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Acoustic Analysis and Material Optimization of a Bike Intake Airbox

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ABSTRACT

In this thesis, a motor bike intake air box is analyzed for reduced noise from the engine. Different configurations of the intake air box are considered and investigated for the reduced noise by analysis. Aluminum alloy and E-Glass Epoxy are taken as air box materials. 3D models of the original and modified configurations of intake air box are done in Creo 2.0.Acoustic analysis is performed in CFD Fluent in Ansys 14.5 to determine acoustic power levels and pressure for all models and compared for the optimal model.

INTRODUCTION

An air box is an empty chamber on the inlet of most combustion engines. It collects air from outside and feeds it to the intake hoses of each cylinder.

Older engines drew air directly from the surroundings into each individual carburetor. Modern engines instead draw air into an air box, which is connected by individual hoses to each carburetor or directly to the intake ports in fuel-injected engines, thus avoiding an extra intake manifold. The air box allows the use of one air filter instead of many. Developments arising from concerns about environmental effects during the late 1970s allow the air box to collect pump gases from the crankcase and the tank air vent and re-feed them to the engine.

Older engines drew air directly from the surroundings into each individual carburetor. Modern engines instead draw air into an air box (an air intake chamber), which is connected by individual hoses to each carburetor, or directly to the intake ports in fuel-injected engines. This allows the use of one air filter instead of many, and allows the designers to exploit the properties of air to improve performance.

Acoustics origins began with the study of mechanical vibrations and the radiation of these vibrations through mechanical waves, and still continue today. Research was done to look into the many aspects of the fundamental physical processes involved in waves and sound and into possible applications of these processes in modern life. The study of sound waves also lead to physical principles that can be applied to the study of all waves. Applications of acoustic technology include music and the study of geologic, atmospheric, and underwater phenomena. Psychoacoustics, the study of the physical effects of sound on biological systems, has been of interest since Pythagoras first heard the sounds of vibrating strings and of hammers hitting anvils in the 6th century BC, but the application of modern ultrasonic technology has only recently provided some of the most exciting developments in medicine. The ear itself is another biological instrument dedicated to receiving certain wave vibrations and interpreting them as sound.

Key features

- Prediction of radiated intake and exhaust noise with source interaction and flow noise effects fully captured
- Moving sources and/or microphones with accurate Doppler shift
- Add custom noise transfer functions to predict interior noise
- Full control over data acquisition and signal processing settings
- All common acoustic plots available:
  - Colour maps, waterfall, order tracking, various 2D SPL plots
  - Frequency resolution/range user-defined to closely resemble plots from lab analysis systems
  - Order/frequency cursors aid identification of problems

Noise Prediction for Air box

Reduction Methods for Intake Noise Methods for reduction of noise are largely divided into 3 types, which include the method of installing a resonator, the method of using a sound-absorbing material, and application of a particular groove shape at compressor inlet. Recently, as studies on optimum design of resonators are being actively conducted to enhance completeness of vehicles, those include porous duct capable of reducing the number of resonators for intake system albeit a high production unit cost and reverse flow-type silencer where a resonator applied to air cleaner interior is attached without outside exposure of the resonator. Also as a measure for optimum improvement of intake flow sound, diversified studies are being c onducted on optimum shapes of the groove positioned at the compressor inlet.

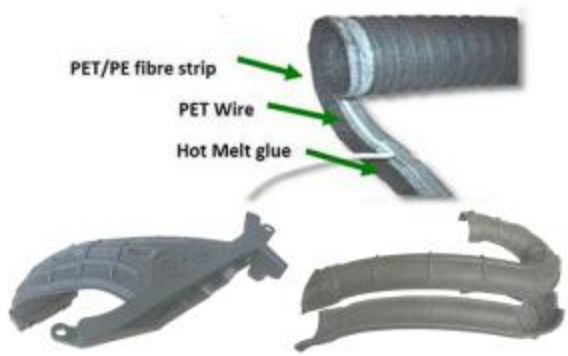

Figure 1: Porous type duct of intake system

Figure 2: Resonator of air intake system

LITERATURE REVIEW

In this work done by Gianluca Montenegro, Augusto Della Torre [1]. The approaches developed and applied for the optimization process range from the 1D to fully 3D CFD simulation, exploring hybrid approaches based on the integration of a 1D model with quasi-3D and 3D tools.

In this work done by M. L. Munjal [2], Recent Advances in Muffler Acoustics. This review paper deals with evaluating approximate source characteristics required for prediction of the unruffled intake and exhaust noise, making use of the electro acoustical analogies.

In this work done by Jongwoo Park [3] Tire noise, road noise, wind noise, combustion noise, inhalation noise, etc. impacted the interior noise of an automobile. Automobile companies have worked hard to reduce the interior noise and now we have comparably less vehicle interior noise. However, the engine miniaturization and the equipment of turbochargers act as a noise source in certain sections these days.

In This paper done by K.L.Srinivasulu , D. Srikanth [4] Air filter system play major role in getting good quality air into automobile engine. It improves the combustion efficiency and also reduces air pollution.

In this work done by 1A.S.Phulpagar[5] CFD Analysis of Air Intake System. .This paper focuses on computational fluid analysis of an intake system in automobile industry to predict the pressure drop.

3D MODELING AND ANALYSIS OF AIR BOX

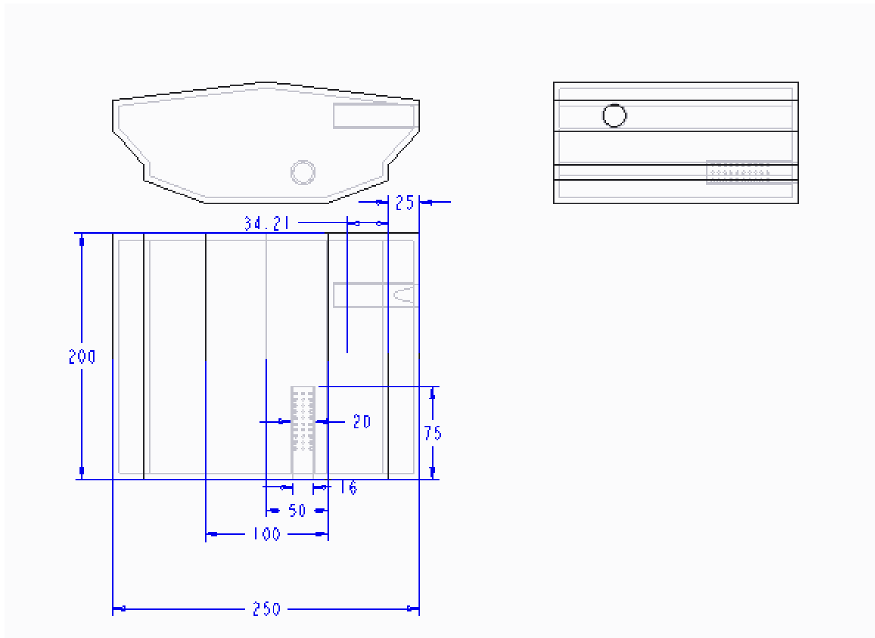

Fig:- Drafting of the original model

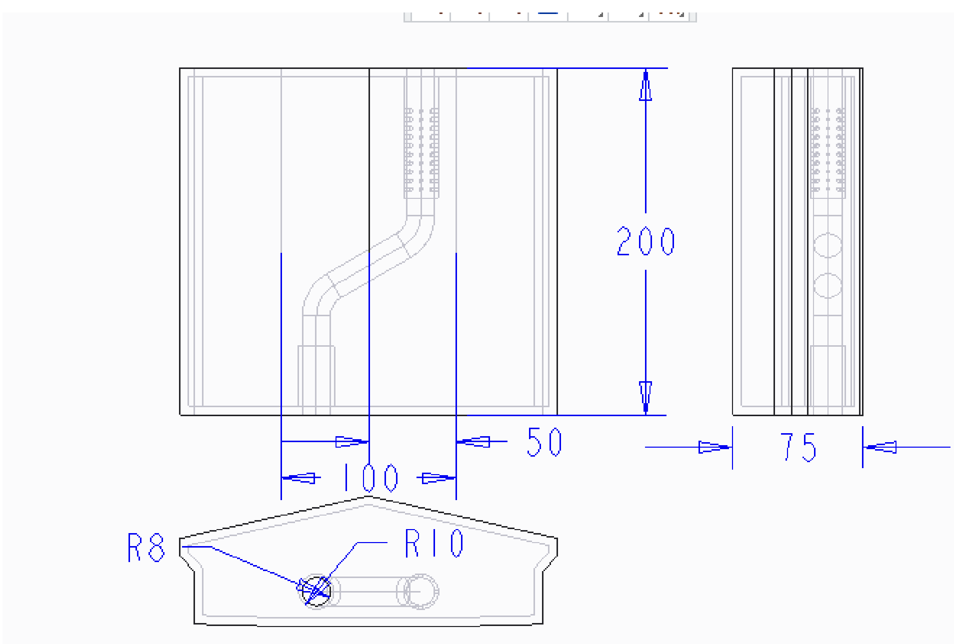

Fig:- Drafting of the modified model

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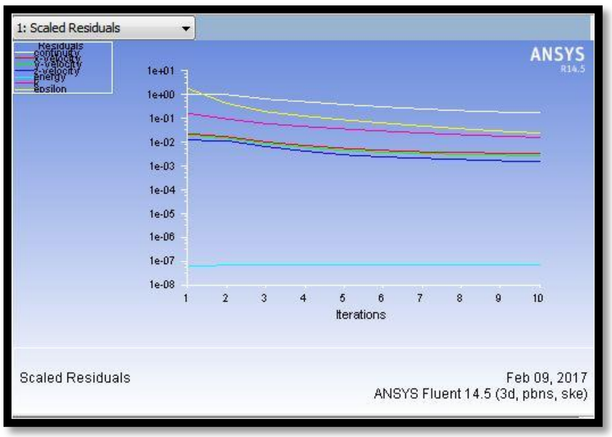
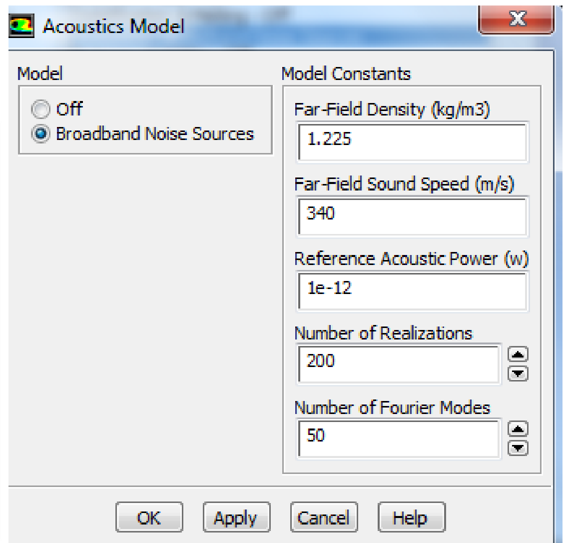
ACOUSTIC ANALYSIS

Inlet boundary conditions for the analysis:- Mass flow rate : 0.3 kg/sec, Temperature: 300 K and pressure is 1 bar. Fluid is passes through the air-box is atmospheric air at normal boundary condition.





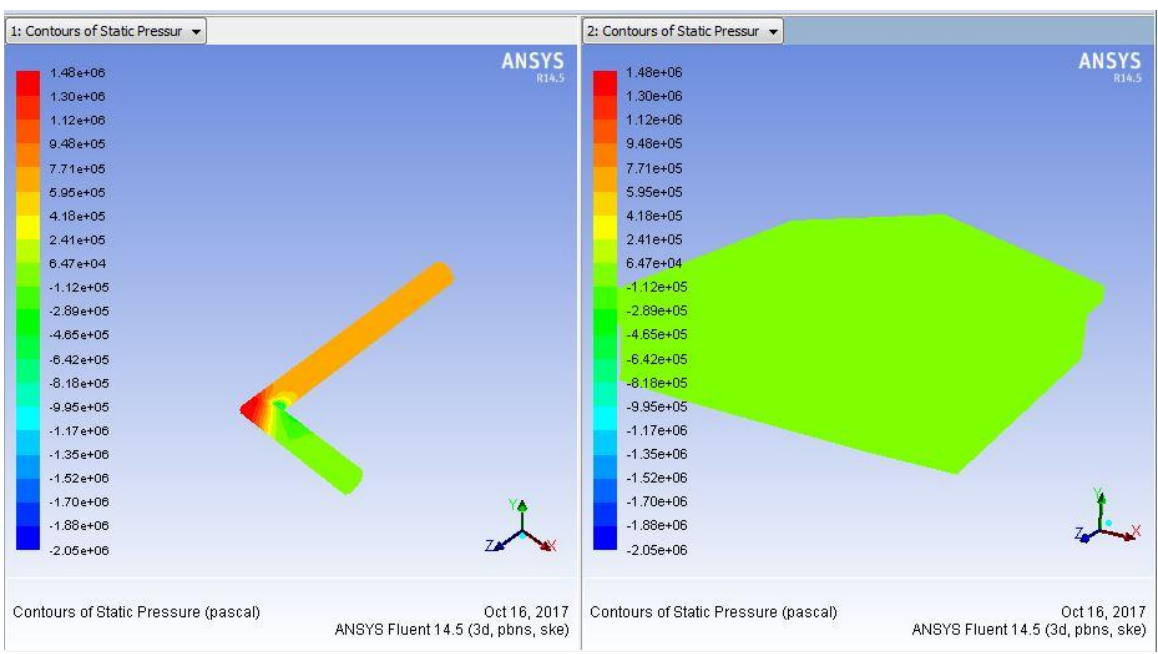


Fig: Pressure obtained when aluminum alloy material is used

The overall pressure is 1.48 e+08 pa obtained at fluid corner area and we observe overall pressure maintained is 2.41e+05 pa

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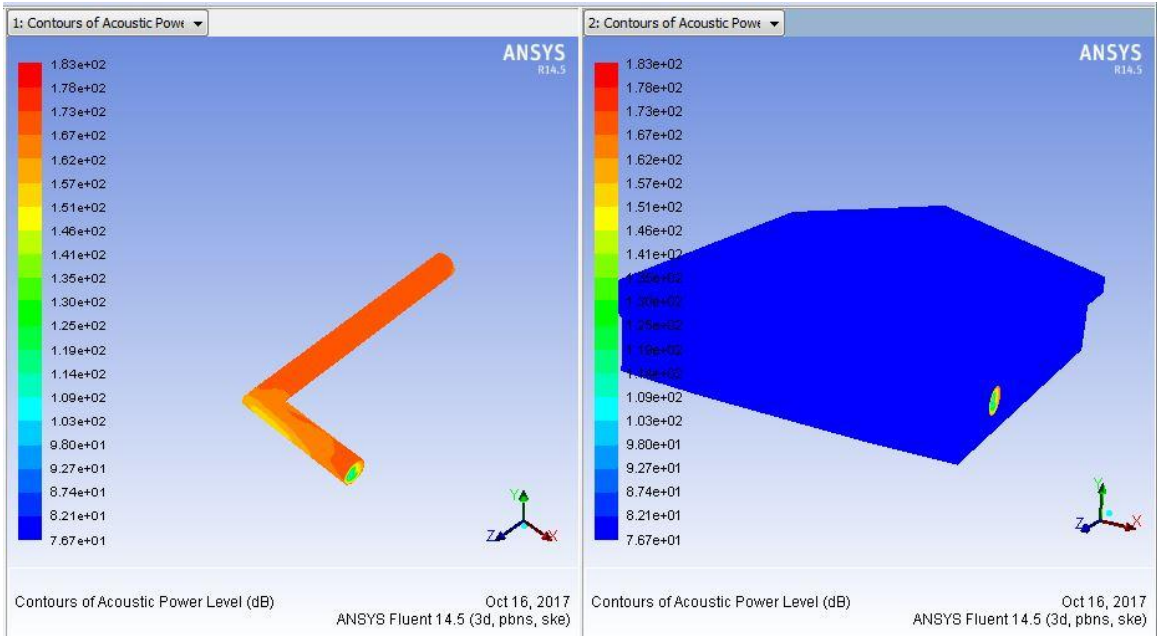


Fig: Acoustic power obtained when aluminum alloy material is used

The acoustic power level (dB) is maximum 183 dB at fluid path and minimum is 70.7 dB at outside view of airbox

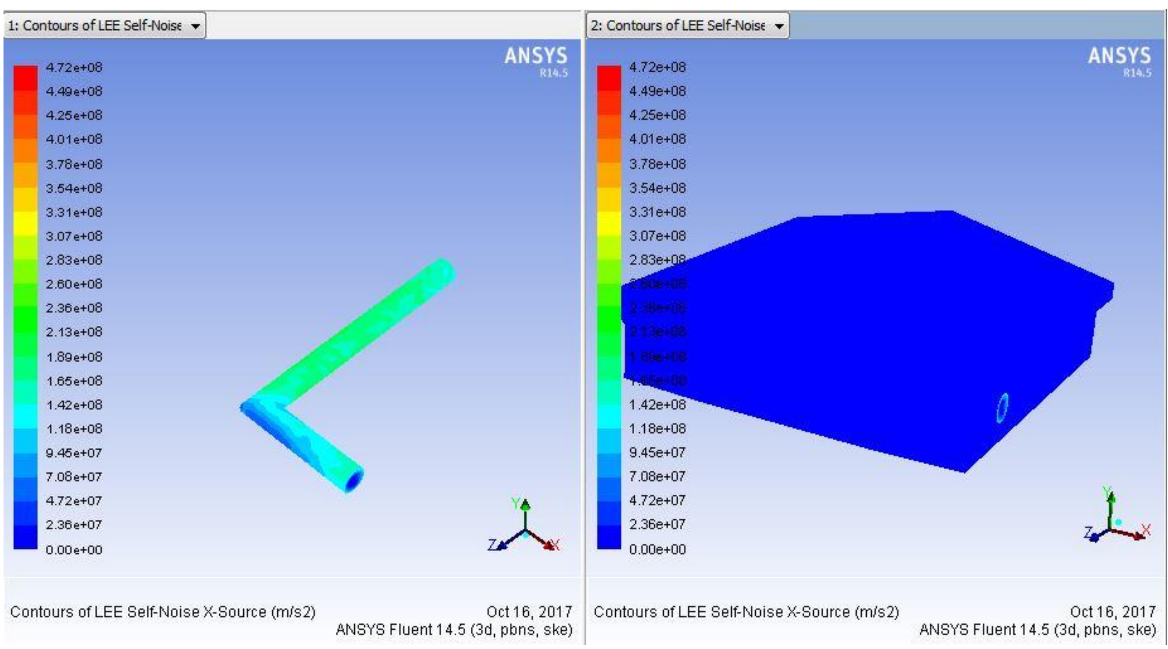
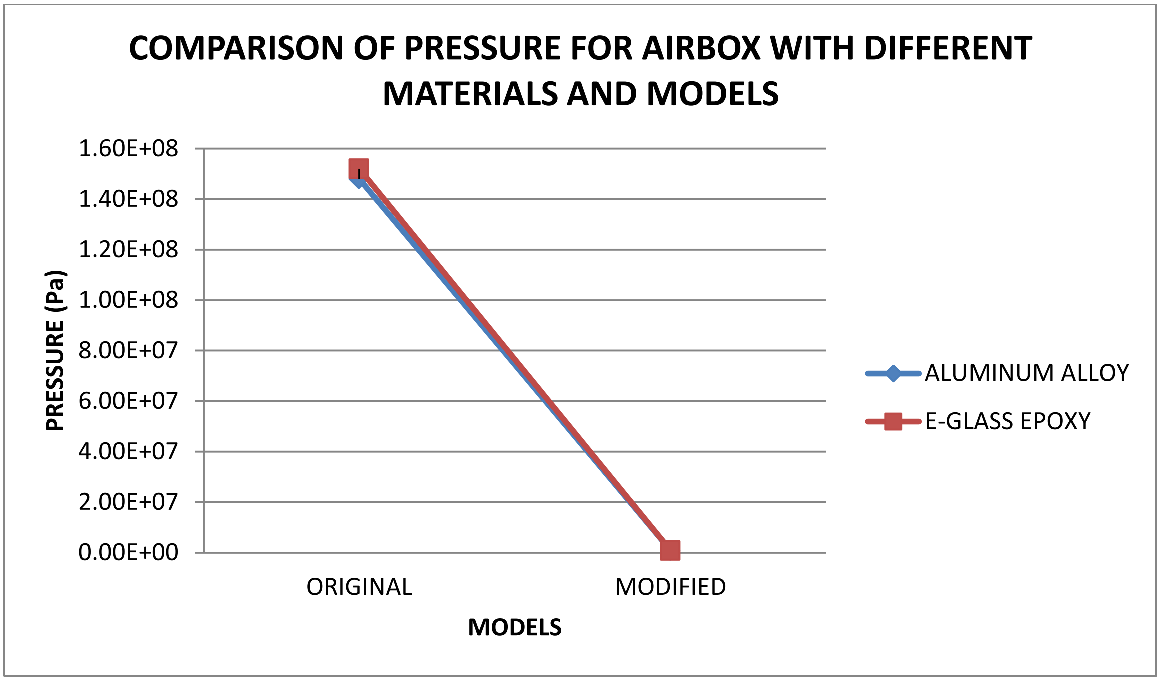
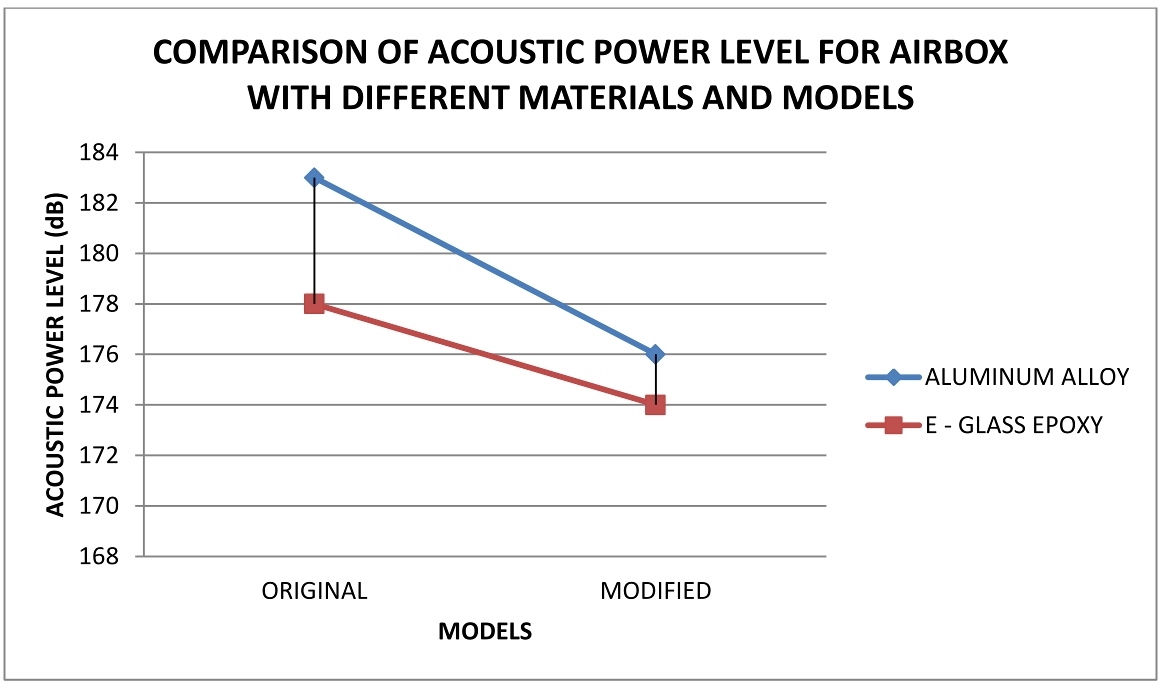


Fig: Noise level obtained when aluminum alloy material is used

The LEE noise source is maximum 4.72e+8 m/s^2 at particular area of fluid path and minimum is 2.38e+7 m/s^2 at outside view of air box

RESULTS - GRAPHS





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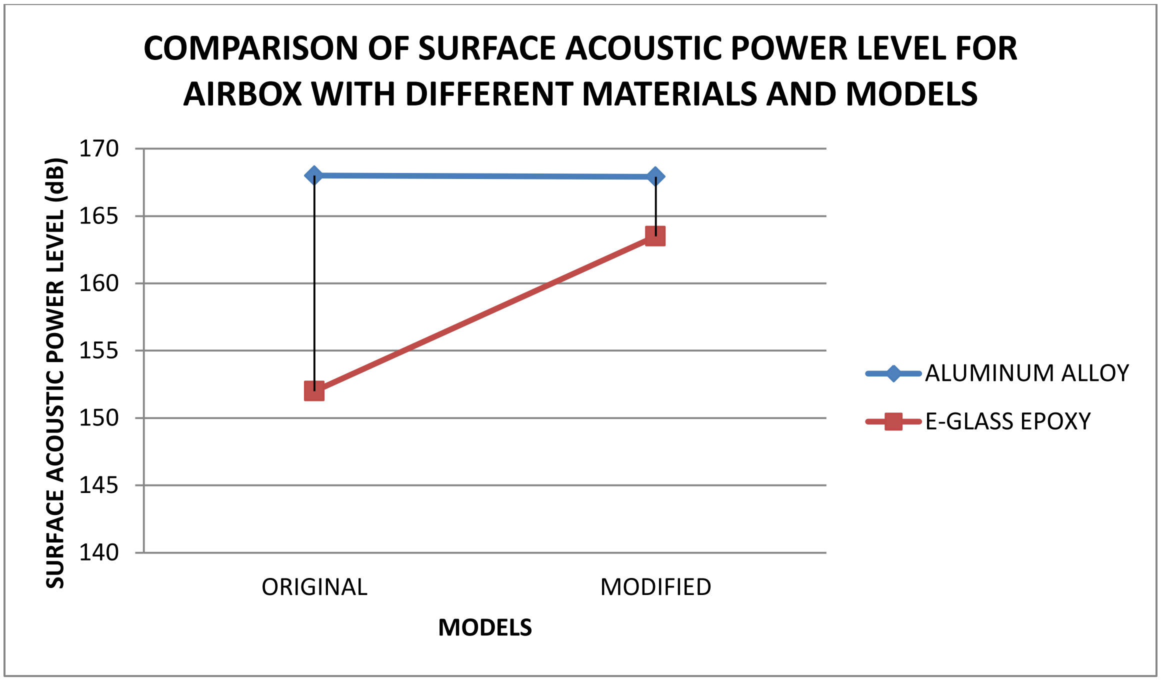

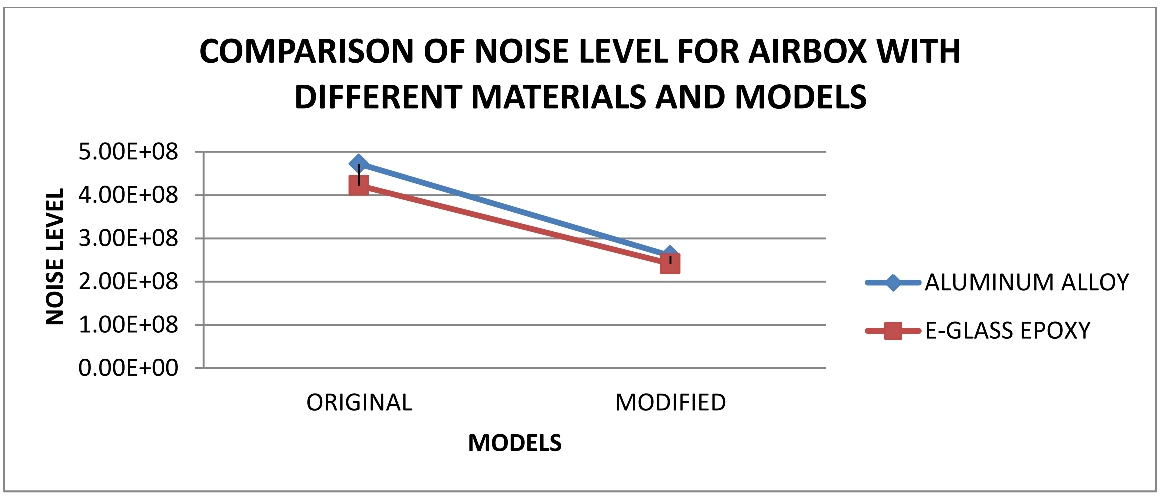

CONCLUSION

By observing above result table, we can say that

1. Considering pressure(Pa) result
   a. The aluminum alloy material is taken and used for the air box, by observing results for original and modified model, 99% of pressure is reduced for the modified model.
   b. The E-glass epoxy material is taken and used for the air box, by observing results for original and modified model, 99.2% of pressure is reduced for the modified model.
   c. Now, comparing aluminum alloy and E-glass epoxy, the pressure is increased by 2.6% for E-glass

for original model and for modified model increased by 1.23% for E-glass.

2. Considering Acoustic power level (dB) result
    d. The aluminum alloy material is taken and used for the air box , by observing results for original and modified model, 3.82% of dB is reduced for the modified model.
    e. The E-glass epoxy material is taken and used for the air box , by observing results for original and modified model, 2.2% of less dB for the modified model.
    f. Now, comparing aluminum alloy and E-glass epoxy, the Acoustic power level (dB) is decreased by 2.7% for E-glass for original model and for modified model decreased by 1.13% for E-glass.

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