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PERFORMANCE AND EMISSIONS ANALYSIS OF A DIESEL ENGINE USING ETHANOL-BLENDED FUEL

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Abstract
This study provides a comprehensive assessment of the performance and environmental implications of ethanol-blended fuels in a Compression Ignition (CI) engine, focusing on noise emissions, carbon monoxide (CO) emissions, brake Results indicate substantial reductions in noise emissions, with ethanol-blended fuel E7D93 showcasing a decrease in noise emission level as compared with diesel fuel at different positions, such as the front position, top position, left position, and back position, compared to D100. These fuels also lead to a noteworthy decrease in carbon monoxide emissions, with reductions of 5.87% for E7D93 compared to D100. However, observe a slight increase in brake-specific fuel consumption with ethanol blends. In summary, this research highlights the potential of ethanol as an environmentally friendly additive for CI engines, offering reduced noise and emissions, along with improved engine efficiency, albeit with a minor trade-off in fuel consumption.

INTRODUCTION

Diesel engine (CI engine), first introduced by a French engineer Rudolf Diesel in the late 19th century. He designed an engine that didn't need a spark plug to ignite fuel. Instead, it compressed air so much that it got really hot. Then, when diesel fuel was injected into this super-hot air, it ignited all on its own. This clever process made the CI engine much more efficient and powerful than the engines that came before it. [1]. Diesel engines play a crucial role in the industrial sector, running generators to provide electricity in remote areas and during emergencies. In maritime applications, they propel ships, facilitating global trade and transportation. Their fuel efficiency and durability make diesel engines indispensable, serving as a cornerstone in modern society. Diesel engines offer several advantages that make them a versatile and indispensable power source across a wide range of applications.[2] Their efficiency, stemming from a higher compression ratio, exceeds that of gasoline engines, resulting in superior thermal efficiency. Diesel engines excel at producing substantial torque at low RPMs, rendering them ideal for heavy-load tasks and towing needs. Diesel emissions contribute to the development of cancer; cardiovascular and respiratory health effects; pollution of air, water, and soil; soiling; reductions in visibility; and global climate change [3]. Diesel engines are also a source of greenhouse gas emissions, primarily carbon dioxide (CO_2). While diesel engines are generally more fuel-efficient than gasoline engines, their CO_2 emissions contribute to global climate change. The accumulation of CO_2 in the atmosphere is responsible for rising temperatures, leading to various environmental consequences, including more frequent and severe weather events.[4]. As regulations drive down the allowed tailpipe emission levels, advances in engine and after treatment technology have made it possible to substantially reduce PM emissions. Besides the reduction in level, new technologies such as diesel particulate filters (DPFs) and selective catalytic reduction (SCR) can also affect the physical and chemical properties of PM [5]. Naphtha is introduced as an alternative fuel for advanced combustion in premixed charge compression ignition [6]. CNSO was separately blended with oxygenates (diethyl ether and dimethyl carbonate), alcohols (ethanol, methanol and butanol) and vegetable oils (camphor oil, orange peel oil, cottonseed oil and coconut oil) in various proportions by volume [7]. Some of these alternative fuels include: Biodiesel is a renewable fuel made from various sources such as vegetable oils, animal fats, and used cooking oil. Most of the studies reveal that the performance of biodiesel is better than that of diesel [8]. Methanol can be used as a fuel in CI engines, although it requires engine modifications due to its lower cetane rating compared to diesel. Methanol can be straightway used as a replacement for gasoline, since it has very high octane number and has been successfully used in many spark ignition (SI) engine applications [9].The results indicate that DME engines can achieve high thermal efficiency and ultra-low emissions, and will play a significant role in meeting the energy demand while minimizing environmental impact in China [10].Today the economics are much more favourable in the production of ethanol and it is able to compete fairly well with standard diesel [11]. Derived from sources like corn, sugarcane, and cellulosic materials, ethanol offers several compelling benefits. Notably, it presents a sustainable and environmentally friendly option, emitting fewer greenhouse gas emissions compared to traditional gasoline. [12]. It was found that ethanol is better than diethyl ether and diesel fuels when used as an oxygenated fuel with acetylene gas [13].

1.2 EFFECT OF ETHANOL BLENDED FUEL ON DIESEL ENGINE

Ethanol blended fuel can improve the performance and emissions of a diesel engine (CI engine), but the benefits depend on the specific blend ratio of ethanol to diesel. Ethanol has a higher octane rating than diesel, so it can improve the knocking resistance of a CI engine. [14].Ethanol can also help to reduce the emissions of carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM) from a CI engine. it is found that the smoke emissions from the engine fuelled by the blends were all lower than that fuelled by diesel[15].

This combustion process offers high efficiency and torque compared to spark-ignition engines. C.I engines play a crucial role in various sectors, including transportation and industry, due to their robustness and fuel efficiency. Transportation sector, Power generation sector and Industry sector mostly use diesel engine as a primary source for their power generation [16].However, the increase in prices of diesel fuel, reduced availability, more stringent governmental regulations on exhaust emissions and the foreseeable future depletion of world-wide petroleum reserves provide strong encouragement for the search for alternative fuels [17].Diesel combustion, which is in principle unsteady turbulent diffusion combustion, is fundamentally controlled by the mixing process of fuel with air in the combustion chamber [18]. Compression Ignition (C.I.) engines, commonly known as diesel engines, are renowned for their robust performance in various industrial and automotive applications. These engines exhibit distinctive performance characteristics that set them apart from their spark ignition counterparts. It has been seen that with the increasing proportion of ethanol in the blend, the overall thermal efficiency, heat release rate, engine volumetric efficiency and cylinder gas pressure increases [19]. While diesel engines are being considered to be attractive due to their high thermal efficiency and corresponding potential to minimize CO2 emissions, concerns over health effects and air quality have promoted proposed reductions in diesel engine emissions, especially particulate matter (PM) and nitrogen oxides (NOx) [20-22].

2.Research Methodlogy

2.1 FUEL SYSTEM OF C.I ENGINE

In this research a compression ignition engine was used for analysis of noise emission, CO, and particulate matter emission using different fuel samples such as diesel fuel (D100) and E7% (7% ethanol and 93% diesel fuel). The C.I. engine's fuel system is made up of two tanks, tank A and tank B. Tank B is utilized for blended fuel, while Tank A is used for standard diesel fuel. Both fuels are controlled separately by separate valves that are connected by a shared line. As shown in fig. (D100), it is put into Tank A, and the choice of blended fuel is put into Tank B. Two fuel samples were evaluated in this experimental inquiry as 100% diesel (D100) and 93% diesel and 7% ethanol (D93E7).

2.2 MEASURING OF NOISE PARAMETERS

In this objective the noise emissions of diesel engine has been measured using the noise level meter at different positions, such as (front, left, top and back) one meter away from the diesel engines at constant

1600 rpm and variable load from 0.1 kg-m to 1.6 kg-m. Each reading were conducted after stabilization of engine between 1 to 2 minute,

Figure 2.1 Sound Level Meter

2.3 measuring of carbon monoxide (co) emission

The analysis of carbon monoxide of c.i engine using diesel fuel (d100) and ethanol 7%. In order to achieve this objective, emissions from diesel engines of carbon monoxide (co) have been measured. Utilizing an exhaust gas analyser, the emissions were measured at the exhaust of a diesel engine test bed at a constant speed of 1600 rpm and a varied load of 0.1 kg-m to 1.6 kg-m..

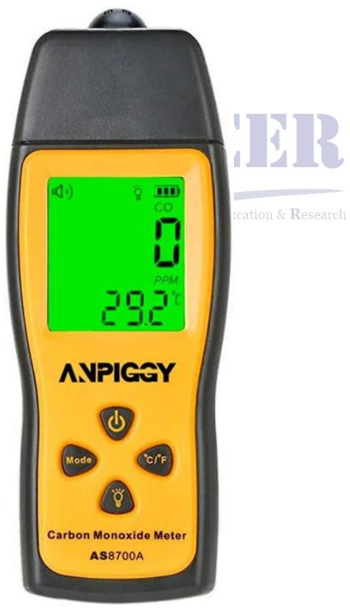

Figure 2.2 Carbon Monoxide Meter

2.3 MEASURING OF PERFORMANCE PARAMETERS

Tests have been conducted on engine performance metrics including (specific fuel consumption, power output, and brake thermal efficiency). At constant rotational speed (rpm) and varying load, these values are calculated. The load can be adjusted from 0.1 kg-m to 1.6 kg-m while maintaining a constant speed of 1600 rpm. However, the first reading is taken while the engine is running at 1600 rpm and load of 1.6 kg-m..

3. RESULTS AND DISCUSSIONS

In this chapter analysis of noise emission level, carbon monoxide Carbone dioxide and performance of compression ignition engine using diesel fuel and ethanol blended fuel as additives. Our findings aim to shed light on the viability of ethanol as an environmentally [redacted] friendly additive in compression ignition engines, with potential benefits for both the environment and engine efficiency.

3.1 ANALYSIS OF NOISE EMISSIONS LEVEL

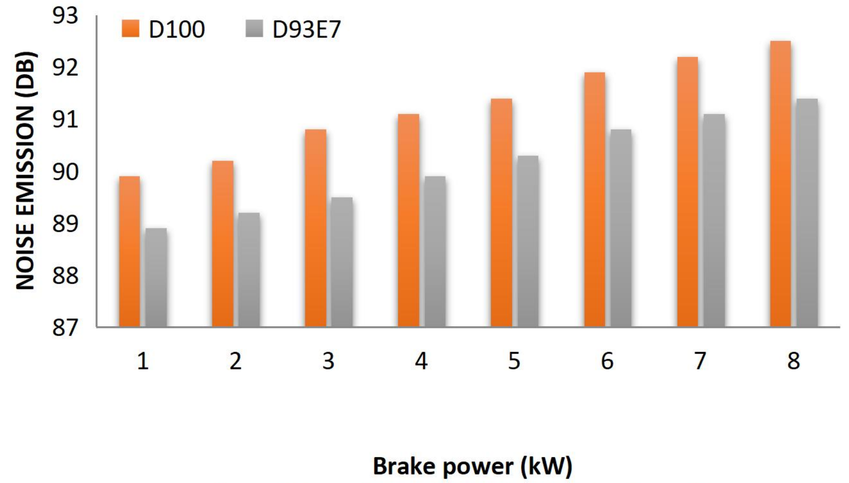

figure 3.1 noise emission level at front position

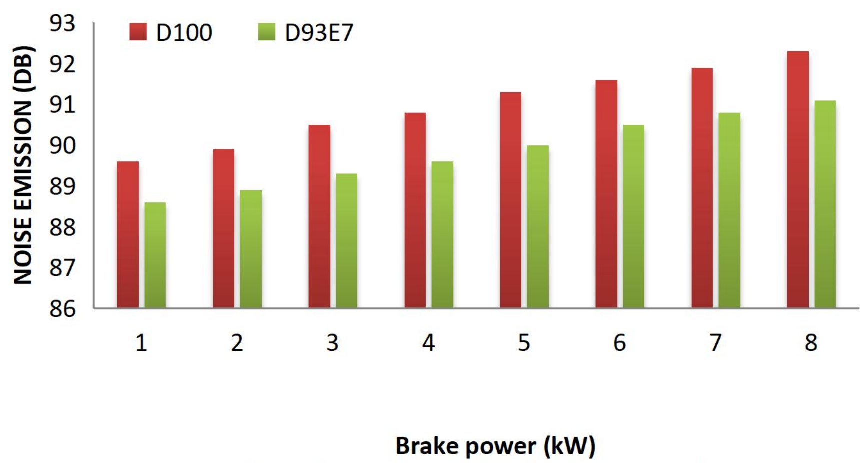

figure 3.2 noise emission level at top position

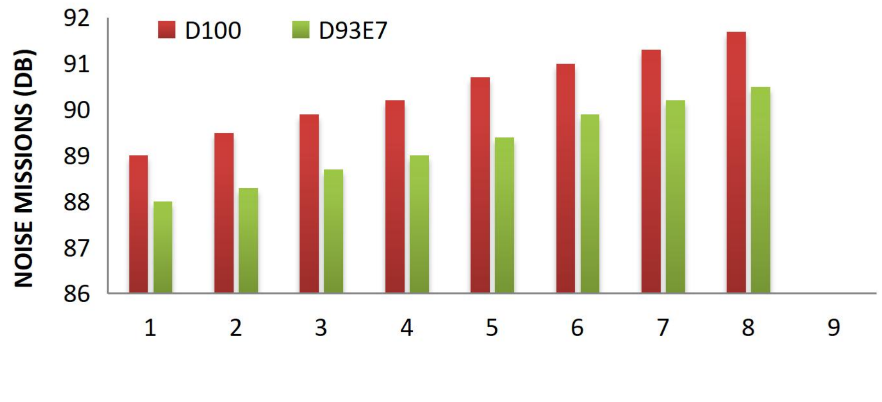

figure 3.3 noise emissions level at left position

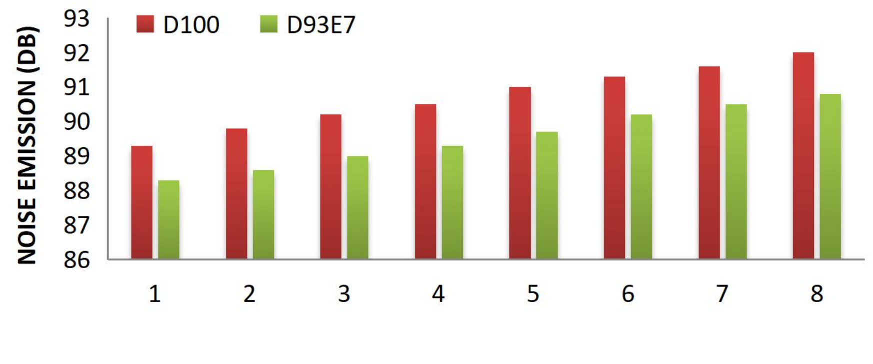

figure 3.4 noise emissions level at back position

In this research, an investigation was conducted on the noise emission levels of a diesel engine using pure diesel fuel and ethanol-blended fuel samples. Noise emissions were measured at various positions around the engine, including the front, left, back, and top. All measurements were taken one meter away from the engine during its operation on diesel fuel.

The results, shown in Figure 3.1, revealed that the engine operating on pure diesel (D100) exhibited higher noise levels compared to the ethanol-blended fuel (E7D93). This finding highlights the potential of ethanol-blended fuels in reducing noise emissions.

Specifically, a noticeable decrease in noise emissions was observed at the front position when using the E7D93 blend. At the top of the engine, noise emissions also decreased, and a reduction was recorded on the left side with the same blend. These results indicate the effectiveness of ethanol-blended fuels in mitigating noise emissions from diesel engines.

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3.2 ANALYSIS OF CARBON MONOXIDE

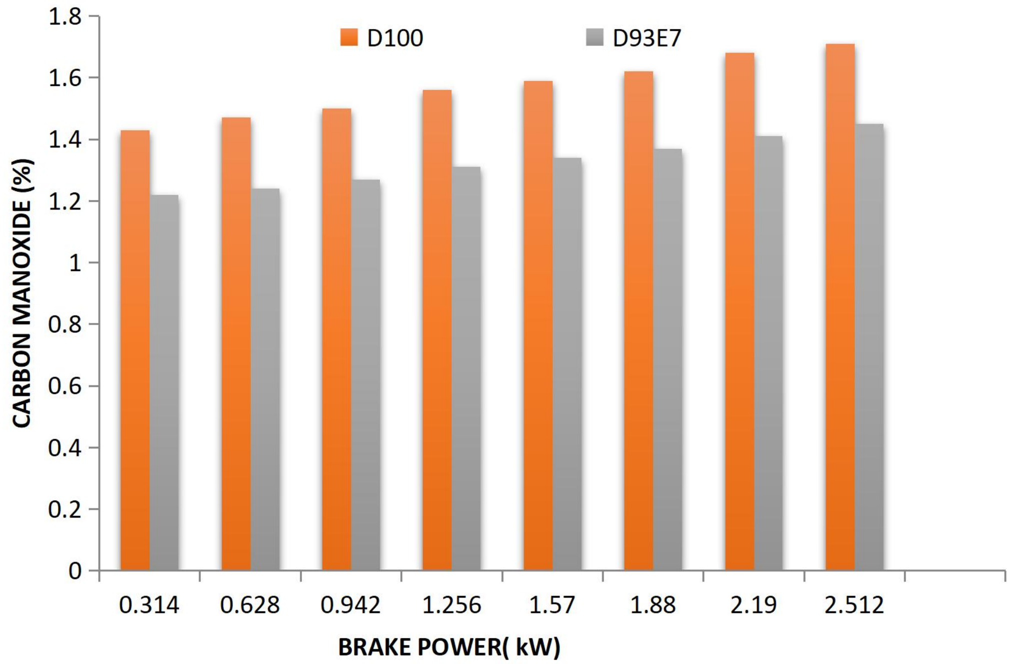

FIGURE 3.5 CARBON MANOXIDE VS BRAKE POWER

Figure 3.5 displays the assessment of carbon monoxide (CO) emissions at the engine's exhaust while utilizing fuel blends of D100, and E7D93. The outcomes derived from operating the engine under these specific fuel compositions indicate that D100 resulted in higher levels of carbon monoxide emissions when compared to E7D93. When blended ratio is E7D93 carbon monoxide reduce as compare to D100. This observation underscores the benefits of incorporating ethanol-blended fuels to mitigate carbon monoxide emissions. The reduction in carbon monoxide (CO) emissions when using ethanol-blended fuel with diesel in a Compression Ignition (CI) engine is primarily due to the higher oxygen content in ethanol, complete combustion of the fuel mixture, which enhances combustion efficiency and reduces the formation of CO.

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3.3 ANALYSIS OF BRAKE THERMAL EFFICIENCY

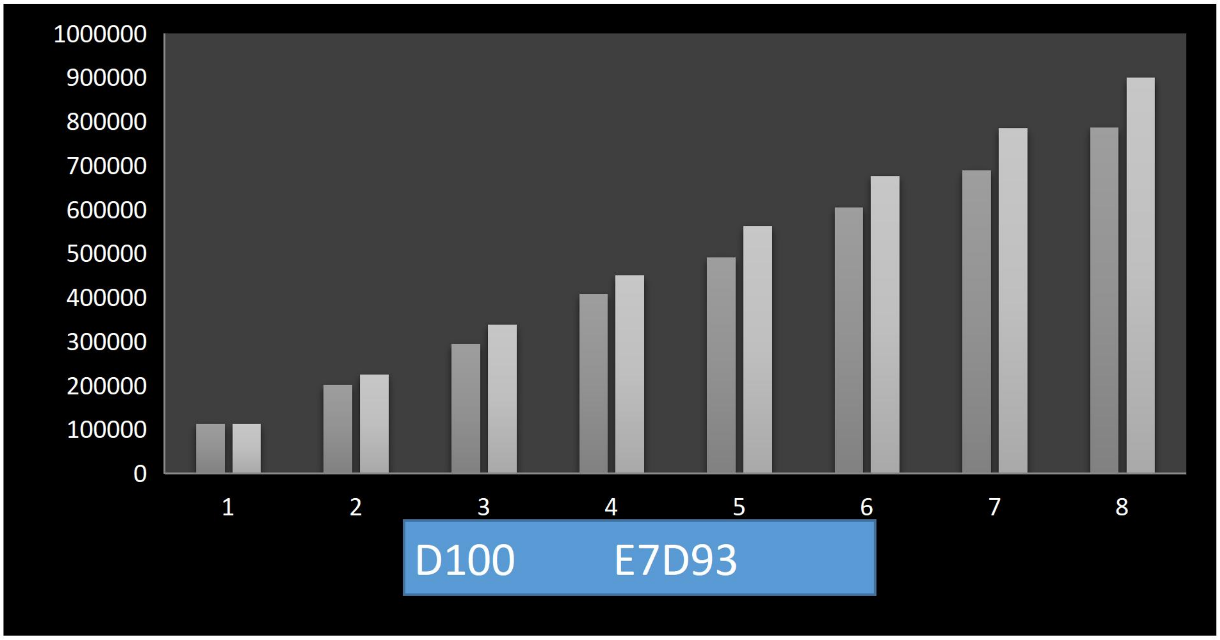

Figure 3.6 The variation of brake thermal efficiency

Brake Thermal Efficiency (BTE) is a crucial parameter for evaluating the performance of diesel engines, particularly when examining the effects of ethanol-blended diesel fuels. Baseline diesel fuel, denoted as D100, represents the conventional and standardized fuel for such engines. In comparison, E7D93—a blend containing 7% ethanol and 93% diesel—demonstrates a slight improvement in BTE over pure diesel (D100).

The observed increase in BTE with the use of ethanol-blended fuel in a compression-ignition (CI) engine can be attributed to several key factors. These include ethanol's higher octane number, greater oxygen content, improved combustion characteristics, lower heat of vaporization, and its cooling effect on the engine. Collectively, these properties promote more complete and efficient combustion, reduce heat losses, and enhance thermal efficiency. As a result, ethanol-diesel blends emerge as a promising alternative for improving CI engine performance while simultaneously reducing emissions and increasing the overall energy extracted from the fuel.

CONCLUSION

The utilization of ethanol-blended fuels (E7D95) exhibited a noticeable reduction in the noise level of the diesel engine during operation. This decrease can be attributed to the inherent properties of ethanol, including its higher octane rating, cleaner combustion, and dampening effect on engine noise. These findings suggest that ethanol-blended fuels have the potential to contribute to quieter engine operation.

Experimental results revealed that the use of E7D95 blends led to a reduction in carbon monoxide (CO) emissions compared to conventional diesel fuel. This outcome can be attributed to the cleaner combustion characteristics of ethanol and its higher oxygen content, which promote more complete combustion.

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