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ANALYSIS OF EMISSION OF COMPRESSION IGNITION ENGINE USING BIODIESEL AS ADDITIVE

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Abstract

Compression ignition (CI) engines are widely utilized in light, medium, and heavy-duty vehicles, as well as in load transport and power generation, due to their superior fuel efficiency and capability to operate under lean burn conditions. This lean burn feature significantly reduces particulate matter and noise emissions when using waste cooking biodiesel blended with diesel fuel. However, CI engines also emit harmful pollutants, including noise and particulate matter (PM), which can react with other substances, contributing to environmental issues such as ozone depletion, global warming, photochemical smog, and acid rain, ultimately disrupting the ecological balance.

Meeting stringent emission regulations for CI engines poses challenges due to elevated levels of particulate matter and noise emissions. High combustion chamber temperatures and dissociation during diffusive combustion processes contribute to substantial particulate emissions. Results indicate that the noise emissions from compression ignition engines are reduced when operating on biodiesel-blended fuels compared to traditional diesel fuel. Further analysis of particulate matter emissions reveals that blending biodiesel with diesel fuel significantly decreases PM emissions in CI engines.

Keywords: *compression ignition engine, diesel fuel, biodiesel, PM, Noise emissions.*

Introductions:

Diesel engines play a critical role in road transportation and power generation. However, the ongoing diesel fuel crisis has driven research into alternative fuels. Efforts in internal combustion engine modifications, alternative fuels, dual-fuel systems, and renewable energy sources are gaining attention to meet today's energy demands. Many researchers have recommended alternative energy sources, such as vegetable oil [1].

Biodiesel production from vegetable oils or animal fats presents significant challenges, primarily due to issues with availability and the transesterification process [2]. Nonetheless, using biodiesel in internal combustion engines has a notable impact on diesel engine combustion [3], as biodiesel tends to produce lower combustion temperatures and has higher viscosity [4]. The transesterification process itself also plays a critical role in influencing engine performance and emissions [5].

Biodiesel emissions largely depend on the oxygen content within the biodiesel molecules [6] and the nature of the fuel bond. Higher oxygen content tends to increase NO emissions [7] while reducing CO emissions, whereas lower oxygen content decreases NO but raises CO levels [8]. Most biodiesels result in elevated NO emissions [9], lower brake thermal efficiency (BTE), and higher specific fuel consumption (SFC) due to lower oxygen content and calorific value [10]. Therefore, numerous researchers have focused on improving biodiesel efficiency, enhancing combustion quality, and reducing emissions.

Research Methodology

3.1 Engine sound pressure level

The study examined the noise levels of a compression ignition (CI) engine operating on various fuel samples under different loading conditions while maintaining a constant speed. Sound pressure levels were recorded from four directions: front, back, and left, using microphones positioned 1 meter away from the test bed at each location. Measurements were taken with a sound level meter that quantifies sound pressure levels in decibels (dB). Detailed specifications of the sound level meter used in the study are provided in Table 1. This analysis offers valuable insights into how different fuel samples affect the noise levels of CI engines and may help identify strategies for reducing noise pollution from engine operations.

Table 1 Detailed Specification of sound pressure level meter.

Type	**Electric condenser microphone**
Range of dB Level	**35dB to 150dB**
Accuracy	**± 1.5 dB**
Resolution	**0.1 dB**
Microphone diameter	**½ “**
Dynamic Range	**55dB**

Examine the emission of particulate matter (PM)

For this purpose, data on PM (particulate matter) emissions from diesel engines operating on pure diesel fuel and biodiesel blend fuels was gathered. The speed, load, and fuel quality of an engine all affect how much pollution it emits. At

the same speed and under various load situations,
diesel fuel and biodiesel combined fuels.

Figure 1 particulate matter emissions measuring device

Results and discussions

In this research analysis of noise emissions level and particulate matter emissions using biodiesel and diesel fuel. For the analysis of noise emissions level and particulate matter emissions constant rpm and variable load.

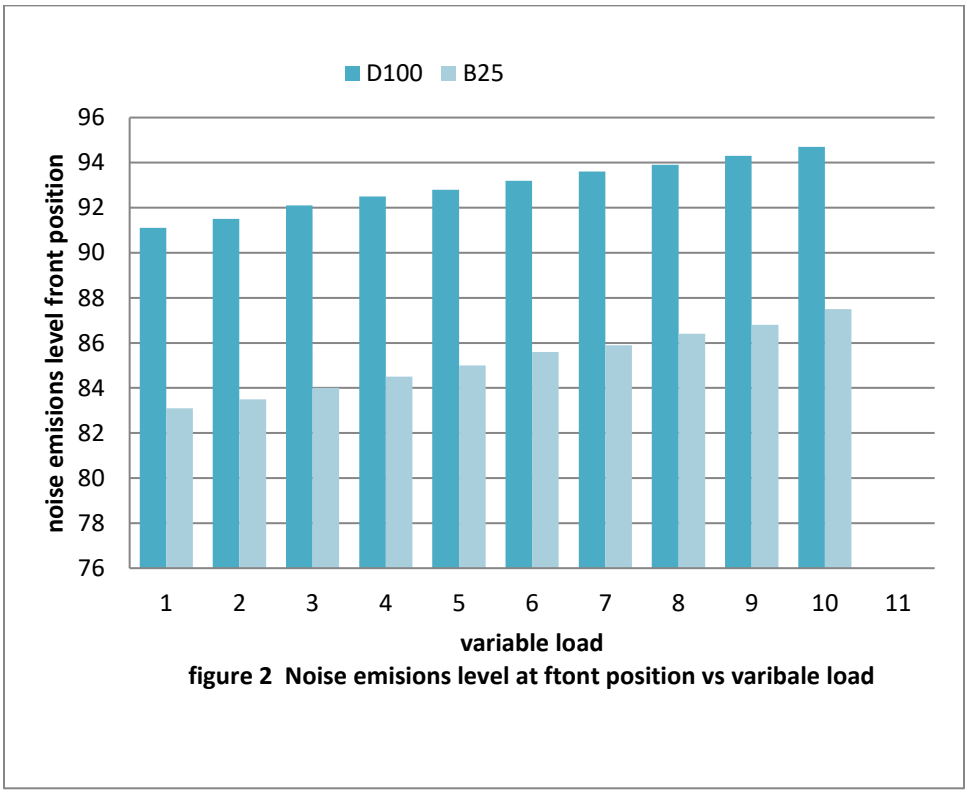

figure 2 Noise emisions level at ftont position vs varibale load

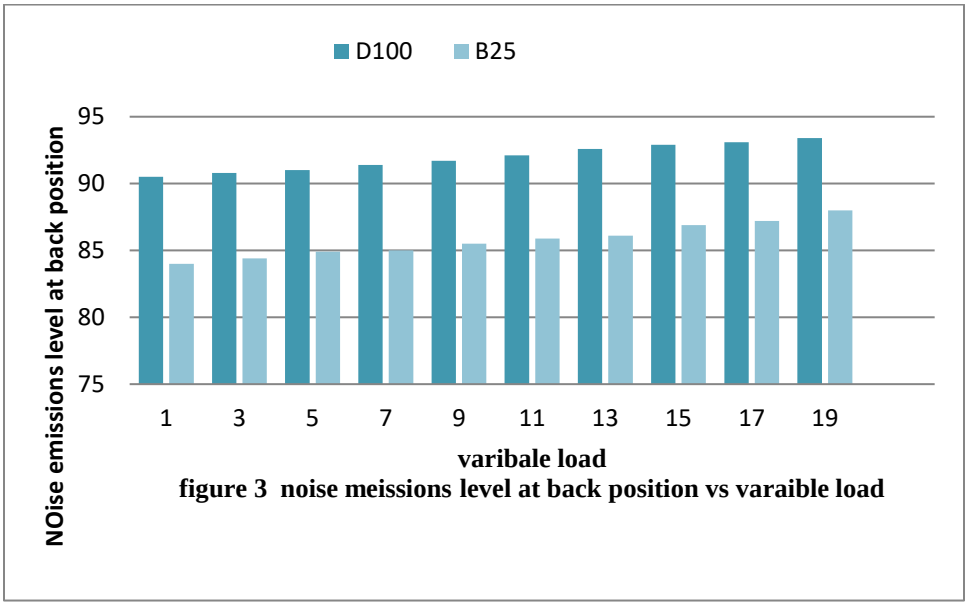

figure 3 noise meissions level at back position vs varaible load

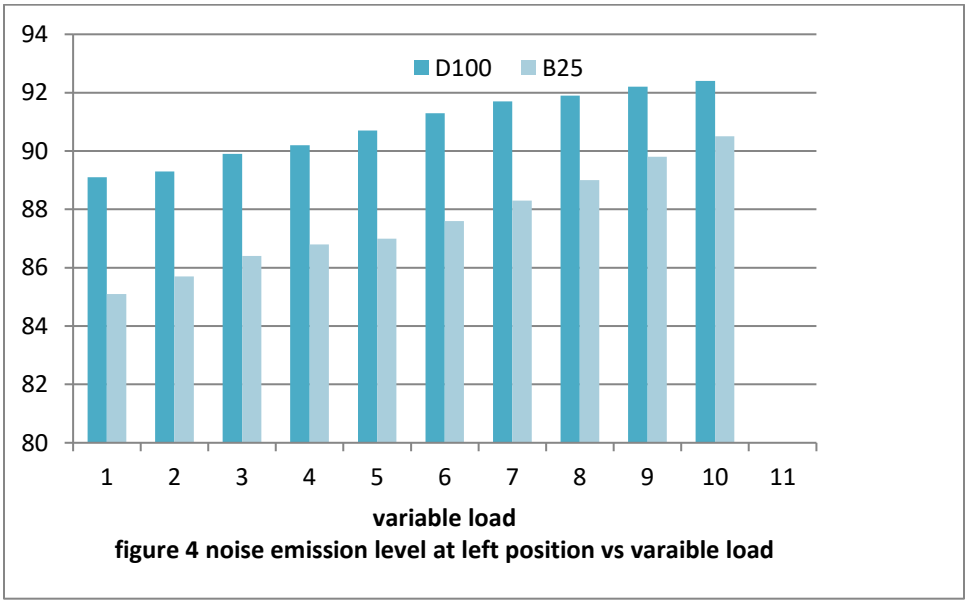

figure 4 noise emission level at left position vs varaible load

In this study, the noise pressure level of a CI engine was analyzed during an endurance test. The engine was run for 100 hours on different fuel samples including diesel fuel (D100) and biodiesel blended fuel (B25+D75), The noise emission level was measured at various load conditions and a constant rpm of 1500. The measurements were taken from a distance of 1 meter away from the engine, specifically at the left position.

The results showed in figure 2-4 that the use of diesel fuel (D100) resulted in higher noise pressure levels at the front position compared to biodiesel blend (B25). When clove oil was added as an antioxidant to the biodiesel blend (B25), the noise pressure level reduced at the left position.

The comparison of the results clearly indicates that the use of diesel fuel (D100) results in higher noise emission than biodiesel blend (B25) .This can be attributed to the better oxygen content in biodiesel blend (B25) which leads to proper combustion inside the engine. Proper combustion inside the engine reduces the noise level when using biodiesel blend (B25). The study shows that the use of biodiesel blend (B25) reduce the noise pressure level of a CI engine compared to the use of diesel fuel (D100). The better oxygen content in biodiesel blend (B25) .

Analysis of particulate matter emission (PM)

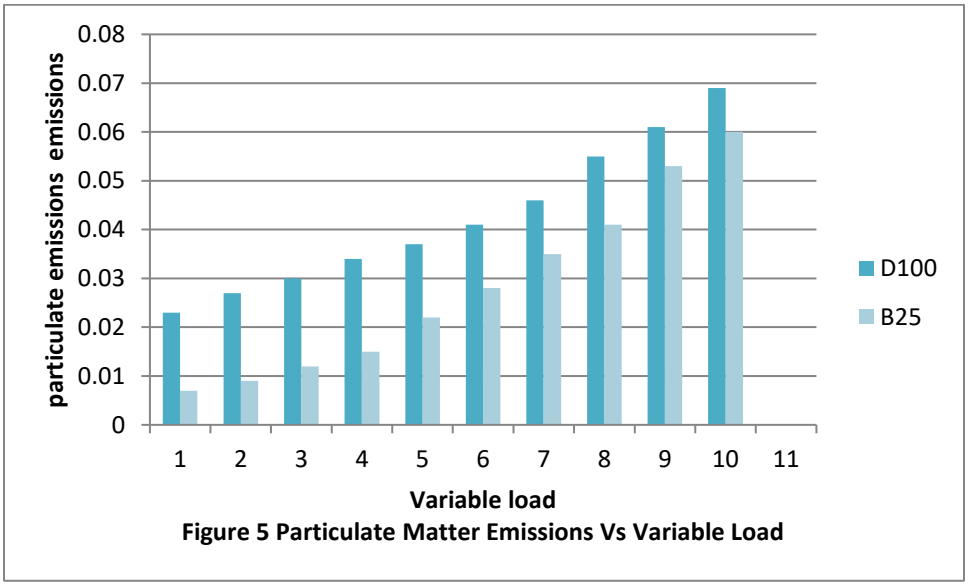

Figure 5 Particulate Matter Emissions Vs Variable Load

This study investigated the assessment of the impact of different fuel alternatives, namely diesel fuel and biodiesel blended with diesel on particulate matter emissions, The figure shown 5 that diesel fuel alone had higher PM emissions than biodiesel blended fuels, with the greatest reduction observed in clove oil blended fuels.

The study showed that particulate matter emissions were reduced in biodiesel blended fuel. When compared to diesel fuel alone. These results suggest that using biodiesel blended fuels could be a promising substitute for diesel fuel, with the additional advantage of lowering engine exhaust pollutants. Overall, these findings demonstrate that utilizing biodiesel blended fuels with biodiesel blended fuel can be a feasible approach to minimize particulate matter emissions from diesel engines, enhance fuel stability, and reduce reliance on fossil fuels.

1.1 Conclusions

Particulate Matter Emissions: The study showed that diesel fuel (D100) produces higher PM emissions compared to biodiesel blends. This is likely due to the oxygen content in biodiesel, which promotes more complete combustion and thus reduces the formation of particulate matter.

Noise Emission Levels: The use of biodiesel blends, especially B25, significantly reduced noise levels during the test compared to diesel fuel. The oxygen content in biodiesel improves combustion, leading to quieter engine operation.

Overall, the study suggests that biodiesel blends, particularly B25, not only reduce PM emissions but also contribute to quieter engine performance, making them an effective alternative to pure diesel fuel for improving environmental and acoustic aspects in CI engines.

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