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Effect of Fin Thickness and Geometry on Engine Cylinder Fins

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Abstract – *This paper describes our effort to find out the effect of thickness and geometry on engine cylinder fins for temperature distribution, for this purpose, we have used fins with rectangular geometry, triangular geometry and thickness 2.5mm, 3mm. Finite Element Analysis (FEA) done using ANSYS software, and Experimental method. The results obtained from both methods are nearly same except some variation in experimental method. Finally, to find out conclusions comparative study carried out between results of both method mention above.*

Key Word: **Finite Element Analysis (FEA), Al6061, Temperature Distribution, Steady State Analysis.**

1. INTRODUCTION

Heat generated between Engines after fuel is burned out. Extra heat generated by friction between the moving parts. approximately 30% to 35% of the energy only released is utilized for actual work. The remaining (65% to 70%) removed from the engine to prevent the parts from melting.

For this objective Engine contain of cooling mechanism in engine to take out this heat from the engine limited heavy vehicles uses water-cooling method and nearly all two bikes uses Air cooled engines, because of Air-cooled engines has rewards like lighter weight and smaller space requisite hence they are only option. Heat produced during combustion in Internal Combustion engine must be maintained at upper level to rise thermal efficiency, but to prevent engine parts from thermal damage some heat must be remove from the engine. In air-cooled engine exterior stretched surfaces are called as fins and provided at the periphery of engine cylinder to increase heat transfer rate[1]. Fins are widely used for cooling of IC engines. Engine cylinder fins are the outside stretched surfaces purposely provided on condition that it removes heat from place. The amount of conduction, convection and radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient and increasing the surface area of the object increases the heat transfer[2]. The different types of fin geometries that can be used for an IC engine are Rectangular fins, Triangular fins, Trapezoidal fins and Pin fins as shown in figure 1.

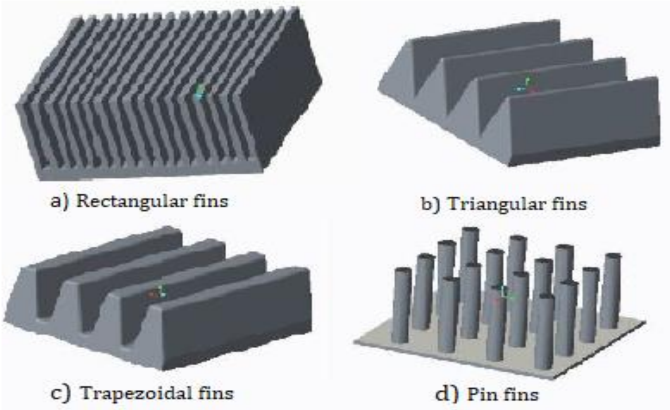

Fig-1: Different types of fin geometries

2. METHODOLOGY

To investigate the performance of the temperature distribution through cylinder with fins first finite element analysis is completed using ANSIS R16.2 to Redefining of design earlier in product development stage also comparing the various design alternatives through simulation[3]. Reduce the amount of time and money required for prototype testing and create more reliable, better quality design[4], during FEA software model of a cylinder with *rectangular geometry* Fins of Aluminum Alloy 6061 are implemented and results are calculated for Temperature Distribution of Rectangular Fins with Alloy 6061 in 2.5 mm and 3 mm Fin Thickness. Implemented model of cylinder is as shown in figure 2.

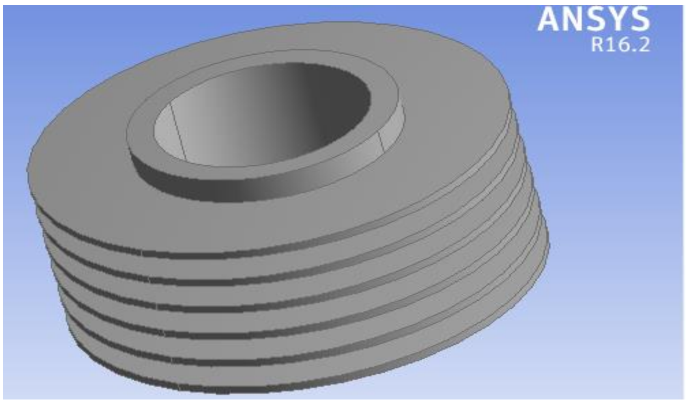

Fig-2: Model of cylinder with Rectangular Fins.

Then experimental setup developed it consists of a cylinder with *rectangular geometry fins* by using Al 6061 as shown in figure 3. Six fins are manufactured on the cylinder so that temperature at the end of fin tip is find out [5][6].

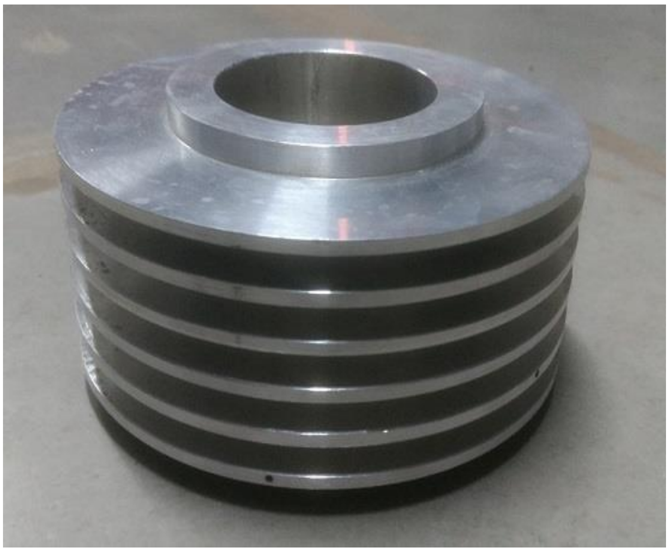

Fig-3: Cylinder with 3.0 mm thick rectangular fin.

A set of two cylinders are manufactured with fin thickness of 2.5 mm and 3.0 mm. The cylinder with fins are enclosed in box made out of cardboard to avoid external wind disturbances. The enclosure also helps in developing a pure natural convection transfer through the set of fins by isolating the cylinder from the surrounding effects[8]. The experimental setup implemented as shown in figure 4, it consists of cylinder with fins, digital temperature indicator, dimmer stat (voltage regulator) and thermocouple sensor cables as shown in figure 5, with the help of experimental setup temperature at tip of the fin measured practically using following procedure[10].

1. Connect the dimmer stat to the heating element. Bring the knob of dimmer stat to zero
2. Connect the probes of digital temperature indicator at different locations on the cylinder and on the fins as per requirement. Switch on the mains supply.
3. Increase the voltage supply to the heating element by rotating the knob slowly then Switch on the power supply of digital temperature meter and See the temperature of the inside and outside surface and fins indicated by the digital temperature indicator by rotating the knob provided.
4. Increase or decrease the voltage supply provided to the heating element depending on the temperature required at the inside surface of cylinder.
5. Wait until the temperature indicated by digital temperature indicator becomes steady. If the temperature indicated is steady, then it means that the experiment has reached steady state.
6. Once the steady state is reached, temperatures at various locations on the fin tips are noted.
7. Tabulated the temperatures and noted properly in the form of a table so that it becomes easy for further calculations.

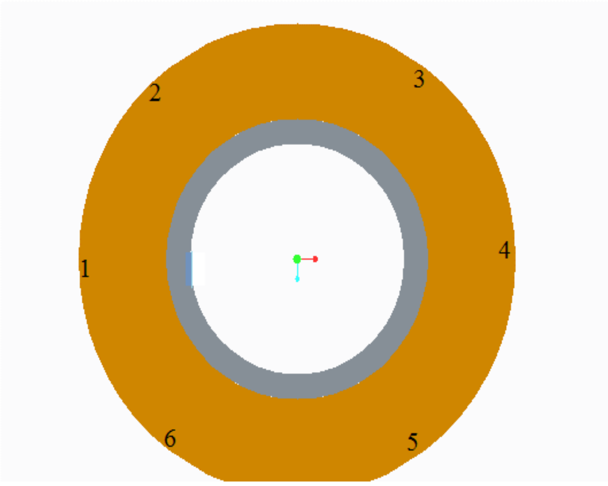

Fig-3: Placement of thermocouples.

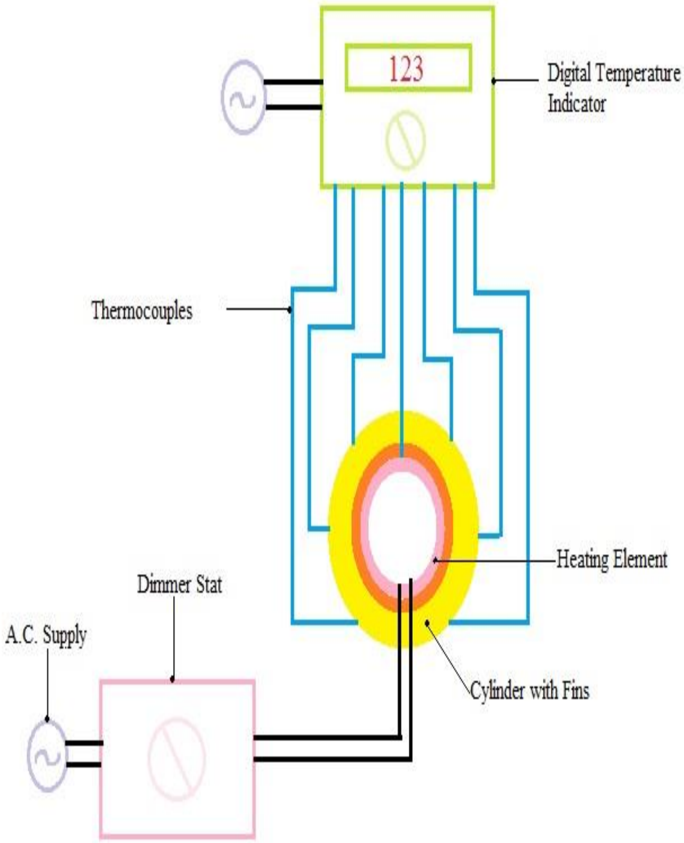

Fig-4: Experimental setup for measurement of temperature at tip of the fin.

3. RESULTS AND RESULTS ANALYSIS

The results obtained for temperature distribution from the Finite Element Analysis using ANSIS are shown in figure 6 and figure 7 and Experimentation of different size models are collected and made it in tabulated form as follows in table 1 and table 2. Various graphs are plotted for experimental results as shown on figure 8 and ANSYS results in figure 9 and discussion is carried out on graphs.

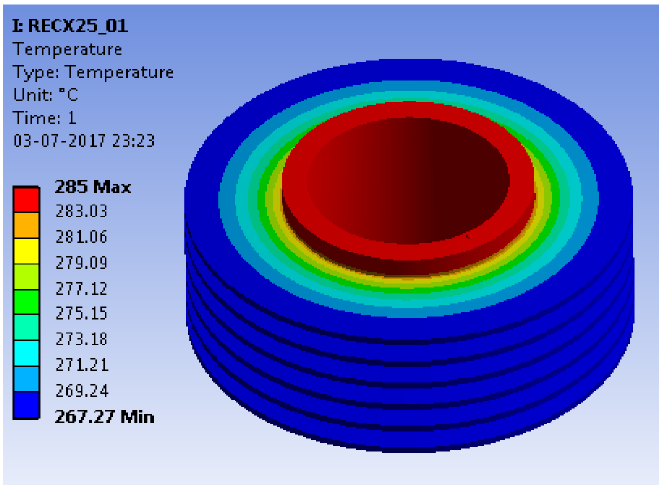

Fig-6: Temperature Distribution for Rectangular Fins of Aluminium Alloy 6061 with 3.0 mm Fin Thickness

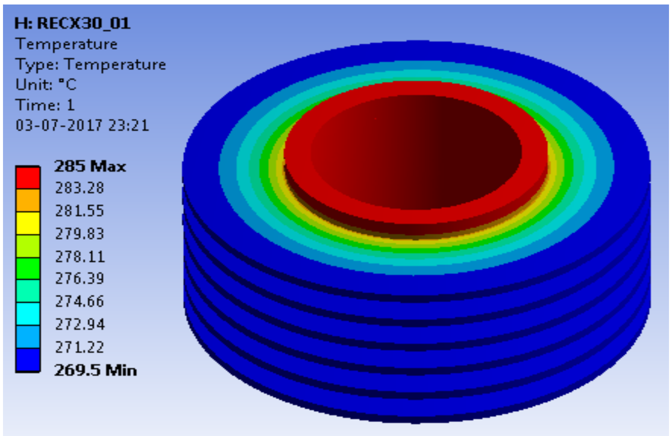

Fig-7: Temperature Distribution for Rectangular Fins of Aluminium Alloy 6061 with 3.0 mm Fin Thickness

Table 1: ANSYS Result table for Temperature Distribution fines with rectangular geometry.

SR. NO.	THIKNESS	TEMPERATURE (°C) for Al 6061
1	2.5	267.27
2	3	269.5
3	3.5	271.14

Table 2: Experimental Results for Aluminium Alloy 6061 fines with rectangular geometry.

Sr. No.	Thickness of Fin (mm)	Average Temperature at Fin Tip (°C)
1	2.5	265.33
2	3.0	266.83

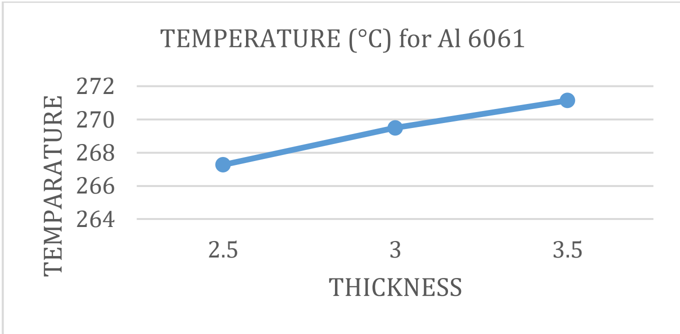

Fig-8: Graphical representation of temperature Distribution results with ANSYS for Rectangular Fins of Aluminum Alloy 6061 with variable size fin thickness.

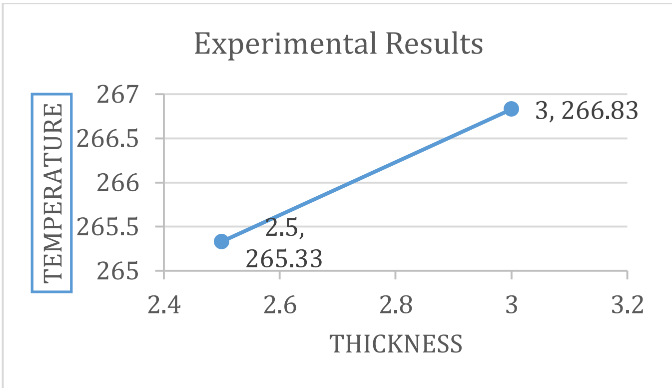

Fig-9: Graphical representation of temperature Distribution results with Experimental Model for Rectangular Fins of Aluminium Alloy 6061 with variable size fin thickness.

Graph in Figure 8 shows the variation of temperature with thickness for cylinder with rectangular and triangular fins of varying fin thickness and materials. From this graph, it is clear that the temperature distribution is maximum for cylinder with rectangular fins having 3.5 mm fin thickness and for the material aluminum alloy 6061 Such as Graph in figure 9 shows the variation of temperature with thickness for cylinder with rectangular fins of material aluminum alloy 6061. From this graph, it is clear that the temperature distribution is maximum for cylinder with rectangular fins having 3.0 mm fin thickness

4. CONCLUSIONS

Finite element analysis and experimental investigation on the thermal behavior of cylinder with different fins of varying fin thickness, geometry and material is carried out. Based on the finite element analysis and experimental investigation of different fins, following conclusions are drawn. Results obtained from the finite element analysis are in close approximation with results of experimental method. FEA and Experimental results analysis shows that the temperature distribution is maximum for the cylinder with rectangular fin of 3.5 mm fin thickness for aluminium alloy 6061 and minimum for triangular fin of 2.5 mm thickness for aluminium alloy 6061.

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