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A Review on Internal Combustion Engine Fins

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***Abstract*— Extended surfaces has its major significance in heat transfer and thermal management in internal combustion engine they plays a major role in performance of combustion engines, In this paper heat transfer effectiveness of fins were studied also with literature survey to identify the previous works that have been performed by mathematical, analytical and numerical methods with optimizing profiles, materials and process parameters, this survey paper segmented and clustered the detail description of internal combustion engine fins, This paper reviews the recent researches that were performed in heat sinks by considering various parameters and methods.**

***Keywords*— Convection, fins, heat dissipation, thermal analysis, Air cooled engines, Water cooled Engines, Heat transfer coefficient.**

I. INTRODUCTION

Internal combustion engines are part of economic development in world economy in present era the goods that are exported imported by means of heavy vehicles like trucks and buses are working in internal combustion engine, although passenger vehicles and civil construction heavy vehicles also works in internal combustion engines these engines generates high amount of heat during working, this heat is dissipated by means of fins with air cooled, oil cooled and water cooled engine systems.

The cooling of engines thoroughly depends upon the fins, it is classified as:

- Air cooled engines
- Oil cooled engines
- Water cooled engines

Air cooled engines – these type of engines are used in both spark ignition and compression ignition engines it consists of fin in combustion cylinder the air direct interacts with cylinder, thus cylinder gets cooled by means of fins.

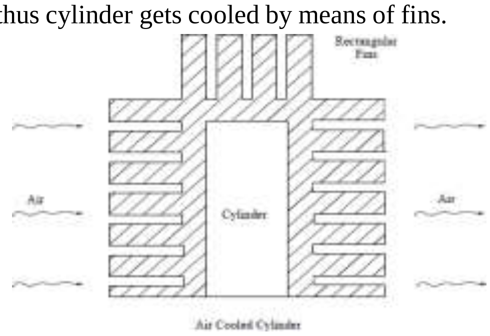

Figure 1 – Air cooled engine fins.

cooling systems. Oil cooling: Technically, An oil cooled engine is an air cooled with oil cooling assistance, the bulk of the thermal effectiveness transfer is from the fins on the engine block .Air-cooled engines are predominantly fuel efficient, economical and require lesser engine area as compared liquid cooled engines. The upkeep costs of liquid cooled ones are above air-cooled engines [28].

Oil and Water cooled engines - Oil Cooled and Water Cooled engine with fin configuration are terms employed bymanufacturer's to identify the slight difference between the

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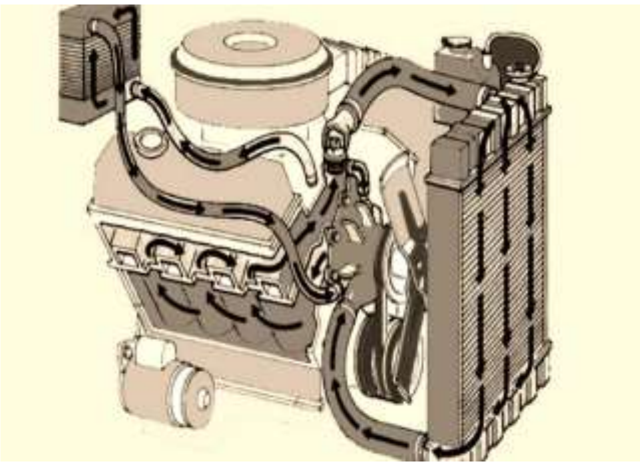

Figure 2 – Water cooling engine fins.

II. COOLING FINS

1. Fins are the extruded surfaces created to extend heat transfer rate for a definite surface temperature, or to decrease surface temperature for a defined heat transfer rate [27].
2. Heat transfer by convection between two surfaces and therefore the fluid around the surface are often increased by fabricating to the surface called fins [27].
3. The conduction of heat through solids, walls, or boundaries has got to be dissipated to the environment or environment to maintain the system during a steady-state condition. In many engineering applications large quantities of thermal exchange is needed to be dissipated from tiny areas [27].
4. The fins increase the effective surface area of a any model thereby increasing energy transfer by convection. Rectangular fin and triangular fins are straight fins. Triangular fins are attractive, since for an equivalent heat transfer it needs much low volume than rectangular fins. Hence the fins have practical importance because it gives maximumheat flow per unit mass with easy manufacture [27].

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III. STRUCTURE OF FIN

The structure of fin supports in effectiveness of heat dissipation, many researchers have proposed different shape of fins and predicted the heat transfer effectiveness in different heat flux as well as parametric evaluation have been performed by varying fin thickness, fin spacing and length of fin, the different type of fin structures are:

- Rectangular fin
- Offset strip fin
- Triangular fin
- Perforated fin
- Wavy fin
- Louvered fin

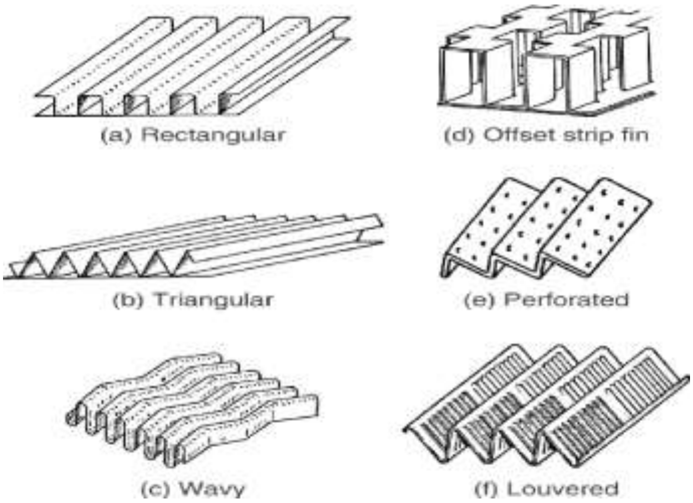

Figure 3 – Classification of fins.

Many of researchers investigated variable outcomes in analysis of fin by performing numerical simulation, mathematically and experimentally, the survey had been done on different types of fin shape to predict behavior of heat dissipation and temperature distribution [1], further material of fin is changed to predict behavior of heat flux and temperature distribution including different shapes of fin [2], the effect of convection condition with conduction on fins were analyzed for improvement in higher heat dissipation [3], natural convection analysis had been performed in fins using software simulation with finite element method for determination of high thermal effect and compared outcome results obtained by variable parameters [4], proposed design of fin considering transient fuel as a working fluid with analyzing distribution of heat with optimization in design of fin [5], the potency of different fins by optimizing their form were reviewed for prediction of thermal efficiency, the review is also done for prediction the thermal effects on fins by finite volume method and finite element method [6], effective cooling performance is analyzed by varying fin thickness, fin spacing. The analysis is performed in ANSYS software by applying parametric evaluation and determined optimum dimensions for effective cooling performance [7], combination of circular and strapped fin with magnesium and alumunium 6061 were used to enhance the heat transfer rate using finite element method [8], further the survey has been performed in four stroke spark ignition engines, the different configurations with materials were predicted and study was done on variable profile of cylinder block that were used in different vehicles [9], thermal performance of fins that were performed using finite element method in different materials were evaluated with highly thermal conductive materials [10].

IV. LITERATURE SURVEY

The investigations that were performed in internal combustion engine fins are elaborated below:

Type of investigation	Type of fin	Materials used	Results obtained
Numerical simulation (ANSYS) [11]	Slotted fins	Aluminum Alloy 6061 Aluminum Alloy C443 Aluminum Alloy 2014	Aluminum Alloy 2014 with the slot width 75mm enhances more heat dissipation.
Numerical simulation (CFD, Fluent) [12]	Helical fins	Aluminum Alloy	Fin pitch of 187 mm performed optimal thermal performance.
Particle swarm optimization algorithm (MATLAB R2010a) [13]	Rectangular fins	Aluminum Alloy	The multi-objective optimization results are more satisfactory
Numerical simulation [14]	Pinned finned	Aluminum Alloy	Schmidt fin efficiency improved by7.0%.
Numerical simulation (AUTODESK INVENTER) [15]	Porous fins	Aluminum Alloy 6061	A fin with fillet edges enhances more heat transfer.
Experimental [16]	Compact plate finned	Aluminum Alloy	The developed empirical relationship enhances temperature distribution.
Numerical simulation (AUTODESK INVENTER) [17]	Surface roughened fins	Aluminum Alloy 6061	250 micron, 300 micro and 400 micron surface roughened enhances more heat transfer
Numerical simulation [18]	Slanted pin fin	Aluminum Alloy	Temperature distribution enhanced.
Numerical simulation (CFD, Fluent) [19]	Circular pin fin	Aluminum Alloy	Improved distribution of heat
Numerical simulation [20]	Plate fin	Aluminum Alloy	4% of improvement in temperature distribution is observed.

P.Senthilkumar et al.[21] – in this study design of circular fin has been done by finite element method, the investigation is performed by comparing the different profiles of fin with determination of thermal stress also the parameters were compared in form of temperature distribution, heat flux as well as structure of fin.

YangXu et al. [22] – investigated thermal performance by parametric evaluation with different configuration of pin fin including impingent flow, the final observation is the optimum ratio of distance between fin and spacing ratio develops maximum heat transfer characteristic in inclusion if impingent flow.

Su MinHoi et al. [23] - the study represents a fractal shaped inserts in plate fin heat sink to enhance convective heat transfer, increase in heat transfer is analyzed by varying thickness of fractal, the results were compared by evaluating

Reynolds number with each optimized design of plate fin heat sink, this study also propose that fractal inserts with unity enhances overall thermal performance of plate fin heat sink.

NgoctanTran et al. [24] – presented the configuration of louvered fins and improved 19.54% of thermal performance using forced convection the velocity ranges that were considered is between 1m/s to 6 m/s with louvered angle between 27 degree to 40.5 degree the results are compared together and heat dissipation is improved.

LeiLi et al. [25] - The pin fins including the inner cavity increases the circular flow and make it move beneath, in order that the Nusselt number within the area below the pin fins is enhanced; meanwhile, local convective heat transfer coefficient and therefore the area of thermal exchange have both increased to enhance the convective heat transfer effect.

AdeelTariq et al. [26] - The experimental data validates the conjugate model of heat sink using finite volume method. The results from the FVM model show that the heat transfer coefficient is higher in the plane fins without slots and perforations. Also need of pumping power is compared to be less in comparison of base model.

V. CONCLUSION

After surveying several literatures of engine fin, the following conclusions were withdrawn,

1. More improvements could be made by considering the materials like graphene and aluminum foam.
2. Fins with different profiles of perforations should be used and would be analyzed for more improvement in heat transfer.
3. Pin fins with slanted edge would be employed in heat sink which would increase the heat transfer rate because slanted edge have capability to converge the flow, due to this effective cooling would be done.
4. It can be concluded that even performing the several attempts have been made to optimize several parameters related to fin for heat transfer augmentation, but still there is a huge scope for fin design modification and optimization.

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