

## Bi-Metallic Fins

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**ABSTRACT** - Engine is one of the most important components of the automobile, which undergoes various thermal stresses and temperature variables. In air cooled engines fins are provided in order to increase the rate of heat transfer and promote rapid cooling. By performing thermal analysis we can determine the heat dissipation rate from cylinder to surroundings. The rate of heat dissipation can also be increased by increasing the surface area of the fins but it would be inconvenient and difficult to design and fabricate such engine cylinders. Hence, the main aim of this research study is to analyze thermal properties of air cooled engine by varying the materials and geometry of the fins using ANSYS Workbench. By varying the fin materials and geometry we can able to increase overall heat dissipation thereby reducing the temperature of the engine cylinder and make it work more efficiently for longer lifetime.

### 1. INTRODUCTION

As we all know the working cycles of engine cylinder in which the combustion of mixture of air and fuel takes place which leads to generation of hot gases. The temperature of these hot gases may reach upto 2300-2500°C. Generation of such high temperatures may lead to deplete the oil film between piston and cylinder and this situation might lead to engine seize.

Hence it becomes essential to reduce this high temperature by 200-250°C so the engine will be in its comfort zone and it will run efficiently. In the sake of increasing the heat dissipation the over cooling of engine is avoided as it may reduce the thermal efficiency, hence the object of cooling system is to keep the temperature of cylinder in range where it runs most efficient.

The precaution to be taken while designing the cooling system is to avoid overcooling. Thus, ideally the cooling system should prevent overcooling when engine is warming up and it attains the most efficient working temperature range.

It should be taken into account that extracting the heat from the engine cylinder and supplying to the atmosphere in the favour of cooling is direct thermodynamic loss.

### 1.1 AIR-COOLING SYSTEM

Usually where small capacity engines is used air cooling system is preferred, the engine is kept exposed to atmosphere. Hence, when the vehicle runs, the air impinges on the engine cylinder with certain velocity there by taking away heat from the engine cylinder.

As the heat is carried away by air due to natural convection this cooling system is known as air cooling system. According to the law of thermal conductivity, the heat transfer rate is directly proportional to the thermal conductivity of the material and the frontal area of the engine cylinder. Hence to achieve better heat transfer rate it is necessary to increase frontal area of engine which might make engine bulky and reduces the power to weight ratio.

Hence as a solution to this, fins are made on the engine cylinder to increase frontal area without much increase in weight. This fins provide larger contact area between engine cylinder and air and this promotes high heat transfer rate. Fins are usually casted integrally with cylinder or can be mounted externally.

### 1.2 FINS

A fin is extended surface of plates or pins which increase the rate of convection heat transfer by increasing the frontal area of the cylinder which comes in contact with air. The rate of convective heat depends upon the temperature difference and the surface area.

Sometimes it is not feasible to vary those factors as increasing surface area will make engine cylinder more bulky and heavy, and the temperature difference depends solely on atmospheric conditions. Hence the required parameters can be achieved by adding fins in economical way. Fins attached to condenser tubes and

the circumferential fins around the engine cylinder are some examples.

### 1.3 LITERATURE REVIEW

- Prof. M.P. Shah stated that heat transfer rate depends on thermal conductivity of material.
- Bob forty notes that copper fins are superior to aluminium because of copper superior strength, reliability, easy of maintenances.
- Amol B. Dhumne, resulted that the high thermal performance is achieved when we use perforated pin fins than compared to cylindrical pin fins. (Research Gate, JAN 2013)
- Tomasz Wróbel, conduced experiment on bi-metallic casting and resulted the characterization of Bimetallic Castings (Journal of Materials\_Engineering\_and\_Performance, May 2014, Volume 23, Issue\_5, pp 1711-1717)

## 2 BI-METALLIC FINNS

Bi-Metallic fins are made of two different materials. In this research paper we are conducting analysis test on **bimetallic fins** which are made of **aluminum** and **copper**. Copper fins are either **welded** or **integrally casted** with method of bimetallic casting.

### 2.1 ADVANTAGES OF COMPOSITES FINNS

- Have greater stiffness and strength per unit weight.
- Have superior corrosion and fatigue resistance property.
- They are durable.
- High convective heat transfer rate.

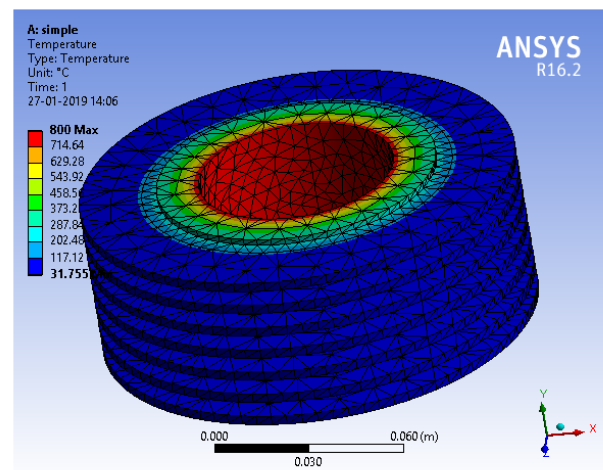
### 2.2 PROBLEM IDENTIFICATION

- If the metal was changed, the cost of production of engine would go up because the production line will add one more stage of joining these fins to the engine. There may be some casting techniques by which on can cast both of them together, but even then the cost of casting would increase.
- If this new material is welded on to the engine, it would change some of physical properties of the cylinder as welding creates a Heat Affected Zone which degrades the quality of the metal.
- A thermal Gradient may also develop between the engine and the fin, which might affect the overall heat transfer coefficient

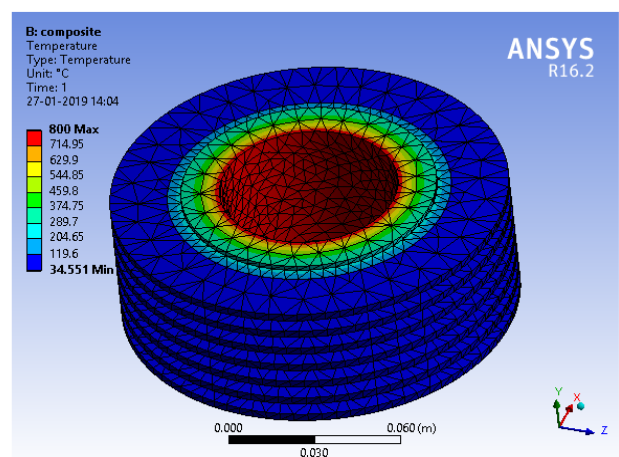
## 2.3 METHODOLOGY

- In this project, we are performing transient thermal analysis on an engine cylinder under certain suitable boundary conditions.
- The cylinder is made of aluminum alloy with integrally made aluminum alloy fins, the integrated fins are partially cut and the copper fins are welded by a lap weld joint
- The copper fins are welded on those partially cut aluminum fins and not directly to the cylinder as the heat produced by welding may degrade the quality of the metal of engine cylinder block
- The lap joint is used instead of regular butt joint so as to reduce the thermal gradient which may produce due to the sudden change in thermal conductivity of these two different metals.

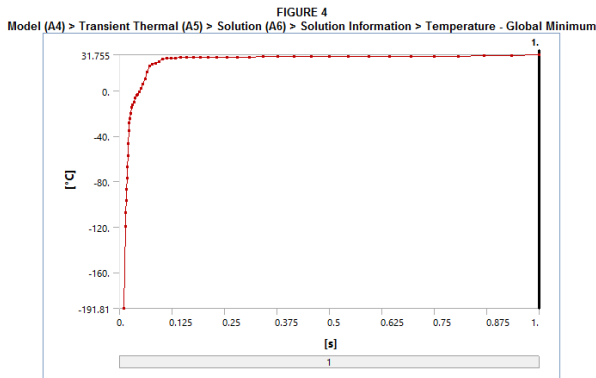
## 2.4 RESULTS.



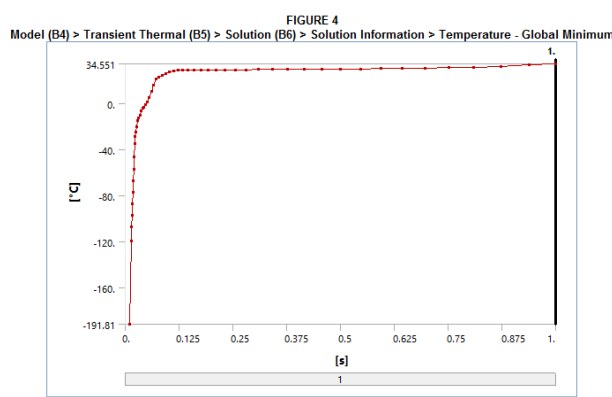
TEMPERATURE DISTRIBUTION OF REGULAR INTEGRATED ALUMINIUM FINNS



TEMPERATURE DISTRIBUTION OF BI-METALLIC FINNS



**GRAPH FOR TEMPERATURE DISTRIBUTION OF REGULAR FINS**



**GRAPH FOR TEMPERATURE DISTRIBUTION OF BI-METALLIC FINS**

As we can observe from the results obtained after conducting the comparative analysis between the regular integrated aluminum alloy fins and bi-metallic fins, there is a better temperature distribution in bi-metallic fins which would ultimately lead in better cooling of the engine cylinder when air impinges on it. The bi-metallic fins would also help in reduced time for heating the engine up to best working temperatures during cold start of the engine. These things may help in getting better thermal efficiency and longer life of the engines.

### 3. CONCLUSION

Hence, by using bi-metallic fins we can get better thermal efficiency and longer engine life. So it is beneficial to use such fins in low capacity engines and other suitable applications. Obviously there is more cost involved in manufacturing of bi-metallic fins as the process of welding is added and also the cost of copper is higher than cost of aluminium. The water cooling system can provide much better cooling but then the cost involved would be much higher. Hence, the bi-metallic fins can be used as a balance between water cooling and

air cooling by traditional fins which can provide better thermal performance at minimal increase in cost.

### 4. SCOPE OF PROJECT

- The thermal performance can further be increased by perforating the copper fins, which would ultimately increase the surface area for the air trapped between the fins and it would also help in weight reduction as during perforating some amount of the material will be removed
- The cost can be reduced by attaching the copper fins by some other means rather than welding. By doing slight modification in the running moulds and the copper fins can also be made integrated by the method of bi-metallic casting.

### REFERENCES

- R. Sam sukumar, G. Sriharsha, S. BalaArun, Modelling and Analysis of Heat sink with rectangular fins having through holes, journal of engineering research and applications (IJERA), VOL. 3, issue 2.
- Deepak gupta, vighneshvenkataraman, rakeshnimje, "thermal analysis of heat sink and its applications in CPU", international journal of emerging technology and advanced engineering, ISSN 2250-2459, VOL. 4, issue 8.
- Tomasz Wróbel, Characterization of Bimetallic Castings with an Austenitic Working Surface Layer and an Unalloyed Cast Steel Base (Journal of Materials Engineering and Performance, May 2014, Volume 23, Issue 5, pp 1711)