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A Study of Finite Element Analysis on Single Tube Fin Arrangement in Radiator

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***Abstract* – Automobiles mostly uses aluminum as a material for radiators fins as it is most economical, but copper has more thermal conductivity with higher performance rate. Hence our main objective in this project is to improve the heat transfer rate in fins by introducing a composite material based on aluminium with copper for the radiators. Finite element model thermal analysis is used for the purpose of studying. Varying shapes of the fins like straight, chamfer and round edges are used and are 3D modeled in CATIA Software and FEA analysis is done on ANSYS WORKBENCH software R15.0.**

***Keywords* – ANSYS, CATIA, Chamfered Fins, Heat Transfer Analysis, Rounded Fins, Straight Fins.**

I. INTRODUCTION

Internal combustion engines produce mechanical power by extracting energy from heat. Engines need cooling to operate because high temperatures damage engine materials and its parts. Cooling is done by many methods through air and water. Commonly used method was by air through fins. Fins increase the contact surface area of the emission from radiator tubes through convection. [1] Three different materials like aluminium, copper and brass are used for studying the improvement in performance. Finite element method is used for studying the heat dissipation rate and it is concluded that brass is more effective. [2] They investigated the temperature distribution in automotive radiators with and without fins and made thermal analysis and the properties are improved with the use of fins.

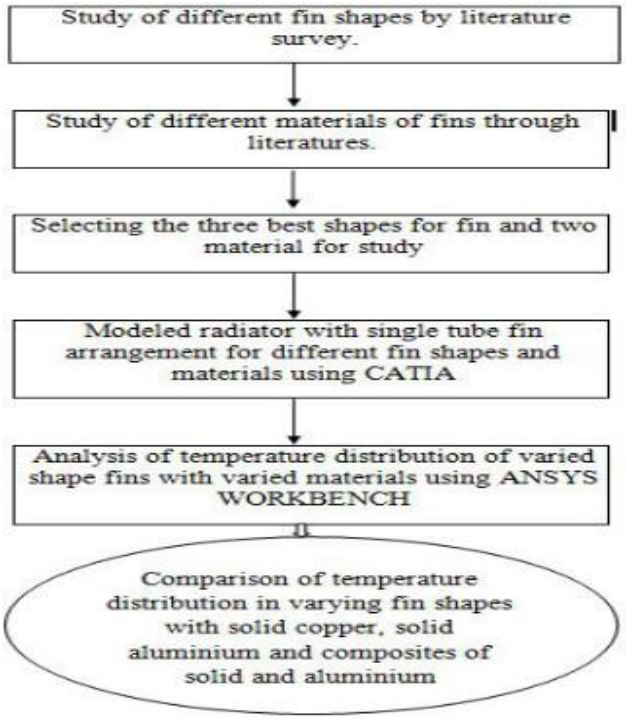
[3] In this work nano silicon carbide is mixed with the coolant and varying shapes of the fins are used for increasing the heat transfer efficiency and he concluded that round type fins have more temperature difference as it has more contact area. [4] It demonstrated the FEM method of heat transfer analysis through different composites with aluminium, brass and copper combination and he stated that heat transfer at the tip of the fins is high in solid copper, brass and aluminium and it is less in composites. [5] It showed temperature distribution of rounded shape fins with varying composition of aluminium, copper, brass are studied it is concluded that solid material shows higher heat transfer rate when compared to composites. [6-9] demonstrates the FEA analysis in various mechanical field sectors.

All these literatures showed the use of composite materials as fins but there is a little research work made on the different shape of the fins as design may influence higher performance in transferring the heat for cooling.

Thus our aim in this work is to study the solid aluminium, solid copper and also with aluminium and copper composites of different proportions with three different shaped fins namely straight, chamfered, and rounded and to study its temperature difference for getting higher performance.

II. METHODOLOGY

The work starts here with selection of different shapes of fins for improved performance in dissipating the heat and also by selecting the material which would create intense effect of temperature distribution for heat dissipation by studying through various literature surveys.



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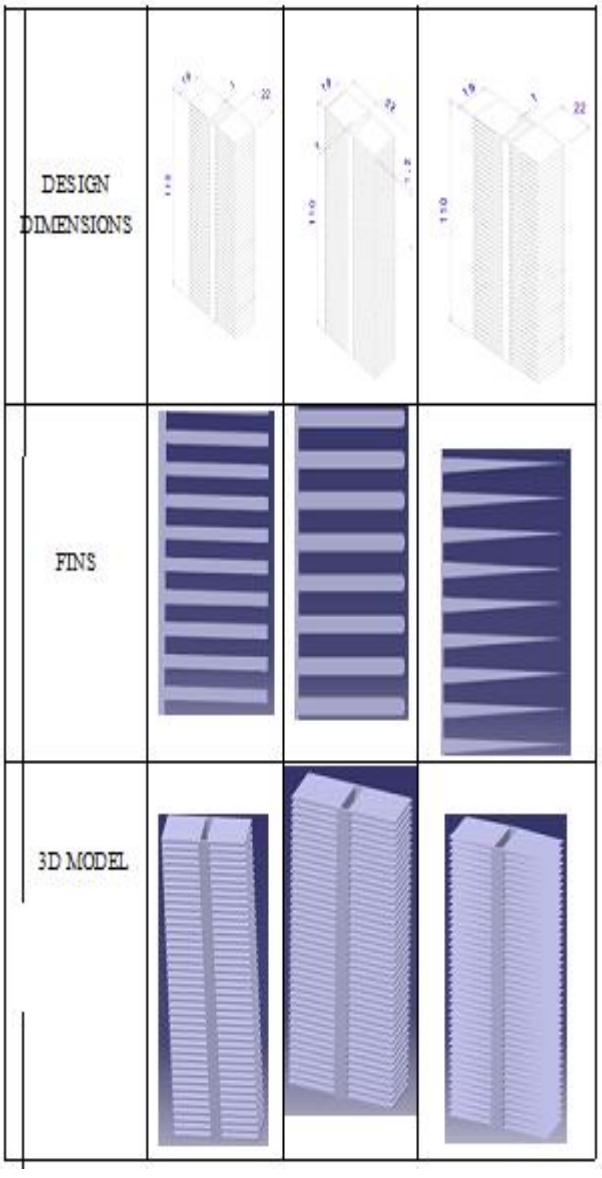
III. DESIGN USING CATIA

A single fin tube arrangement of radiator is designed using a three dimensional modeling software with three different shape fins and are shown in table 1.

- Straight fins
- rounded fins
- chamfered fins

Table –I: shows 3d model of straight fin, rounded fin and chamfered fins.



IV. ANALYSIS USING ANSYS WORK BENCH

Ansys, a finite element analysis software which is used in almost all engineering design. In fem, the finite element model is created by dividing the structure in to a number of finite elements. Each element is interconnected by nodes and the process of performance in ansys can be broken down into three main steps like pre-processing, solver and post-processing.

Models which are sketched are then imported to ansys work bench and are meshed with varying nodes, elements and similar element types which are shown in Table 2.

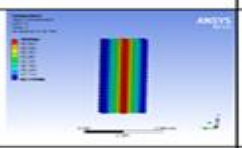
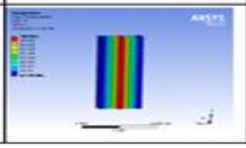
Table –II: shows varying nodes, elements with element types and meshed model of fins.

NODES	75713	218710	218396
ELEMENTS	35193	108398	106803
ELEMENT TYPE	TETRAHETRONS	TETRAHETRONS	TETRAHETRONS
MESHED MODEL			

V. RESULTS FOR STRAIGHT FINS

The temperature distribution Analysis is done by Ansys work bench R15 for straight fins with the five different materials and is shown in Table 3.

Table –III: shows Analysis result for straight fins with varied materials.

DIFFERENT MATERIALS	STRAIGHT FINS	TEMPERATURE DIFFERENCE
COPPER		24.064
ALUMINIUM		13.822
ALUMINIUM 50% + COPPER 50%		19.3
ALUMINIUM 60%+COPPER 40%		17.561
ALUMINIUM 40%+COPPER 60%		21.604

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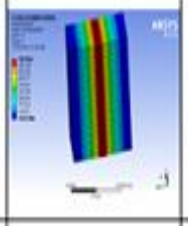
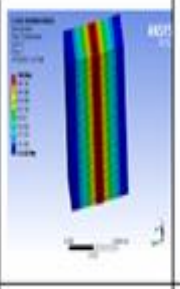
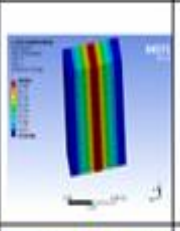
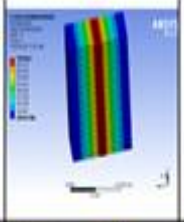
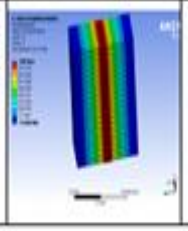
VI. RESULTS FOR ROUNDED FINS

The temperature distribution analysis is done by ansys work bench r15 for rounded fins with the five different materials and it is shown in table 4.

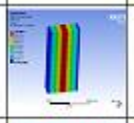
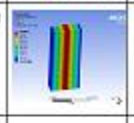
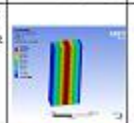
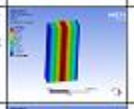
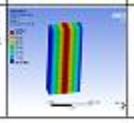
Table –IV: shows Analysis result for rounded fins with varied materials.

DIFFERENT MATERIALS	ROUNDED FINS	TEMPERATURE DIFFERENCE
COPPER		29.17
ALUMINIUM		16.362
ALUMINIUM 50% + COPPER 50%		21.734
ALUMINIUM 60%+COPPER 40%		19.146
ALUMINIUM 40%+COPPER 60%		24.911

VII. RESULTS FOR CHAMFERED FINS

The temperature distribution analysis is done by ansys work bench r15 for chamfered fins with the five different materials and it is shown in table 5.

Table-V: shows Analysis result for chamfered fins with varied materials.

DIFFERENT MATERIALS	CHAMFERED FINS	TEMPERATURE DIFFERENCE
COPPER		35.019
ALUMINIUM		21.244
ALUMINIUM 50% + COPPER 50%		28.819
ALUMINIUM 60%+COPPER 40%		26.461
ALUMINIUM 40%+COPPER 60%		31.857

VIII. RRESULT AND DISCUSSION

Various cross sections of fins are discussed and are shown in table 5.

Table-VI: comparison of various cross section fins.

IX. CONCLUSION

The solid copper, solid aluminium and aluminium with copper composite at different ratio proportions material is considered and compared with straight fins, round edge fins, chamfered fins models and are examined for thermal analysis. the results are discussed below clearly

1. Solid copper showed higher performance in varying cross section of fins as because it has its higher

thermal conductivity when compared with the aluminium and aluminium-copper composites.

2. Since copper may have higher performance but its heat transfer coefficient is merely equal to aluminium and also density of copper is higher when compared with aluminium or other composites which automatically increase the weight and cost in production.
3. composites made with aluminium 40% and copper 60% gave better performance in temperature distributions at varying cross sections of fins.
4. The composites consisting aluminium 40% and copper 60% compared with solid aluminium and other compositions of aluminium and copper which in turn it may be in reduced weight and density with increased thermal conductivity and heat transfer rate.
5. Chamfered fins gave better performance, next to that rounded edge fins and then straight fins in its cross section.

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