A Review Paper on Thermal Analysis and Heat Transfer of Single Cylinder S. I. Engine Fins

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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 convection. 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 temperature distribution by varying geometry and thickness of cylinder fins using ansys work bench.**

Keywords*— Convection, fins, heat dissipation, thermal analysis.

I. INTRODUCTION

The power source in case of automobiles is IC engine. The energy produced in the IC engine is due to the combustion of fuel inside the combustion chamber. Out of the total energy produced inside the engine, approximately 30% of it is available at crankshaft in the form of propelling force & rest of the 70% of energy is exhausted in the atmosphere. The energy dissipation in the atmosphere is in the form of heat in the cooling water, exhaust gas, lubricating oil & through fins. IC engine fins are the extended surfaces provided on the periphery of cylinder surface for heat dissipation. The heat transfer from engine to atmosphere through fin occurs by the mode of convection. To enhance the rate heat transfer by fin, the surface area must be increased. But due to space restriction it is not feasible. So the aim of this project is to do few modifications in the fin geometry & shape in the fin design so as to achieve the optimum design of fin geometry which can help to improve heat dissipation.

So keeping these points in mind, we can focus on modification in the fin design. The aid of Ansys Workbench & CFD fluent has to be taken to validate the results obtained so as to confirm the results. This review paper is made after studying some related literature done by other people around the world.

II. LITERATURE REVIEW

P. Sai Chaitanya, B. Suneela Rani, K. Vijaya Kumar(1) have analyzed in their research paper ," Thermal Analysis Of Engine Cylinder Fin By Varying Its Geometry" that there is scope of improvement in the fin geometry & material used for fin manufacturing for enhancing the temperature distribution along the fin length.

Prof. Arvind S.Sorathiya, Ashishkumar N. Parmar, Prof. (Dr.) Pravin P. Rathod (2) have researched in their "Review Paper on Effect of Cylinder Block Fin Geometry on Heat Transfer Rate of Air-Cooled 4S SI Engine", that there are several geometries of fins are available in the two wheeler engine cylinder. These geometries vary from company to company. They have did the comparative study of few models of engine& ultimately concluded that if the configuration of fin cross section, geometry is changed from conventional one, the contact time of air & fin can be increased, thus the heat carring capacity can also be improved.

Dhanawade Hanamant S, K. N. Vijaykumar, Dhanawade Kavita,(3) have did the experimental calculations & compared them with the CFD simulation data in "Natural Convection Heat Transfer Flow Visualization Of Perforated Fin Arrays By Cfd Simulation". After experimentation they have found out that, the perforations provided on solid fin surface help to improve the temperature distribution over the fin arrey. Also the performance of Nu against Rayleigh number (Ra) at the same heat input the Nu of the perforated fin array is higher than the Nu of the solid fin array of the experiment well as of the simulation and heat dissipation rate increases with an increase in the size of the perforation.

Abdullah H. AlEssa, Ayman M. Maqableh and Shatha Ammourah (4) have done thermal analysis for "Enhancement of Natural Convection Heat Transfer from a Fin by Rectangular Perforations with Aspect Ratio of Two" and after the completion of the research work they have found that for certain values of rectangular perforation dimension, the

perforated fin enhances heat transfer. The magnitude of enhancement is proportional to the fin thickness and its thermal conductivity. Also the fin dimensions i.e. thickness, length & width, geometry of the fin perforations also play important role in improving heat transfer. Along with the geometry of perforation the spacing between two perforations & thermodynamic properties of material also have significant impact on the heat convection process.

Raaid R. Jassem (5), have studied the, "Effect the Form of Perforation on the Heat Transfer in the Perforated Fins" in his research work. Where he found that the shape & size of perforations in the fin have great influence on the rate of heat transfer & drop in temperature. Also the no. of perforations in the fin & its lateral dimensions also affect the heat transfer rate of the fin.

Mohin A. Ali & Prof. (Dr.) S. M. Kherde (6) presented a review paper on "Design Modification & Analysis Of Two Wheeler Cooling Fins", in which they have studied several review papers. After study & research they have found out that if fin thickness is increased, it results in swirls which enhance heat transfer. Also they have studied the comparison of the rate of heat transfer of solid & permeable fin. Permeable fins are formed by drilling three holes per fin in solid rectangular fin. It was found that for permeable fin block avg. heat transfer rate improved by about 5.63% & avg. heat transfer coefficient by 42.3% with reduction in material cost by 30%.

Jabar Al Hossain, Kazi Ehsamul Karim & A. H. M. Fazel Elahi (7) have shown in their research paper "Heat Transfer Augmentation Of Cylinder Block By Using Permeable Fin Over Solid Fin By Using CFD Analysis" the graph of temperature difference vs time between fin tip & fin base for solid & permeable fin. It was evident that permeable fin have temperature difference higher than solid fin. Thus HT rate of permeable fin is higher than solid fin.

Pulkit Agrawal, Mayur Shrikhande & P. Sriniwasan (8) presented a paper on "Heat Transfer Simulation by CFD from Fins of an Air Cooled Motorcycle Engine under Varing Climatic Conditions". In this paper after doing simulation, they have concluded that the temperature & heat transfer coefficient values from fin base tip are not uniform. The extra heat loss which takes place in regions of sub zero temperature is also found out, which causes excessive fuel loss. This excessive fuel loss can be reduced by reducing the velocity of air striking on engine cylinder by providing a diffuser in front of it. This will help in improving the engine efficiency.

R. Arularasan, P. Hemanandhan, T. Thamizhsel Van, B. Arunkumar, S. Senthilnathan, S. Prathap (9) performed "Modeling & Simulation of Engine Cylinder Fins by Using FEA". In this research they have studied various fin configurations of fin such as trapezoidal, triangular, rectangular & elliptical profile. After studying all these profile they have found the fin tip temperature if all the profiles, out of which lowest temperature is found to be of triangular configuration (48.89°C). This can be concluded as triangular configuration is best suitable for fin shape.

Prasad R. Godbole, Prof. Dr. S. G. Taji & Dr. S. S. Thipse (10) presented their research work in paper "Experimental Investigation of Modified Annular Rectangular Fins". Their key findings are: more number of fins results in cooler system, stack of modified fin is found to be more effective in heat transfer also results in material reduction. Optimum number of fins is found to be 3 fins.

J. Swain, K. Gaurav, D. Dingh, P. K. Sen & S. K. Bahidar (11) presented stdudy paper on "Comparison of HT in Straight Triangular Fin & Porous Fin under Natura Convection". It has been observed that straight fins with rectangular cross section transfer heat at a good rate. But it was also observed that the heat transfer rate decrease as the thickness increases which implies unnecessary use of thick material. Straight triangular fin are fins which yields the maximum heat flow per unit weight. But porous fin yields maximum heat flow than straight triangular fin because of huge surface area as pores & outer surface.

K. H. Dhanawade, V. K. Sunnapawar & H. S. Dhanawade (12) did "Thermal Analysis of Square & Triangular Perforated Fin Arrays by Forced Convection". They observed that the Nusselt number of perforated fin arrays as well as solid fin arreys increases with increase in Reynolds number. Avg. of percentage improvement of effectiveness in square perforated fin arrays is more than fin arrays of circular perforated fin of same size.

P. Singh, K. K. jain, R. K. Dave & P. Tiwari (13) concluded in their research paper "Comparison Of Performance Of Different Profiles Of Fins Using Thermal Analysis" that helical fin configuration gives best heat transfer rate for the same boundary condition, thus can be used to get optimum result.

III. CONCLUSION

After studying several literatures about engine fin modification, we can see the following results,

By comparing experimental & CFD simulation on a solid & perforated fin array it is observed that in both cases HT rate increases as the size of perforations goes on increasing, as more free convection due to perforation(3).

By doing CFD analysis on permeable fins, HT efficiency of is observed to be increased by 10-15% over solid fin (7).

By doing experimental work on array of perforated fins of solid Vs square & circular perforation it is observed that; Nusselt number of solid as well as perforated fins increase with increase in Reynolds number. Also for same size of perforations square perforations give slight higher percentage of effectiveness improvement in square holes than circular (12).

Thus we can conclude that even though the attempts have been made to modify several parameters related to fin for HT augmentation, but still there is a vast scope for fin design modification.

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