Frequency Analysis of Radiator Shroud Using FEM

[1]Lokesh Rathee, [2]Naveen Kumar, [3]Rahul Malik
[1]Student,[2]Assistant Professor,[3]Assistant Professor
[1]Department of Mechanical Engineering,
[1]Nameoforganization of 1st AuthorP.M college of Engineering Kami, Sonepat,India

***Abstract* - Today the automobile industry is one of the biggest in the world. In United State, about 12 million people work in the automobile industry and its related business. Burning fuel inside the engine cylinder produces heat. If some of the heat is not removed, metal engine part will melt. Some of the heat helps to push the pistons down the cylinders. This is the useful heat. Some of the heat escapes in the form of hot burn gases that leave engine cylinders. This is wasted heat. And some of the heat removed by the engine cooling system which is also wasted heat. The cooling system removes just enough heat so that the engine runs at a proper temperature. A water pump circulates liquid called coolant between the engine and radiator and cool outside air flow through the radiator. The air picks up and carries away the excess heat. A thermostat help keep the coolant at the proper temperature. A fan helps keep air moving through the radiator.**

I. INTRODUCTION

An automobile radiator has three main parts. These are the core and inlet and out let tanks. The cores are usually made of aluminum. The tank may be made up of plastic and metal. The core has two sets of passage, a set of tubes, and a set of fins attached to tubes. The tubes run from inlet tank to outlet tank and coolant flow through the tubes and air flow between the fins. The hot coolant sends heat through the tube of the fins. The outside air passes between the fins picks up and carry away the heat. This lowers the temperature of coolant. Radiator shroud improves the efficiency by keeping the high pressure air from spilling up over the radiator thus shroud perfectly shaped to fit around the radiator, hood latch and grill. The radiator shroud covers the space on the top and sides of the radiator so that air forced through the radiator. Due to this the temperature reduces up to 10 degree centigrade. By using Radiator shroud the heat removal rate increases due to which the size of radiator decreases or less surface area is required for cooling so size of the radiator becomes compact. Radiator shroud improve the fan performance. It is always preferable to use the shroud.

II.LITERATURE REVIEW

The following sections present a detailed review of the modeling and analysis radiator shroud:

Lawrence P. Ludwig& Francis S. Stepka [1] analyze the heat transfer in composite wall shroud which have ceramic thermal barrier layer surrounded by a porous metal layer which is assembled to a metal base. The porous metal layer help in mitigation of strain differences between the metal and the ceramic for determining the layer thickness required for maintaining the limiting temperature in porous metal layer various combinations of ceramic and porous metal layer thicknesses, porous metal densities and thermal conductivities were investigated. The analysis on composite wall showed that it offered significant air cooling flow reductions compared to an all-impingement air-cooled all-metal shroud

Ngy Srun, Pascal Guerrero and Philippe Jouanny[2] analyze the radiator working, efficiency and performance on the vehicle. On the other side the air velocity through the A/C condenser and its heat performance are two main parameters which will be shown. These studies will be presented for further research work. various geometry influence the cooling radiator performance. The size and position of A/C condenser influence the cooling radiator, The size, power of the electric fan also influence the performance of cooling radiator, the influence of fan shroud and vehicle will also influence cooling radiator performance which includes pressure coefficient, grill, size of air inlet, under-hood, size of under-hood air outlet, without fan shroud, with full fan shroud or with partial fan shroud.

III.NEED FOR PRESENT WORK

(A) Radiator Shroud is generally found to fail due to excessive vibrations. This warrants a rigorous vibration analysis to be carried out for given condition of excitations.

(B) In the quest to achieve near exact result analytically for the purpose of the design of the radiator shroud, the thesis aims to carry out 3-D modeling using CATIA R-12 Software and analysis using ANSYS 8.1 software package.

The thesis model an actual shroud used in automobile and was observed to generally fail due to excessive vibration. The modeling and analysis work of the shroud has been carried out in association work with M/s Sphinx Worldbiz Limited 19-A, Ansari Road, Darya gang, New Delhi-110002 which is a consultancy firm.

(C)1. To develop a general 3-D model of standard shroud using CATIA R-12and carried out FEM modeling and analysis using ANSYS 8.1.

2. To examine the validity of the this analytical model by applying it to the actual shroud data supplied by the consultancy firm M/s Sphinx Worldbiz Limited in term of shroud structure ,material and excitations.

3. To examine the suitability of a new radiator shroud by examine various mode shape of vibration

IV.RESULTS AND DISCUSSION

This report documents a model analysis of the radiator shroud, which was modeled in CATIA R-12 software. Then it was imported from the CATIA R-12 to ANSYS 8.1 (CAE Software) for validating the concept by performing model analysis of radiator shroud

The model was assigned the properties of the material of steel and showed the following results:

Model Information

Table 1 lists the number of nodes and elements and Table 2 lists the properties of the material (mild steel) used in the model. Fig.1 shows radiator shroud i.e. three dimensional model of radiator shroud Fig.2 shows the radiator shroud finite element-meshing model.

Table 1: Details of the Finite Element Model

Radiator Shroud		
Entity	Number Defined	Description
SOLID90	19720	10-Noded Tetrahedron
Nodes	38827	
No. of elements	27586	

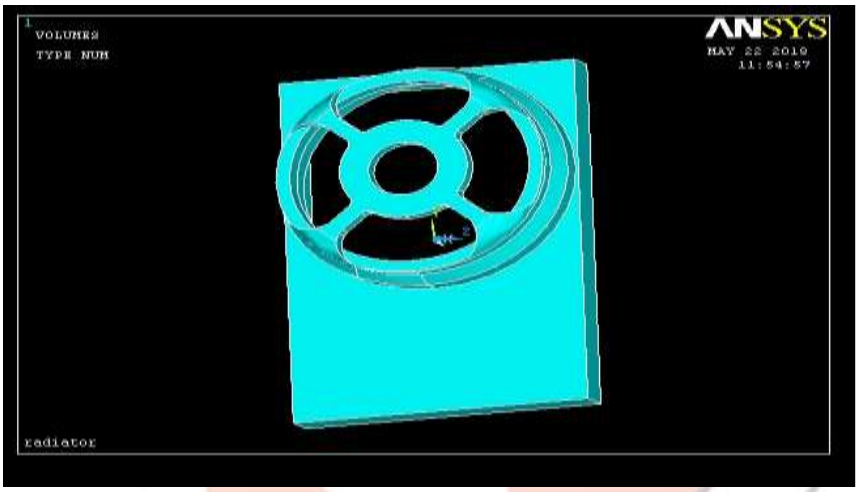

Figure 1 Radiator Shroud model geometry

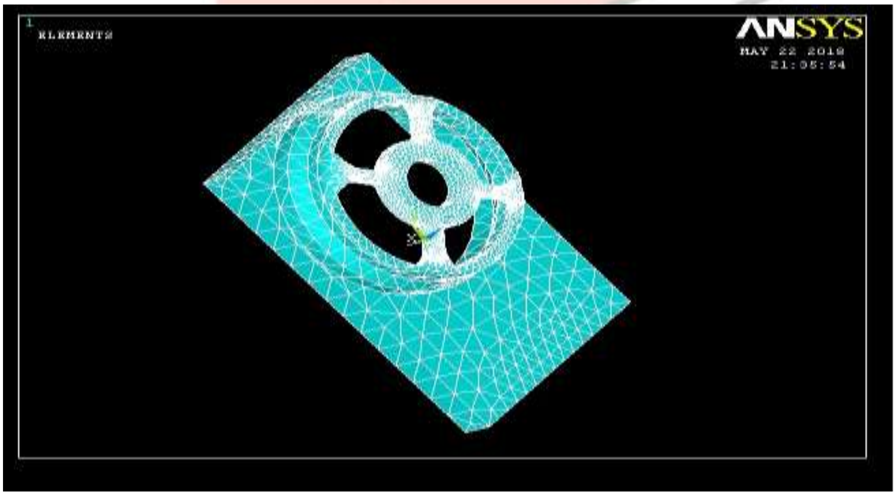

Figure 2 Finite Element Mesh of the radiator shroud

V.ANALYSIS OF RESULTS

The results in terms of deflection and stresses have been found under different mode of vibration scenarios and are discussed here.

Frequency Analysis

The results of radiator shroud having thickness 1.5mm are presented in Table 1 and Figs.3 & 4 from these results it is found that the maximum deflections is 8.7377 mm at the tenth mode shape, natural frequency of 5.266 Hz and 7.3298mm at natural frequency 3.3808 Hz. Fig.3 shows the displaced shape of radiator in the form of color contours.

In ANSYS 8.1 different areas of the radiator shroud occupies different colors, and every color signifies specific information. In any figure of ANSYS results, the color bar has different colors ranging from blue to red via light blue, greenish blue, green, light green, yellow, dark yellow and red. Every color occupies a range of values of stress or deformation. In this bar except red color, all colors exhibits the values of deflection & stresses, which are within permissible limits & this makes the design safe.

Table 2: Material properties Imposed on Finite Element Model

Material	Steel
Elastic Modulus	2 e5N/mm2
Poisson's Ratio	0.29
Density	7600kg/m3
Yield Stress	200 m pa
Ultimate Strength	270-350N/mm2

Table 3: Equivalent deflection at different Mode Shapes radiator shroud

FREQUENCY	**Mode Shape**	**Min. Def.(mm)**	**Max. Def.(mm)**
1.598	1st	.2898	4.449
2.996	2nd	-3.9834	6.4317
3.113	3rd	-3.5104	4.1308
3.381	4th	-2.8883	7.3298
3.979	5th	-2.0055	4.5416
4.11	6th	-2.3364	5.2887
4.645	7th	-4.528	5.1072
4.670	8th	-3.865	5.5769
5.147	9th	-5.2702	6.4987
5.267	10th	-8.3653	8.7377

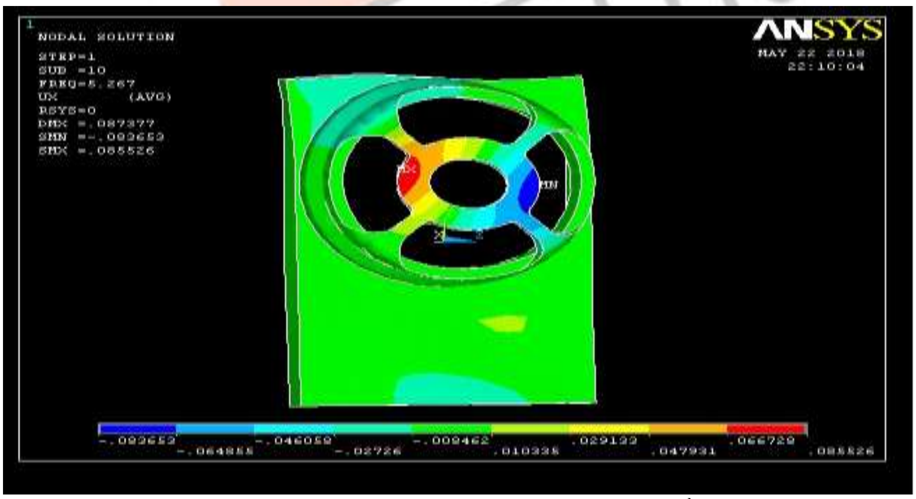

Figure 3 Displaced Shape of radiator shroud in 10th Mode.

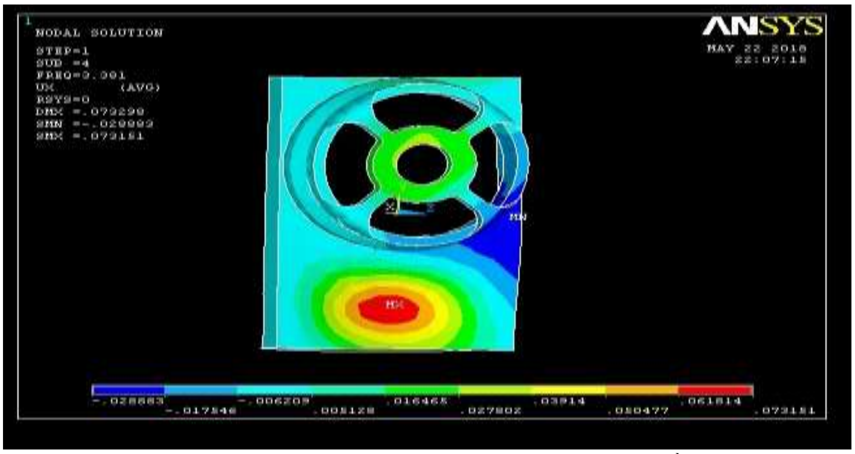

Figure 4 Equivalent contours of Radiator Shroud in 4th Mode

VI.CONCLUSION

Following conclusions are made after the analysis of results:

1. Natural frequency of radiator shroud having thickness 1.5mm lies between 4.67Hz and 5.147 Hz which does not match with the external excitation frequency,hence the model is found to be in safe limits & hence the design of the radiator shroud is acceptable.
2. The thickness of radiator shroud is increased from 1.2mm to 1.5 mm.
3. The creation of surface patches in solid model, which uses 3-D coordinate & 3-D elements yield very accurate results unlike those which are achieved by using the traditional 2-D approach.
4. Through the use of an engineering analysis tool such as ANSYS, dramatic improvements of the cost and performance of a system may be achieved. Analysis used for understanding instead of analysis used for checking or verifying a design is the key to success. This implies that giving CAD systems information from analysis tools should be the focus of the design process instead of using CAD models as FE-models

Verification of the ANSYS 8.1 Results

It has been found and observed from the CAE results that the existing design of the radiator shroud is safe for the given external excitation frequency here with the results obtained by the prototype testing.

These prototype-testing results are obtained directly from the consultancy company" M/s Sphinx Worldbiz ltd." for radiator shroud of material steel The Tables 4 shows the comparison between the CAE and experimental results.

Table 4: Comparison of CAE Results of frequency analysis of the Radiator Shroud having thickness 1.5mm and radiator shroud having 1.2mm thickness

Natural Frequency(Hz) in between 8th mode & 9th mode for the model having thickness 1.5mm	Natural Frequency(Hz) in 8th mode for the model having thickness 1.2mm
4.670 & 5.147 Hz	**4.850 Hz**

This is quite evident from the comparison that the results obtained from the ANSYS 8.1 that the natural frequencies of new model having thickness 1.5 mm does not match the frequency 4.85 Hz of Old model having thickness 1.2mm. Hence this is concluded that the results obtained from ANSYS 8.1 are truly valid and hence can be applied in the industry without any discrepancy.

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