

REVIEW OF ACOUSTIC ENCLOSURE FOR NOISE CONTROL IN DIESEL GENERATOR**R. Dhanasekaran*, A. S. Anirudh**, Ch. Sai Kiran*** & S. Sreenatha Reddy******

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Abstract:

The developments in commercial and industrial sectors have raised the requirement of alternate power supply for uninterrupted workflow. The diesel generators sets used for such purposes are usually of larger power output, which produce a noise levels of 110-170dB (decibel). As the sound levels exceed acceptable standard range there is a need to reduce the noise generated. Furthermore due to continuous usage of such heavy machinery the heat developed at the system is quite high which effects efficient working of machinery. The proposed design of acoustic enclosure helps to reduce the noise generated and controls the ambient temperature for optimal working of the generator set. The use of multiple layer composite wall construction for reduction of sound and proper venting for cooling of the system is majorly focused.

Key Words: Acoustic, Noise Attenuation, Exhaust & Diesel Generator

1. Introduction:

These days necessity of electric power in domestic, commercial and industrial sectors have become so important that its absence becomes difficult to continue the daily living. Frequent power cuts made it necessary to develop an alternate power source, mobile electricity requirements and necessity of electricity to places that are not connected to grid are few other factors considered in development of alternate power generators. Use of diesel engine power to generate electricity was found to be the best solution for alternate power supply as diesel as fuel is cheap and would develop high power output when compared to others. Even small power cuts lead to huge losses in commercial and industrial sectors, where a substitute power supply is necessary where diesel generator was found to be best option. Diesel engines could develop higher power output to the unit volume of fuel as compared to other fuels, even the cost of fuel is cheaper. Thus diesel engines have multiple advantages but it is associated with few complications.

Diesel engines have compression ignition system with multiple cylinders and number of components moving at very high speed, as a result there is loud noise produced. In addition to this radiator, cooling system, exhaust system and alternator add more noise to the ambience. A generator adapted to commercial or industrial purpose where power requirement is high the generator machinery is heavier leading to louder noise. Usually generator sets of 125KVA-2000KVA produce noise around 110-170 decibels, these noise levels are very high from standard acceptable range which is about 70 decibels [4] and are polluting the environment [8, 3, 9]. There are several experiments being conducted regarding the reduction of vibrations generated by diesel generator by the use of biodiesels instead of conventional diesel [12, 7]. The aim of this project is to build an acoustic enclosure which could restrict the noise generated during the working of diesel generator to acceptable range and to terminate the problem associated with the enclosure, which is to provide proper ventilation to the generator set, as on working engine would develop high temperatures which would decrease the working efficiency of the generator set. Hence an optimal plan for ventilation is made to drive the hot fumes and cool the generator to reach the best working conditions of the diesel generator set.

2. Diesel Generators:

Diesel generators sets are AC power supply sources which generally are compression ignition engines where power is produced from combustion of fuel used to drive shaft which is linked to the alternator to generate electric power. The radiator is fixed on the other side of engine in order to dissipate heat produced and to meet better efficiency and nonstop working at optimal conditions. The complete assembly is mounted on to a rigid setting as shown in the Figure 1



Figure 1: Industrial Diesel Generator

3. Source of Noise:

An unpleasant and disturbing sound that makes the living environment very uncomfortable is called noise. Generation of such sound is basically from a vibrating body. As in case of diesel generator, vibrations are generated due to very fast moving parts [5], radiator and alternator. Compression ignition of a diesel engine should also be considered as a vibration source.

4. Resolution of Problem:

A. Introduction: Noise limitation can be achieved by blocking vibrations arising from the machine. Vibrations from the machine can be restricted by using rubber mount between the different parts of the facility and the basement, which functions as a cushion and further limits overtaking. It is important to build a basement that would absorb most vibrations and restrict them from passing through the enclosure wall.

B. Design and Construction of Composite Wall: The proposed solution describes the design of an acoustic enclosure. Composite walls are designed and portrayed with the aid of design software based on the theory and calculations made. The wall core that limits high levels of noise is made using a compact fiber material called mineral wool. Mineral wool is a porous insulation material used for various purposes such as insulation material, acoustic insulation material, filtration material, packing material, gasket filling material. This mineral wool fiber is about 4 μm in diameter and is made from different synthetic materials like mineral slag and ceramics or fiberglass. Asbestos is volcanic stone dolomite, diabase and basalt, glass wool is sand and glass slag. Selection of mineral wool depends not only on the material from which it is made but also on the density required. The wool considered in the design is rock wool with a density of 64 kg - 96 kg depending on the level of noise being restricted. The power of the sound to be attenuated depends on the machine and the environment. Like mineral wool, there are various sound absorbing materials such as wood wool cement board [1], thermocol, rubber pad, polyurethane foam, coconut fiber pad [6]. The property of this wool material is to confine a small amount of air between the fiber layers acting as a cushioning material and the frequency generated by the vibration is absorbed by the wool slab.

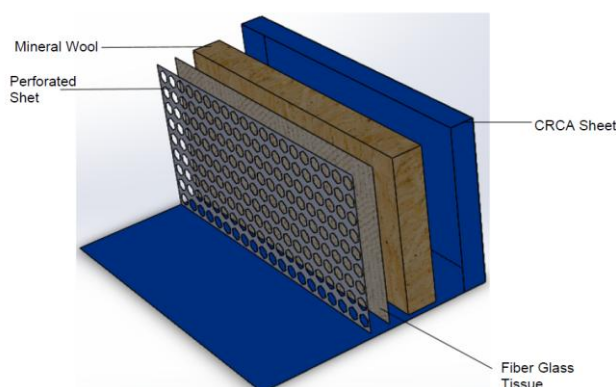


Figure 2: Different layers of composite wall

This rock wool slab is covered by nonwoven type fibre glass tissue works as a reflecting acoustic insulator and as thermal insulator, it also helps to protect the core of the construction. They are sandwiched between cold rolled close annealed sheet metal of 16gauge from outer side and by perforated GI sheet of 0.5gauge from the other. The perforated sheet acts as the one of the major barrier for the sound from reaching the core of the construction. Acoustic impedance of micro perforated sheets confine air vibrations interacting with it thereby reducing the resonance [2] inside the enclosure. The layers of perforated sheet, fibre glass tissue paper, mineral wool and CRCA sheet are arranged to form a compact acoustic wall. This wall construction is used to enclose the diesel generator set on five sides. Use of silicon rubber sealant between the joints of the wall would prevent any unnecessary vibrations. Diesel generator set is to be placed on specially constructed concrete basement to avoid transfer of vibrations to the enclosure body.

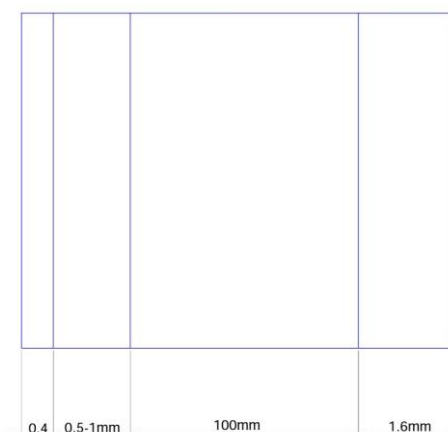


Figure 3: Varying thickness of the composite wall

Table 1: Thickness of different materials used

No	Material	Thickness in mm
1	CRCA Sheet	1.6
2	Mineral Wool	100
3	Fiber Glass Tissue	0.5 - 1.0
4	Perforated Sheet	0.4

C. Design for Exhaust: High temperature gas generated from engine combustion is drawn out completely from the enclosure with a special duct structure. The muffler itself is designed to attenuate the sound. There is a flow restriction plate on the muffler to restrict vibration of the sound and the orifice to these plates to discharge hot gases.

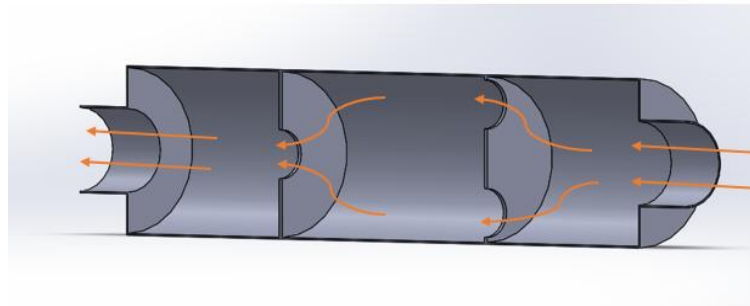


Figure 4: Cross sectional view of silencer

D. Design for Ventilation: As we know, when there is heat generated from working machinery added due to the restriction of noise to the external environment, the generated sound energy is converted to heat energy and dissipated [10]. Thermal energy constrained by the enclosure in the atmosphere of the machine may reduce the efficient operation of the machine and may also stop unacceptable devices. Improper ventilation will lead to:

- ✓ Poor performance of diesel generator Set
- ✓ Fuel efficiency decreases.
- ✓ Poor reliability
- ✓ Premature failure of engine motor, the alternator and the electrical components.
- ✓ Intolerable running conditions due to higher room temperature.



Figure 5: Acoustic Enclosure

The maximum cylinder head temperature allowed as defined by original equipment manufacturer is around 270°C [11] but it has to be maintained at least operate able temperature to meet its expected working lifetime. The temperature raised due to employment of acoustic enclosure.

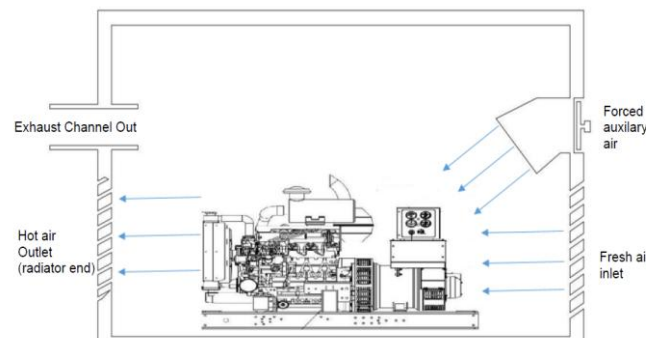


Figure 6: Design for Ventilation to diesel generator through acoustic enclosure

A solution to the related problem is achieved by designing the ventilation in the enclosure so that fresh air always flows over the machine which must cool the machine and carry the hot air in the enclosure to the external environment . In order to obtain such an air flow, the louvers are provided at the two ends of the generator installed i.e., on the radiator side and the alternator side. These acoustically designed louvers absorb the sound and provide an appropriate air flow. Optimum cooling air intake on the radiator side 2500 m³ / mm cfm. The louver are formed similar to composite wall, i.e., CRCA sheet filled with mineral wool sealed with tissue and perforated sheets. They are designed and fixed at an angle and distance. The angle between them limits the sound but lets out hot air. The louvers are fixed to the radiator side and the louvers on the side of the alternator are

useful for taking in fresh air, as hot air can flow out of the enclosure due to the forces generated by the radiator fans. The requirement of free space around the enclosure must be as described in Table 2

Table 2: Free air Space requirements for DG set acoustic enclosure

No	Description	Spacing in meters
1	space on both sides	Min. 2 m
2	Free space at Radiator side	Min. 3 m
3	Free space at Alternator side	Min. 2 m
4	Fresh air inlet opening area	Min. 1.5 times of the Radiator area
5	Hot air discharge opening area	Min. 2.5 times of the Radiator area



Figure 7: Acoustic Enclosure for Mobile DG Set

5. Conclusion:

The design and construction of acoustic enclosure to attenuate noise generated above acceptable standard levels by a diesel generator is discussed in this paper. The selection of materials used in the construction of the composite wall and the properties of those materials in the perspective of reduction of noise generated is conferred and the associated problem of rise in temperature inside the enclosure has been solved by providing optimal ventilation design to the diesel generator set. The built design has reduced the noise levels to the acceptable standard range, the reduction of noise can be achieved by varying the thickness of the sound absorbing material as mineral wool used in above case. The investment made in the manufacturing and assembling the enclosure is worth as it would provide the best solution for the concerned problem. Further research regarding the selection of better absorbing material which can attenuate to required levels of sound at minimum thickness and cost, with even superior thermal properties to achieve improvised results has to be made.

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