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Noise Control Solutions for Diesel Generator Sets

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Abstract

A persistent challenge for Oman's energy infrastructure was the deafening rumble of diesel generators. The Silent Generator Project addressed this challenge, developing advanced generators that deliver power quietly and efficiently. Diesel generators have historically been notorious for being noisy and vibrational, making them unsuitable for sensitive environments. To dramatically reduce noise levels, the project utilized innovative materials and design modifications to ensure reliable and quiet electricity for various applications. In all directions, the project advanced the knowledge of noise reduction through rigorous testing and meticulous integration of insulators and mufflers. As a result, quieter, more sustainable energy production is on the way, marking a major advance in silent generator technology. Furthermore, the Silent Generator Project lays the foundation for more efficient and environmentally friendly diesel generator technologies in the future. As a result of this research, a new standard for quieter, greener energy generation is established, demonstrating the critical role noise reduction plays in energy generation. Additionally, this work also suggests future diesel generator technologies that are more efficient and environmentally friendly. As a result of this research, a new standard for quieter, greener energy generation is set, demonstrating the critical role noise reduction plays in energy generation.

Keywords

Diesel Generator, Noise Control, Design Solution, Silent, Temperature, Sustainability

1. Introduction

Standby diesel generators, also called backup diesel generators or emergency

diesel generators, are designed to provide electrical power during power outages or when there is no main power supply available. The emergency engine is critical to military operations and is used to provide reliable backup power on a variety of occasions, to mitigate Power outages, blackouts, and disruptions of the energy supply to ensure that essential functions and operations are not compromised [1]. For example, in medical facilities especially in powering critical medical equipment, operating theatres, life support systems, refrigeration for medicines, and maintaining a high level of security and surveillance even during power outages or disruptions. Some common problems are associated with diesel engines, for instance, GHG emissions and air pollution and their impact on human health and the environment. Moreover, high levels of noise and temperature that generated by the engine's internal components [2].

1.1. Problem Definition and Technical Review

Initially, attempts were made to start the diesel generator, but it failed due to poor maintenance. Technical assistance was then sought to address maintenance issues that hindered the proper functioning of the engine. During this process, faults in certain coils were identified, leading to the replacement of the malfunctioning coils with new ones. While working on the generator, it was discovered that infrequent usage and air entering the fuel tank caused fuel to return to the tank. To initiate the generation process, the generator was switched on multiple times to release the trapped air from the fuel tank [3].

Upon completing the generator's maintenance, efforts were made to measure the generated noise. Unfortunately, the workshop lacked a sound measuring device, necessitating the exploration of alternative options. A mobile application capable of measuring sound was identified as a suitable substitute [4]. To address the issue, the team researched various sound measurement applications and selected the most appropriate one. This allowed for the replacement of the unavailable noise-measuring device. Overall, through troubleshooting and finding alternative solutions, the challenges related to the diesel generator's maintenance, noise measurement, and sound analysis were successfully addressed [5].

1.2. Goal and Project Description

The primary aim of this project is to explore and propose effective solutions for isolating the noise generated by a diesel generator. The focus is on utilizing materials with high noise insulation capacity, while also seeking guidance from specialists in the field. The noise isolation approach involves employing sound-absorbing rubber and cork, along with covering the exhaust sound while maintaining a small opening.

To validate the efficacy of the sound insulation work, comprehensive testing was conducted before and after the modifications. Measurements of sound levels and temperatures were taken at various distances to identify and compare the differences. These tests were crucial in ensuring the project's success and verify-

ing the efficiency of the implemented sound insulation techniques.

2. Test and Performance

Cork was chosen as the material of choice for different reasons. Its lightweight and flexible nature allowed us to shape it according to our needs, even accommodating the curved surfaces of the diesel generator's outer structure. Additionally, cork possesses excellent insulating properties for sound, heat, and vibration. Consequently, upon the installation of the cork, we observed noticeable changes in the temperature of the generator's external structure and a reduction in sound intensity [6].

The decision to utilize cork in this project was inspired by its successful application in buildings where it serves a similar purpose of sound and heat reduction. To further enhance soundproofing, we incorporated soundproof rubber along the perimeter of the doors to prevent sound leakage through the door edges. This type of rubber is often a thick neoprene material, commonly found in wetsuits for insulation against cold temperatures.

In order to achieve a strong between the cork and rubber materials, we utilized silicone adhesive. This choice was motivated by its exceptional ability to withstand vibrations without any negative impact. Furthermore, this adhesive showcases strong and reliable bonding properties, remaining unaffected by challenging weather conditions like high temperatures and direct sunlight. An additional benefit of opting for silicone adhesive is its versatility in adhering to various types of materials.

By combining Cork, soundproof rubber, and silicone adhesive shown in Figure 1, effectively accomplished the goal of diminishing sound transmission and enhancing insulation within the diesel generator.

Measurement and analysis:

Multiple experiments were conducted by the project team on the diesel generator to assess its efficiency and ensure the attainment of anticipated and satisfactory results. Various tools and programs, such as a heat camera, a heat gun, and the Decibel X program for noise measurement, were employed during these experiments. The purpose was to measure the noise levels produced by the generator and validate its performance.

After thoroughly reviewing the results, comparing them with previous

Figure 1. Diminishing sound transmission.

experiments, and consulting with the project supervisor, significant differences were observed. These differences provided clear evidence of the success of the conducted experiments on the diesel generator, highlighting the variations before and after the modifications were made.

To ensure the accuracy of our work, it was essential to measure the noise levels of the diesel generator before and after the modifications. This enabled us to assess the effectiveness of noise mitigation. Additionally, the temperature of the generator was evaluated before and after the modifications to confirm any changes in temperature. To maintain consistency, predefined directions for measurements were established, ensuring a standardized methodology for data collection and adjustment.

By conducting these measurements and analyses, we successfully confirmed the positive impact of the modifications on the diesel generator's noise output and temperature levels of the diesel generator. Figure 2 shows the four main directions of the diesel generator to know the direction from which the measurement is taken.

The measurements results:

Sound (noise) level measurement before modifying shown in Table 1. And Figure 3 shows the noise level with varied distance before modification to diesel generator on the X-axis, the graph represents the distance and direction of the

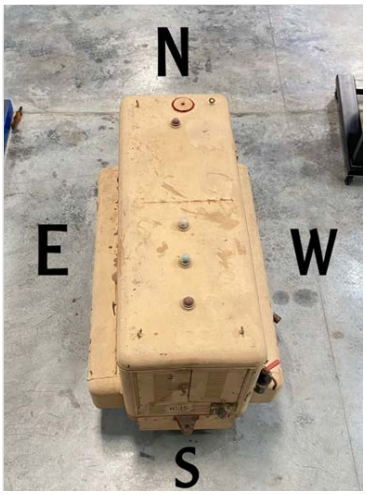

Figure 2. Diesel generator with shown varied directions.

Table 1. Show the result of measured noise before modification

Distance (m)	Noise Level (dB)			
	Point North	Point South	Point East	Point West
1	112	98	97	98
2	108	96	94	94
3	103	93	92	91
4	100	91	90	89

measurement, while the Y-axis displays the noise level in decibels. The graph has four distinct colors, with each color indicating the distance at which the measurement was taken.

Diesel generator measurement after modification:

Table 2 shows the sound (noise) level measurement after modification. And in Figure 4 show the noise level with varied distances after modification to diesel

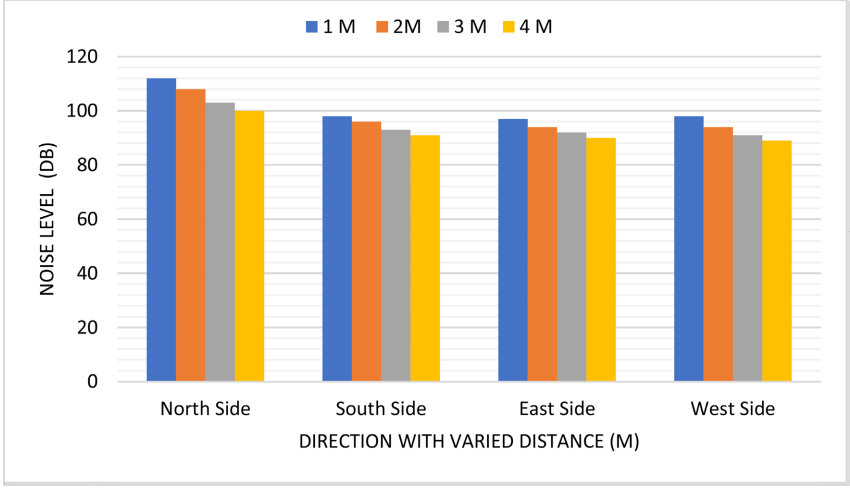

Figure 3. Show the noise level with varied distance before modification to diesel generator.

Table 2. Show the result of measured noise after modification.

Distance (m)	Noise Level (dB)			
	Point North	Point South	Point East	Point West
1	95	81	80	81
2	91	79	77	77
3	86	76	75	74
4	83	74	73	72

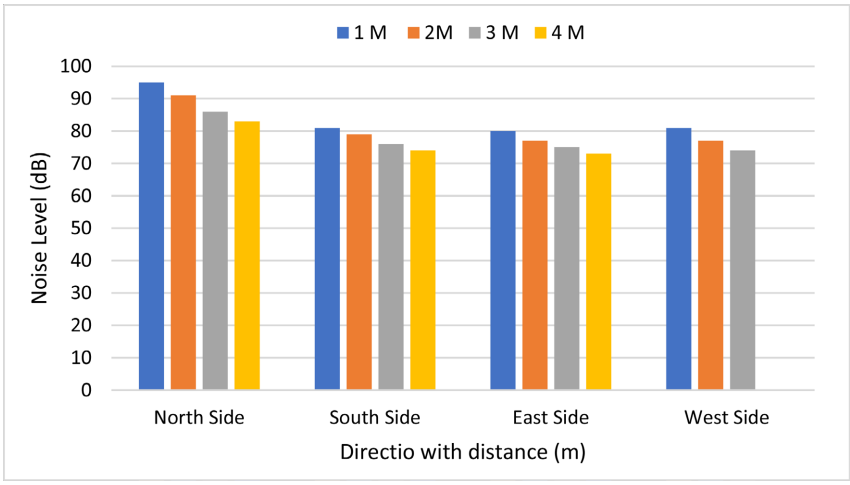

Figure 4. Show the noise level with varied distance after modification to diesel generator.

generator, the X-axis shows the distance and direction from which the measurement is taken, while the Y-axis shows a level of noise in decibels. And there are 4 colors, each color determines the distance from which the measurement was taken.

Figure 5 shows the X-axis represents the direction from which it is measured in distance and the Y-axis indicates the measurement of noise level in decibels upon contrasting to the modification for 1 meter distance, found that after the modification, the noise level has decreased, and validate the suggest modification design. The graph illustrates the comparison before and after the adjustment from a distance of one meter. Notably, the sound has decreased from all directions which is a very good indicator.

Figure 6 and Figure 7 show the temperature before the modification, fluctuated from 30.7˚C to 32.3˚C and was considered relatively high. However, after the modification, the temperature decreased within the level between 26.5˚C to 27˚C, and this temperature is considered excellent and encouraging to reduce level of noise in the diesel generator.

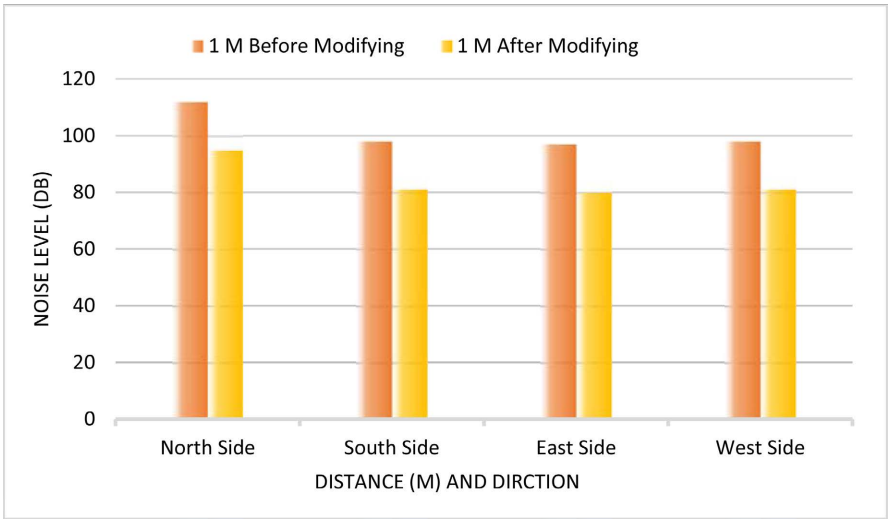

Figure 5. Comparison of noise level before and after modification

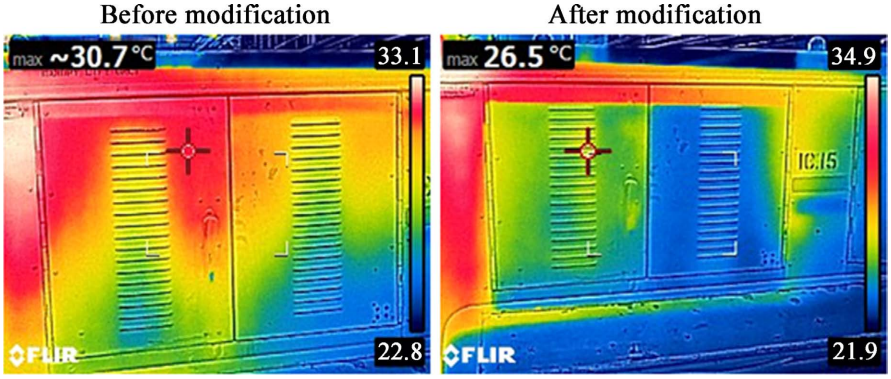

Figure 6. Shows the measured temperature before and after modification to diesel generator.

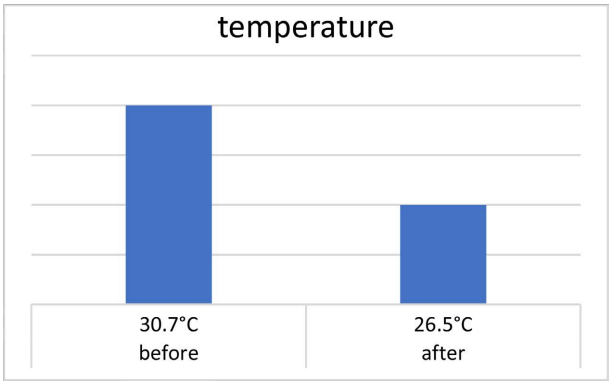

Figure 7. Shows comparison of temperature before and after modification.

3. Conclusion and Recommendation

The project has successfully achieved its desired goals, as indicated by a notable reduction in the noise of the diesel generator. The outcomes obtained were highly satisfactory. Post-adjustment measurements revealed a significant decrease in noise level, highlighting the excellence of our work. Furthermore, an encourages further sound reduction in the future. It developed the creation of a soundproofed moving room to accommodate the diesel generator, effectively eliminating noise leakage. To address potential vibration concerns, we can integrate a specially designed device to mitigate shocks and vibrations, ensuring optimal performance. Additionally, we can implement modifications to the exhaust system, which will contribute to an additional noise reduction. Furthermore, introducing a specific liquid with diesel can effectively decrease engine noise during operation.

With these improvements and future prospects, we are confident that the project will continue to enhance its noise reduction capabilities and maintain its exceptional level of excellent performance.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper. And thanks to all systems students for their contribution.

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