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Elemental transient thermal analysis on I.C. Engine Fins Using ANSYS

Ankit Sharma, Shivam Paharia, Mayank Gaur, Yogeshwar Sharma, Prof. Subhash Chandra Pal

Student Department of Automobile Engineering Madhav Institute of Technology & Science, Gwalior, India
Student Department of Automobile Engineering Madhav Institute of Technology & Science, Gwalior, India
Student Department of Automobile Engineering Madhav Institute of Technology & Science, Gwalior, India
Student Department of Automobile Engineering Madhav Institute of Technology & Science, Gwalior, India
Assistant Professor, Department of Mechanical & Automobile Engineering Madhav Institute of Technology & Science, Gwalior, India
Corresponding author: Ankit Sharma

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ABSTRACT: Vehicles havingair cooled engines often face problems of overheating resulting in damage to the engine parts and even stall of a vehicle through ECU cut off. This usually occurs when a vehicle is in stop and go traffic and sometimes on highways where speeds are high and atmospheric temperature is not suitable. The purpose of the study is to increasing the cooling capacity (heat transfer rate) of the engine by increasing the surface area of fins keeping the volume of material same, while trying out different fin shapes providing more exposed area to the atmosphere than the prior ones .

I. INTRODUCTION

Extended surfaces (fins):- Extended surfaces or fins are the extra material provided to the surface of source in order to increase the spread of heat throughout the surface, thus increasing the surface area resulting in increased heat transfer rate through convection.

Natural air cooling: -In normal cases, larger parts of an engine remain exposed to the atmospheric air. When the vehicles run, the air at certain relative velocity impinges upon the engine, and sweeps away its heat. But in cases where there is nearly low or no relative velocity between air and engine parts, there comes the need to provide extended surfaces such that air in contact with hot surfaces gets warm and oozes upwards while allowing the surrounding cool air to take away the rest of heat through convection.

Note: - While making comparison between different shapes of fins, we tried to keep the base area of same so that it won't affect any changes in dimensionless numbers being a barrier in designing fins.

Objective: -1. The main aim of the project is to increase the heat dissipation rate of cooling fins by increasing the surface area while keeping the amount of material constant to prior. This will be achieved by changing the shape (i.e. Thickness) along the length. Thus, greatly increasing the area exposed to atmospheric air resulting in increased convective heat transfer rate.

2. Increased cooling rate will keep the engine working at the desired temperature at much ease than usual.
3. This will greatly reduce the cost of mass production.
4. But the designing process might become to prior fin designs.

Need for project: -In essence of heat transfer from finned surfaces, there are two ways to increase the rate of heat transfer:

(i) To increase the convection heat transfer coefficient h or to increase the surface area As. Increasing convective heat transfer coefficient may require the installation of additional pump or fan, or by replacing the existing one with a larger one, but this approach may or may not be practical. Besides, it may not be adequate.
(ii) The other way is to maximize the surface area by attaching to the extended surfaces called fins which are made of highly conductive materials such as aluminium. Finned surfaces are manufactured by many processes like extruding or welding or wrapping a thin metal sheet on a surface. Fins increases heat transfer from a

surface by exposing an increased surface area to convection and radiation.

Essence of need: A step further in the part race of maximizing the heat transfer performance from finned surfaces, we have done transient thermal analysis on standard fins and trying different geometry (perforated or non-perforated) while trying to reduce or keeping the amount of material same.

After a no. of fin analysis done on heat transfer, a comparison between a collection analyses is made to figure out the most suitable geometry for the system than prior ones. solution will include the following: Temperature distribution over time, Total heat flux and directional heat flux for the detailed comparison between the tests.

Tools Used:

1. Solidworks :- Used for 3-D design of objects which can be used in ANSYS for analysis.
2. ANSYS

Analysis:-

Transient Thermal Analysis Performed On Fins:

No. of tests performed on different fin designs:
1. Rectangular Fin
2. Trapezoidal Fin
   a. Trapezoidal (non perforated) fin
   b. Trapezoidal perforated fin

PREREQUISITE

Material Used – Alluminium Alloy

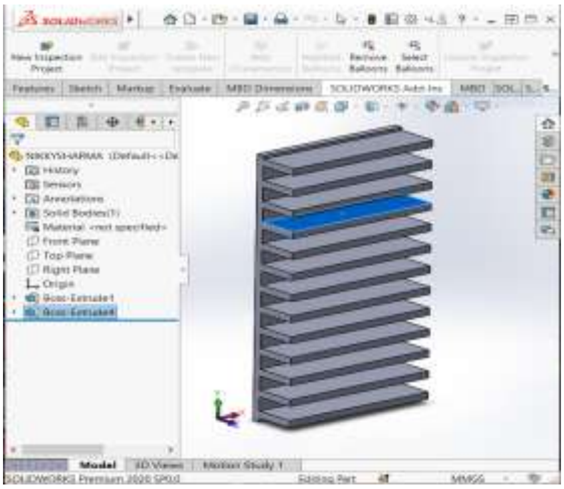
Boundary Condition –

Ambient Temperature - 22℃

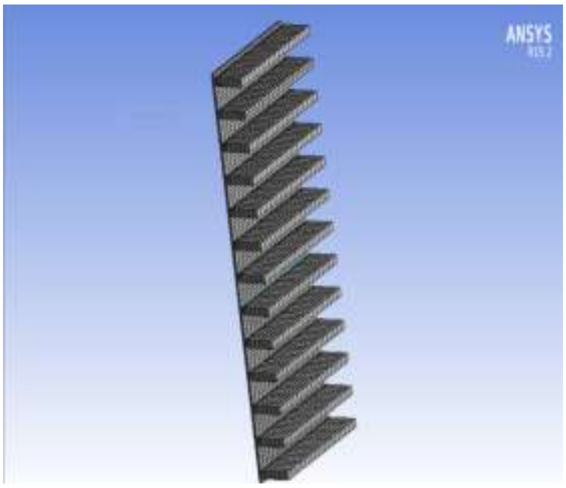
Cylinder Internal Temperature - 200℃

Simulation –

RECTANGULAR FIN



GEOMETRY



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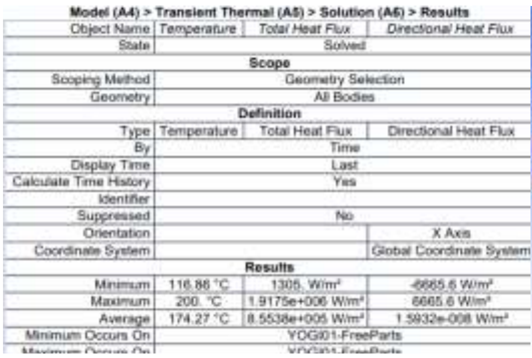
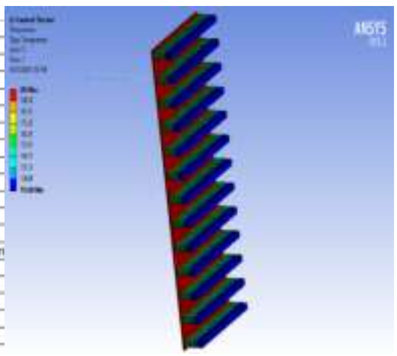


Model (A4) > Transient Thermal (A5) > Solution (A6) > Results

Object Name	Temperature	Total Heat Flux	Directional Heat Flux
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Temperature	Total Heat Flux	Directional Heat Flux
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Orientation			X Axis
Coordinate System			Global Coordinate System
Results			
Minimum	116.86 °C	1305. W/m²	-6665.6 W/m²
Maximum	200. °C	1.9175e+006 W/m²	6665.6 W/m²
Average	174.27 °C	8.5538e+005 W/m²	1.5932e-008 W/m²
Minimum Occurs On	YOGI01-FreeParts		
Maximum Occurs On	YOGI01-FreeParts		

RESULTS



TEMPERATURE

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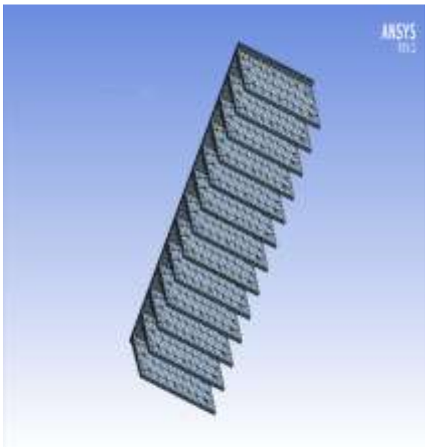
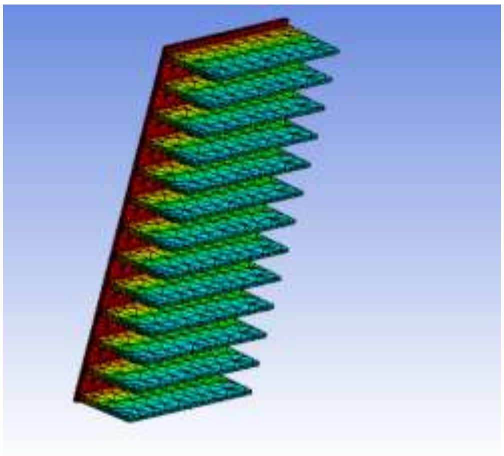
TRAPEZOIDAL FINS



GEOMETRY/MESH



TEMPERATURE

TABLE 14
Model (A4) > Transient Thermal (A5) > Solution (A6) > Results

Object Name	*Temperature*	*Total Heat Flux*	*Directional Heat Flux*
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Temperature	Total Heat Flux	Directional Heat Flux
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Orientation			X Axis
Coordinate System			Global Coordinate System
Results			
Minimum	97.417 °C	2375.2 W/m²	-93476 W/m²
Maximum	200.17 °C	1.61e+006 W/m²	99661 W/m²
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		

TRAPEZOIDAL FINS WITH PERFORATED FINS

result

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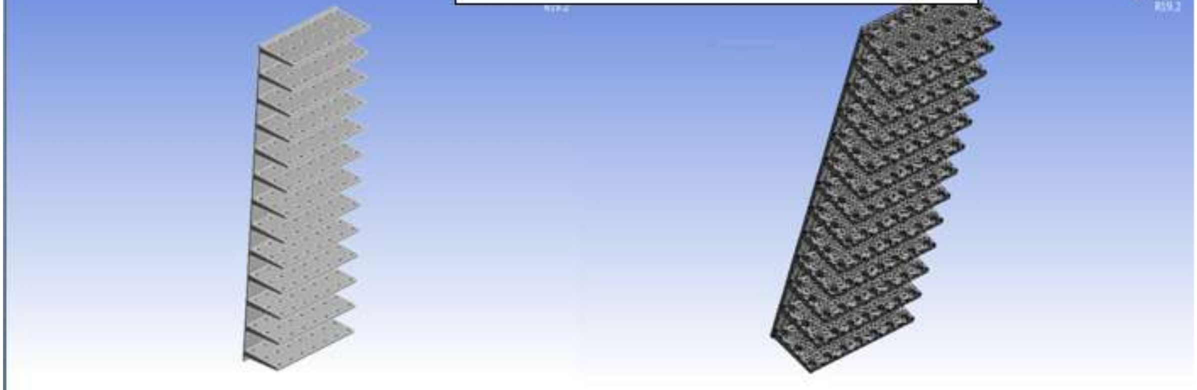
RESULTS



GEOMETRY MESH

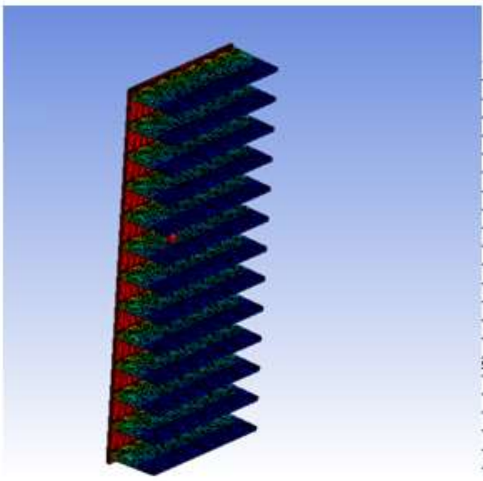


TABLE 14
Model (A4) > Transient Thermal (A5) > Solution (A6) > Results

Object Name	*Directional Heat Flux*	*Temperature*	*Total Heat Flux*
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Directional Heat Flux	Temperature	Total Heat Flux
Orientation	X Axis		
By	Time		
Display Time	Last		
Coordinate System	Global Coordinate System		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Integration Point Results			
Display Option	Averaged		Averaged
Average Across Bodies	No		No
Results			
Minimum	-1.5442e+006 W/m²	89.518 °C	1291.6 W/m²
Maximum	1.5496e+006 W/m²	200.23 °C	3.1308e+006 W/m²
Average	-616.66 W/m²	137.65 °C	1.0198e+006 W/m²
Minimum Occurs On	YOGI03-FreeParts		

TEMPERATURE RESULTS

II. RESULT COMPARISON –

Conclusion –

On the basis of above analysis and their results, we have jumped to the conclusion that by changing the geometry in such a way that will increase the area exposed to atmosphere, resulting in increased heat transfer rate as compare to prior one. This explains by changing geometry or by reducing material (using perforated fins) while keeping the geometry same we can enhance our overall performance notonly by saving amount of material but also by increasing temperature difference. As can be seen from above analysis, trapezoidal perforated fin lands the most appropriate result along with reduced material adding that the cost of mass production will be greatly **reduced.**

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