. As an important result, it is depicted that the DTM results are more accurate in comparison with those obtained by VIM and HPM. After these verifications the effects of parameters such as thickness ration, α, dimensionless fin semi thickness, δ, length ratio, λ, thermal conductivity parameter, β, Biot number, Bi, on the temperature distribution are illustrated and explained.

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In the paper by **N.A. Khozeniuk, V.A. Romanov [3]**, Experience of the Diesel Engine Cooling System Simulation. The cooling system of the designed diesel engine was investigated using specially prepared models. For selected initializations of a cooling fluid in the available cooling jacket, quantitative estimates of the levels of the heat flow to the coolant and of the temperature of the cooling surfaces of various cylinders were made. Changing the terms of the initiation of the cooling fluid flow (for example, the places where the coolant penetrates into the jacket) is accompanied by a significant redistribution of the convective component of the heat sink and this influences the temperature of the cooling surfaces. It is shown that the uniformity of the cylinder cooling and the intensity of cooling of the cylinder heads can be controlled by choice of the place of coolant penetration into the jacket for the considered design of a crankcase and cylinder heads.

ANALYSIS OF RECTANGULAR FIN BODY WITH AL 204 MATERIAL

IMPORTED MODEL

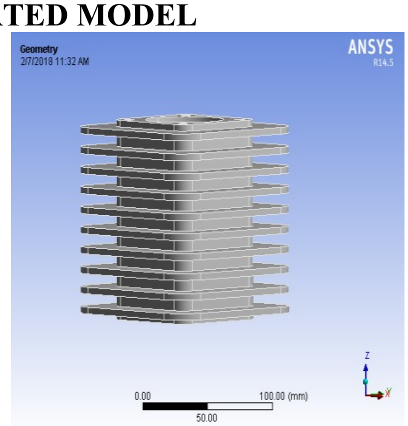
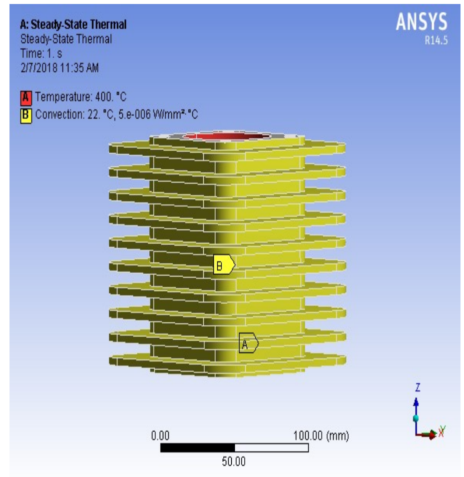


Fig. imported model

INPUT DATA



ANALYSIS OF CIRCULAR FIN BODY WITH AL 204 MATERIALS

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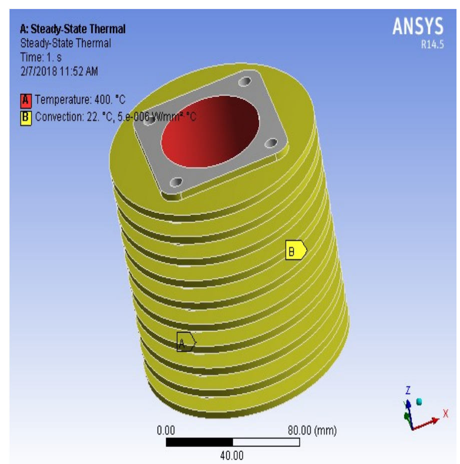

ANALYSIS OF TRIANGULAR FIN BODY WITH AL 204 MATERIALS

IMPORTED MODEL

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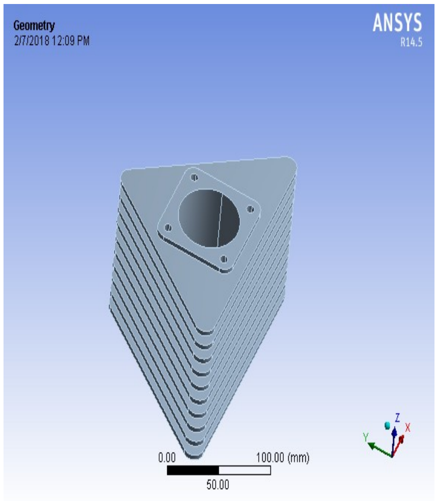

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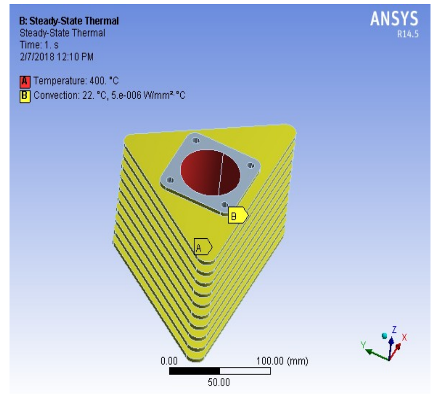

RESULTS TABLE
RECTANGULAR FIN

	TEMPERATURE (°C)	TOTAL HEAT FLUX (W/mm^2)	DIRECTIONAL HEAT FLUX (W/mm^2)	THERMAL ERROR	WEIGHT OF THE BODIES (Kg)
AL 204	400	0.034421	0.029025	14.594	1.9203
AL 6061	400	0.034587	0.029136	9.8084	1.8516
AL 7075	400	0.034574	0.029127	10.199	1.9271

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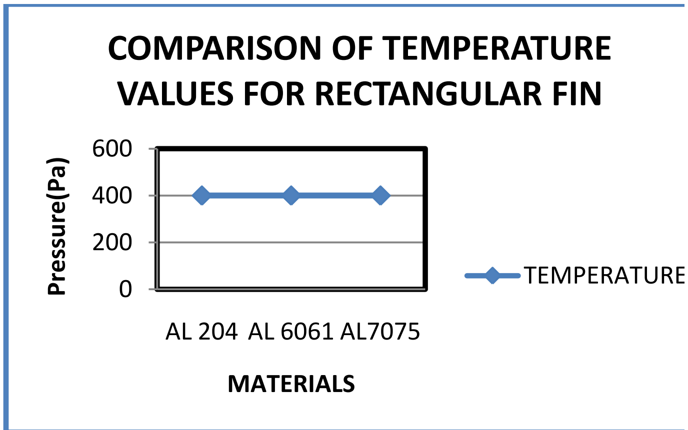

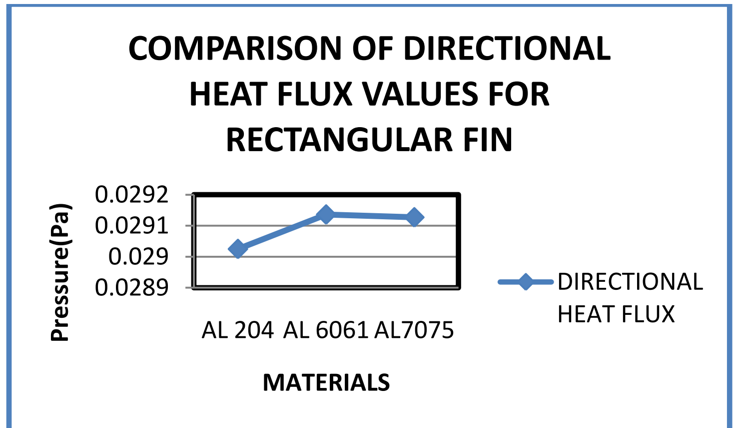

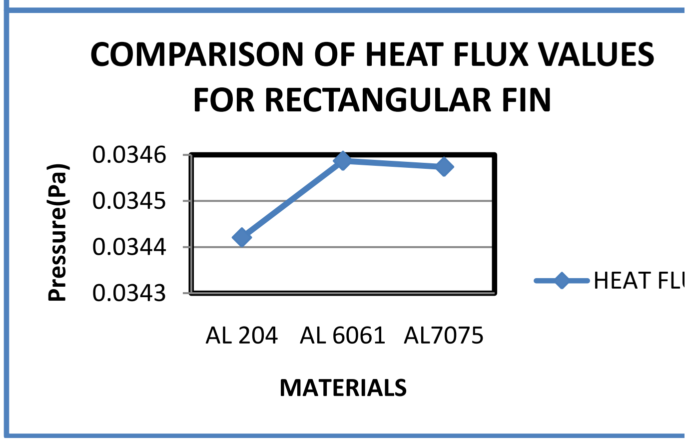

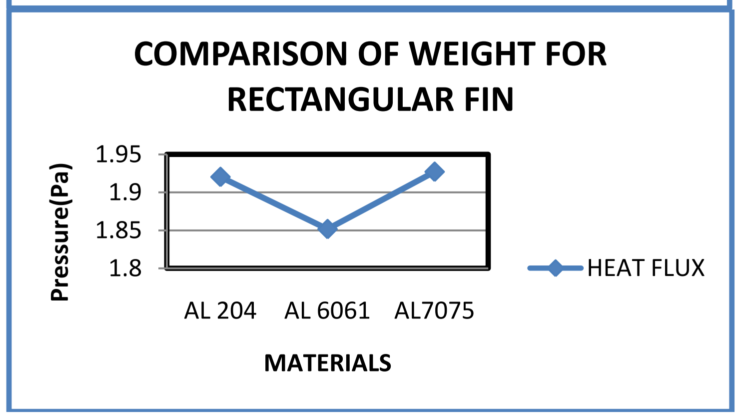

CIRCULAR FIN

	TEMPERATURE (^{O}C)	TOTAL HEAT FLUX (W/mm^2)	DIRECTIONAL HEAT FLUX (W/mm^2)	THERMAL ERROR	WEIGHT OF THE BODIES (Kg)
AL 204	400	0.025669	0.022109	8.945	1.6143
AL 6061	400	0.025731	0.022164	5.9912	1.5566
AL 7075	400	0.025726	0.022159	6.2313	1.6120

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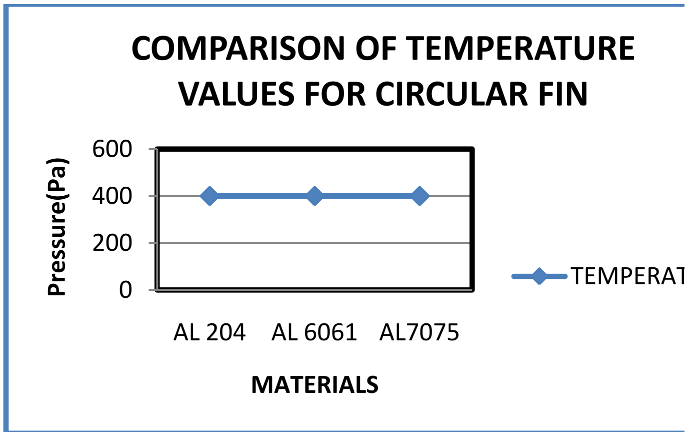

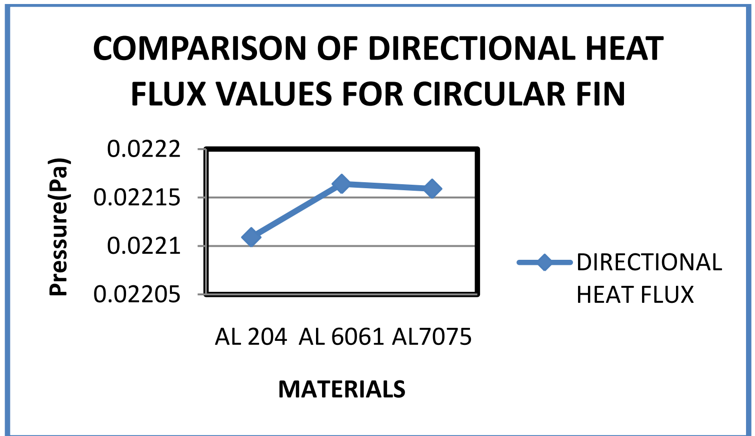

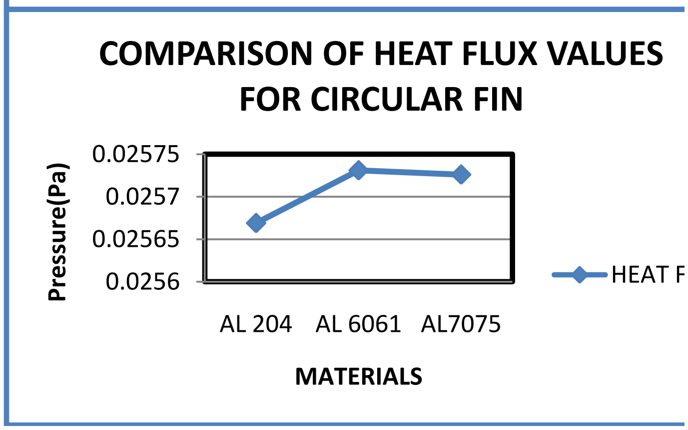

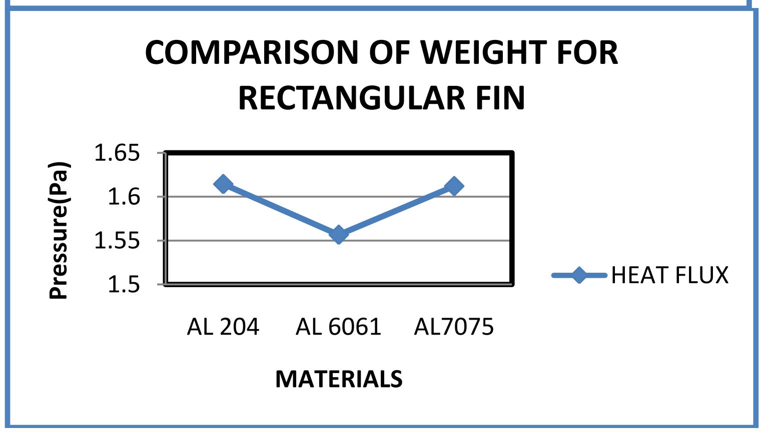

TRIANGULAR FIN

	TEMPERATURE (^{O}C)	TOTAL HEAT FLUX (W/mm^2)	DIRECTIONAL HEAT FLUX (W/mm^2)	THERMAL ERROR	WEIGHT OF THE BODIES (Kg)
AL 204	400	0.046487	0.046092	92.784	2.0598
AL 6061	400	0.046891	0.046491	62.961	1.9862
AL 7075	400	0.046858	0.046459	65.414	2.0671

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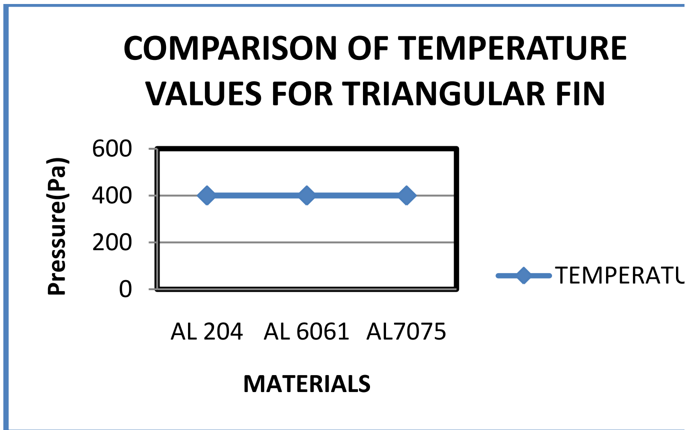

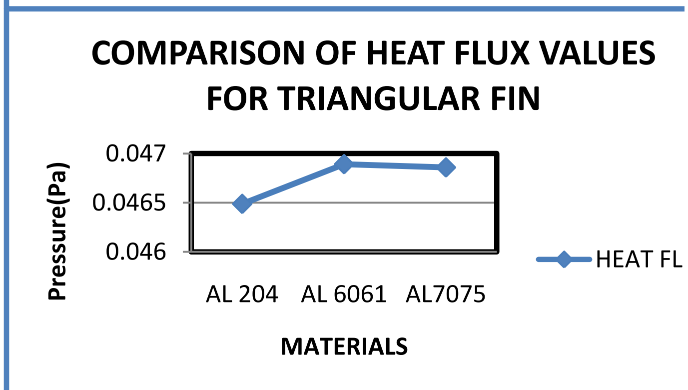

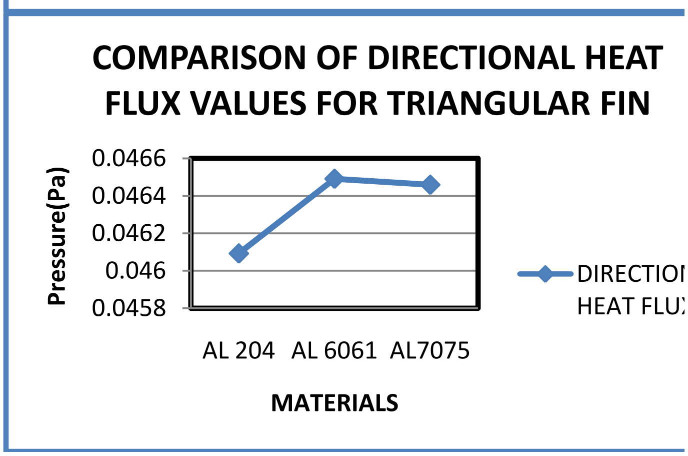

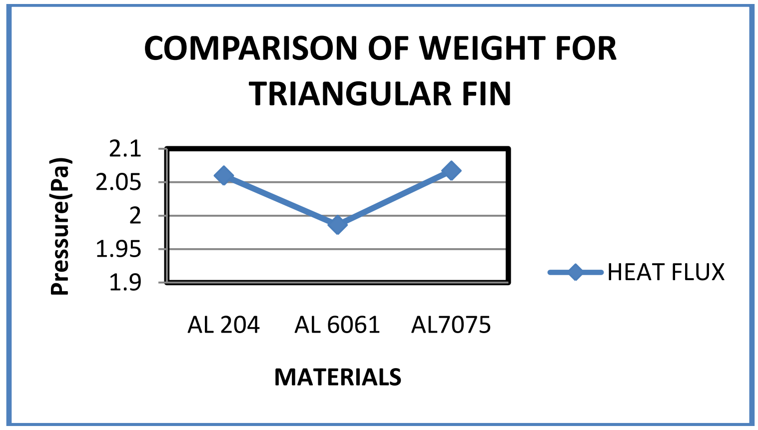

CONCLUSION

In this thesis we have designed a single cylinder 4 stroke petrol engine with different fin profiles. Here we have designed an original model of rectangular and modified models of circular and triangular profiles. And even we have varied the materials of the geometry as Al - 204, Al 6061 and Al 7075. Using these materials we have analyzed at max optimum temperature levels.
As if we verify the results obtained in the above figures, all the results are tabulated in the tabular form and the comparison of the graphs are also done.
As per the output results obtained

- As if we verify the results obtained for the rectangular fin profile model, here we can clearly observe that the Al 6061 meets the requirements and even the weight of the object is also less when compared with others
- As if we verify the results obtained for the circular fin profile model, here we can clearly observe that the Al 6061 meets the requirements and even the weight of the object is also less when compared with others
- As if we verify the results obtained for the trianglular fin profile model, here we can clearly observe that the Al 6061 meets the requirements and even the

weight of the object is also less when compared with others

- As if we compare the all the three profiles we have obtained Al 6061 is the better material, but as if we compare in the fin profile, here the resulted graphs shows that the circular fin has obtained the requirements and even if we consider the manufacturing process, this would be very easier and the time taken will be less when compared with other materials and the weight is also less than the other profiles.

REFERENCES

[1] International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 8, August 2013 IJERTIJERT ISSN: 2278-0181

[2] Paul W.Gill, James H. Smith, JR., and Eugene J. Ziurys., 1959, internal combustion engines - Fundamentals, Oxford & IBH Publishing Company.

[3] Dr. Kirpal Singh, 2004, Automobile engineering vol.II, Standard Publishers Distributors, Delhi.

[4] Prof. R.B.Gupta, 1998, "Automobile engineering," SatyaPrakashan, Incorporating, Tech India Publications.

[5] Prof. R.K. Rajput, "Heat and Mass Transfer", S. Chand Publications.

[6] KENNEDY, F. E., COLIN, F. FLOQUET, A. AND GLOVSKY, R. Improved Techniques for Finite Element Analysis of Surface Temperatures. Westbury House page 138-150, (1984).

[7] COOK, R. D. Concept and Applications of Finite Element Analysis, Wiley, Canada, (1981).

[8] BEEKER, A.A. The Boundary Element Method in Engineering, McGraw-Hill, New York, (1992).

[9] ZIENKIEWICZ, O. C. The Finite Element method, McGraw-Hill, New York, (1977).

[10] https://www.quora.com/How-much-is-the-exhaust-temperature-of-ic-engine

[11] https://en.wikipedia.org/wiki/Air-cooled_engine