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Research Article

Potential performance of diesel engine powered by mango seed blends + pyrolysis oil doped with zirconium catalyst

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ABSTRACT

The release of exhaust gases from compression ignition engines has gradually increased daily due to increased demand for automobiles. This causes a heavy depletion of diesel. The novelty in this work is testing the single-cylinder diesel engine followed by 50D25MO25PO+ 20 ppm zirconium oxide, 70D15MO15PO + 40 ppm zirconium oxide, 80D10MO10PO + 60 ppm zirconium oxide, 50MO50PO + 80 ppm zirconium oxide, and diesel. The zirconium oxide is a novel catalyst for boosting engine performance, improving combustion rates, and reducing emission formations. The method used for proportions is the ultra-sonification process. The results were good in terms of superior brake thermal efficiency for the blend 50D25MO-25PO+ 20 ppm zirconium oxide is 34.2%, which is 11.67% greater than diesel, Brake specific fuel consumption is 0.20 kg/kWh for the blend 50D25MO25PO+ 20 ppm Zirconium oxide 31.43 % less than diesel, Maximum heat release rate is reached for the blend 80D10MO10PO + 60 ppm zirconium oxide followed by 89 KJ/CA with highest peak pressures of 69 bar for blend 70D15MO15PO + 40 ppm zirconium oxide. 70D15MO15PO + 40 ppm zirconium oxide blend offers very few Hydro carbon emissions, followed by 77.7% than diesel; the least Carbon monoxide formations are found for the same blend, followed by 40% less than diesel. 70D15MO15PO + 40 ppm zirconium oxide blend possesses very low carbon dioxide with a marginal difference of 5.6% than diesel, and lower nitrogen emissions are 50MO50PO + 80 ppm zirconium oxide found to be 700 ppm.

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INTRODUCTION

The generation of emissions in diesel-based vehicles is gradually increasing in the automotive sector. The thrust beyond the usage of automobiles is also growing, and the usage of automobile research in engine parts and emissions parts is also increasing [1]. Although several researchers focus on reducing emissions strategies by incorporating the latest emission techniques, there is a slight modification in engines, increasing preventive maintenance costs every year. This results in an increase in automobile costs by 5 to 10% per year [2]. The latest engine modifications require the highest specific fuel consumption and provide high sophistication and driving comfort. The people from the middle background did not get the latest modified vehicles. Hence, the researchers are working on reducing fuel costs and introducing alternative fuels with reduced emission techniques [3]. Alternative fuels such as blends extracted from cotton, soya beans, palm seeds, sunflower seeds, jatropha seeds, and nonedible seed oil are investigated in the automobile engine industry [4]. The main merit of these nonedible blends is that improvised brake thermal efficiency is found when the engine operates at optimal workload conditions [5]. It is also noted that few pure alternative fuels operated on diesel engines have enormous benefits regarding smooth running and the lowest possible emissions [6]. The major drawback that persists owing to the combustion of pure biodiesel blends is a higher heat release rate, which results in deteriorating the piston and cylinder-associated parts [7]. The recent research on Al_2O_3 coatings by modified piston crown with plasma arc process improves the brake thermal efficiency (BTE) by 0.8% and Brake-specific fuel consumption by 0.5 %, and emissions are also reduced by 2 % compared to CE engines [4]. The thermal barrier coating is applied on palm oil biodiesel and diesel, and they investigated different blend ratio combinations from B5 to B25. From the results, it is observed that there is a decrease in emission rate by 1.5 % for coated engines as compared to CE engines [8]. Increasing compression ratios from 16:1 to18:1 for coated and uncoated engines maximizes the improvement by 2% higher for coated engines with less compression ratio of 16:1, and BSFC was achieved by 4% as compared to uncoated engines [9]. The combination of silicon with aluminium signifies improvement for BSFC and BTE, and a reduced emissions rate of 6% compared to diesel [10]. Adding Al_2O_3 and YSZ powder improves the BTE by 2% and reduces the BSFC by 1.4% compared to the CE engine [11]. Utilizing thermal barrier coatings leads to an improvement in the efficiency of 2.3%, reduced BSFC by 1.9%, and H.S.U by 1.9% in maximum load conditions operated by diesel engines [12]. The addition of coatings on the piston liner improves the engine efficiency by 1.06% compared with the CE engine, and the addition of liner coating in the range of 100 μm operates the engine at higher temperatures [13]. The introduction of magnesium alloys as an insulating material gives optimal performance in the range of 30 % as a BTE and less in BSFC as compared to a CE engine. $MgZrO_3$ and YSZ coating is done at self-governed engine components such as engine combustion chamber piston, heads, and liner, and from the results, it is observed that $MgZrO_3$ possesses the best ceramic coating to attain complete combustion results in 10.5% more than compression work has been developed [14]. The seed within the mangoes (Mangifera indica) has been removed using the Soxhlet treatment solvent procedure and subsequently turned into biofuels using transesterification. It entailed the chemical reaction of the oil obtained with alcohol at a perfect temperature of sixty degrees Celsius, utilizing a catalyst dosage of one percentage point w/v (KOH) to achieve maximum biofuel output [15]. Mango (the Mangifera indica) fruit bio-oil is trans-esterified with methanol using hydroxide as an accelerator in this study, particularly investigating the effect of how much catalyst is used on the process. At the ideal ambient temperature of fifty degrees Celsius, a weight content of eighty-five percent was achieved. Similarly, when considering the effect of reagent amounts, an 85%the weight solution containing ten millilitres of zinc oxide nano catalyst was found to be optimum [16]. The following mixtures are made using magnetic stirring: at twenty percent, diesel, and all measured on a volume basis. Each of these mixes is called 5% mango biodiesel, 10% mango biodiesel and 15% mango biodiesel, 20% mango biodiesel [17]. Compared to MSB20B0, experimental results show that MSB20B5 reduces the BSFC percentage by 27.22 per cent while raising the amount of BTE by 8.94 per cent when loaded with full capacity and getting close to the diesel fuel level. Furthermore, while comparing the 5% mango biodiesel blend to the 20% mango biodiesel blend at optimum launching, the former cuts output contaminants by 9.21 % and the latter by 18. 22 %, the former by 9.92 percent, and the third by thirteen percent [18]. All things considered, diesel engines benefit from the better efficiency and less pollution provided by the MSB20B5 multimodal mixture [19]. According to the findings, the introduction of five percent decanol to small and medium 20 per cent diesel substantially boosted braking thermal performance by four percent and significantly reduced emission levels of HC, CO, and smoke. At maximum capacity, nonetheless, NOx emissions rise slightly [20]. Hence, in this research, the mango seed blends are utilized to reduce the viscosities and improve the desired qualities of the blends offered by the different proportions. The effects of mango seeds blended with pyrolysis oil, and the addition of zirconium catalysts have potential benefits in terms of improved engine performance followed by reduced emissions and better combustion characteristics. The research gap found from past literature is mixing mango biodiesel with pyrolysis oil owing to different proportions of zirconium oxide catalysts. The novelty in this work is many researchers tried the replacement of diesel with other biofuels, and some combustion studies and results were compared, Here in this research, the proportions of mixing for mango seed blends and pyrolysis blends have potential benefits, and also the addition of zirconium catalysts boosts the performance, boosts the combustion rates and reduces the emissions levels of the engine. Hence this motivation study helps several researchers work with different blends with different proportions and different types of catalysts. The choice of the catalyst depends upon its morphological structures and the costs. This work is very interesting to refer to the researchers who work on biofuels with wide applications in the automobile industry. The motivation of this study is to analyze the combination of pyrolysis oil with mango seeds oil, Since pyrolysis oil has greater demerits in terms of pungent colour and high density that results from heavy vibrations, This property of reducing the viscosities for reducing the vibration of the engine has been happening with the blending of different blends. This work aims to test the different types of blends with the presence of zirconium coatings powered with mango seeds and pyrolysis oil combinations for improving engine performance and combustion levels. The other objective of this work is to reduce the emission of particulates from diesel engines powered with zirconium coatings powered with mango seeds and pyrolysis oil combinations, which improves the maintenance of peak loads.

MATERIALS AND METHODS

Materials

The materials used in this analysis are Mango seed biodiesel, purchased for RS 500 per litre at a local biodiesel company in Andhra Pradesh, Hyderabad. Pure diesel is purchased at RS 100 per litre. The Zr_2O_3 nanocatalyst is purchased at the Chennai dealer's price of RS 250 per kilogram. The pyrolysis oil is purchased from Andhra Pradesh for RS 500 per litre.

Methods

The proportions such as 50D25MO25PO+ 20 ppm Zr_2O_3, 70D15MO15PO + 40 ppm Zr_2O_3, 80D10MO10PO + 60 ppm Zr_2O_3, 50MO50PO + 80 ppm Zr_2O_3, and 100D. The proportions of Zirconium catalyst with the pyrolysis and mango biodiesel blends are done with the help of ultrasonication method process with time interval of 10 minutes for heating and solidification process. The mechanical stirrer rotating at 120 rpm is constantly worked on to mix this Nano catalyst with biodiesel blends properly. After this process is completed, it should be cooled for one hour and transesterified with the help of KOH and 5% ethanol to remove the impurities in the form of glycerine and dust. The final step is removing the dust particles with the help of a cotton filter and keeping it free for 8 hours before the experiment is started. Table 1 represents the properties of blends.

Experiment Setup

The Schematic experimental setup, as shown in Figure 1, defines the various components like the air supply system, exhaust system, fuel supply system, and loading arrangement setup. The experiment was conducted on a conventional engine, and the results of the performance, combustion, and emissions were recorded [21]. Again, the test will be conducted, and all the necessary results will be recorded. All three experimental results will be studied and compared to find the best performance and lowest emission values. The engine is a Kirloskar single-cylinder, water-cooled direct injection diesel engine [22].

Figure 2 shows the actual experimental setup used to conduct the analysis. The engine is operated by well-trained labour to carry out all the experiments more smoothly. The engine specifications are also mentioned in Table 2. The accuracy of the results depends upon the accuracy of the instruments used and test specifications in errors. Hence, the engine is cleaned well before the experimentation, which takes two to three hours. The engine trial and report are carried out to check the accuracy of the results.

Uncertainty Analysis

The important term that determines the least possible errors from the calibration instruments and the nature of the atmospheric defects caused by these defects is measured with the help of uncertainty analysis [23]. The experiments will be carried out at least three times to check the accurate results. Through uncertainty analysis, the instruments used

Table 1. Properties of blends

PROPERTIES	UNITS	DIESEL ASTM D975	BIO DIESEL ASTM D6751	D100	50D25MO25PO + 20 ppm Zr_2O_3	70D15MO15PO + 40 ppm Zr_2O_3	80D10MO10PO + 60 ppm Zr_2O_3	50MO50PO + 80 ppm Zr_2O_3
Density	kg/m^3	800-867	800-860	818	848	830	821	798
HHV	kj/kg	44118	44910	43910	44979	42191	42245	39523
Viscosity	cs	1-4.5	1 -4.5	2.79	3.21	2.88	1.94	1.24
LHV	Kj/kg	43005	43124	42515	43422	40181	39441	38355
Flash point	ºC	49-110	42-63	38	37	32	31	34
Fire point	ºC	41-315	46-210	60	53	46	42	38
Cetane	-	43-65	46-55	67	59	58	53	42

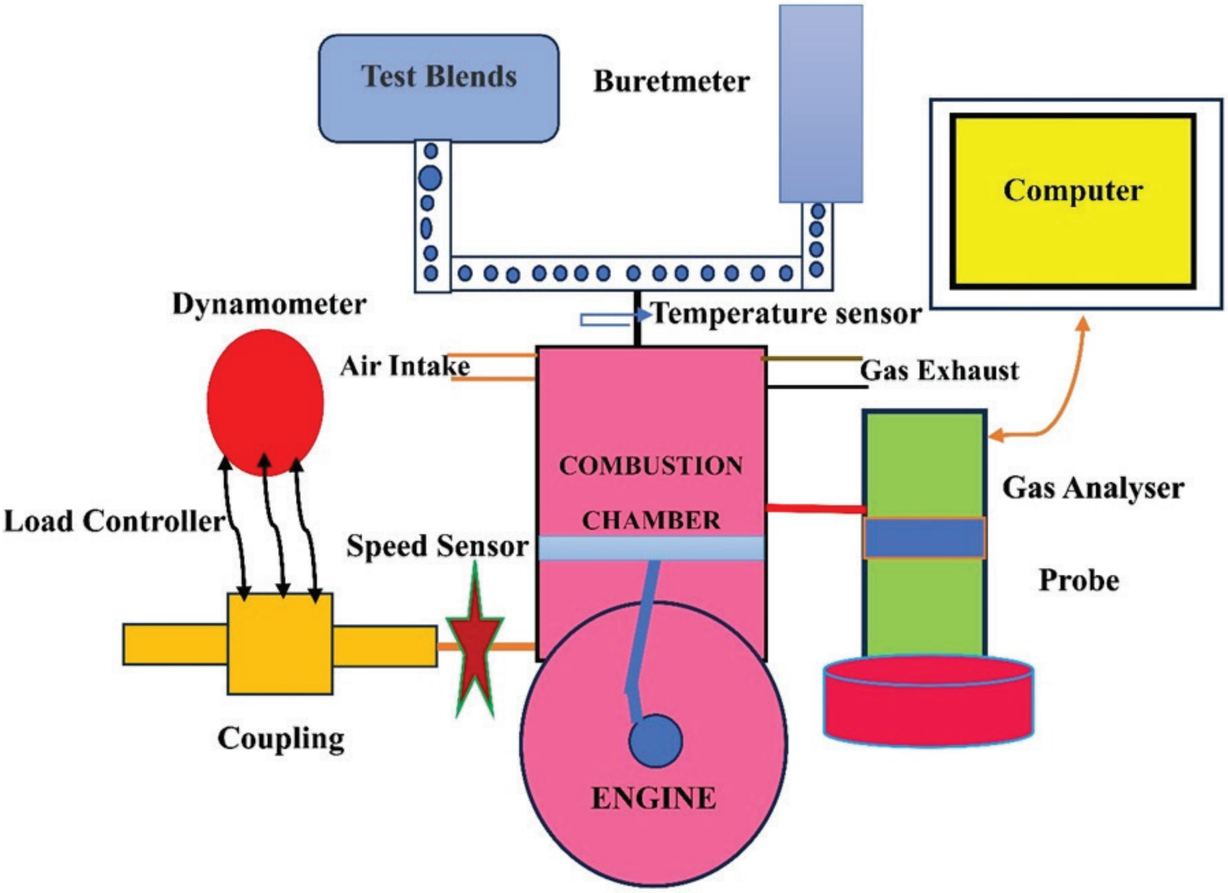

Figure 1. Schematic experiment set up.

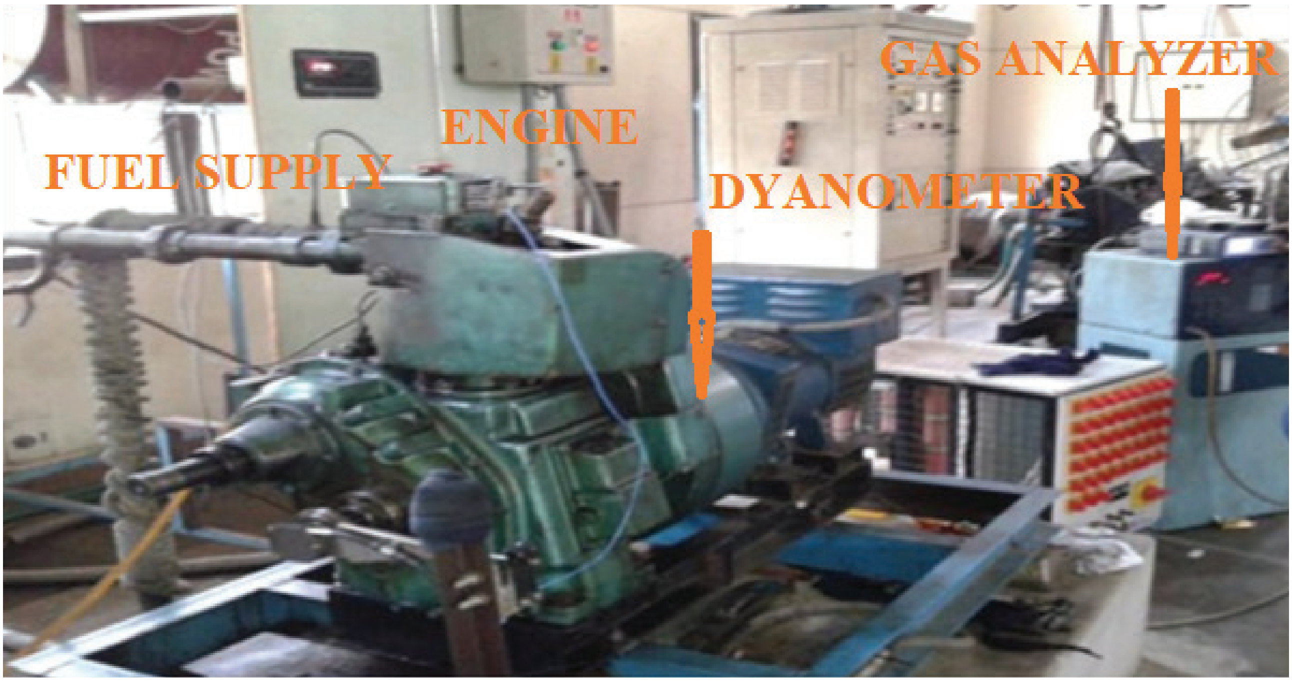

Figure 2. Actual experimental setup.

Table 2. Engine specifications

S.no	Type of description	Make of specifications
1	Strokes type	4 stroke
2	Injection type	Direct injection
3	Compression ratio	18.5:1
4	length -Rod (connecting)	238 mm
5	The radius of the Crank	70 mm
6	Cubic capability Capacity	662 cc
7	Aspiration	Natural
8	Power	5.2 kW @ 1550 rpm
9	Bore & Stroke	88.5 & 110 mm

in the experiment were thoroughly inspected for repeatability to confirm the final results [24]. Table 3 shows the accuracy of the different instruments used.

RESULTS AND DISCUSSION

Brake Thermal Efficiency

The power generated from the fuel supplied is called BTE. In other words, the engine performance can be measured by the maximum power generated for the given amount, called BTE [25].

An engine's thermal efficiency of brakes is a measure or ratio indicating the actual brake horsepower achieved

Table 3. Measure of the uncertainty of data

S.no	Instrument	Accuracy	Range	Uncertainity %
1	Smoke meter	±0.1	0-10 BSU	1
2	Stopwatch	±0.5s	-	0.2
3	Manometer	±2 mm	0-210 mm	1.1
4	Tachometer	±10 rpm	0-11000 rev/min	0.11
5	Temperature of Exhaust gas	±1 °C	0-900 °C	0.12
6	The encoder of Crank angle	±1 °deg	250-420 deg	0.13
7	Loading indicator	±2 kg	0-100 kg	0.2

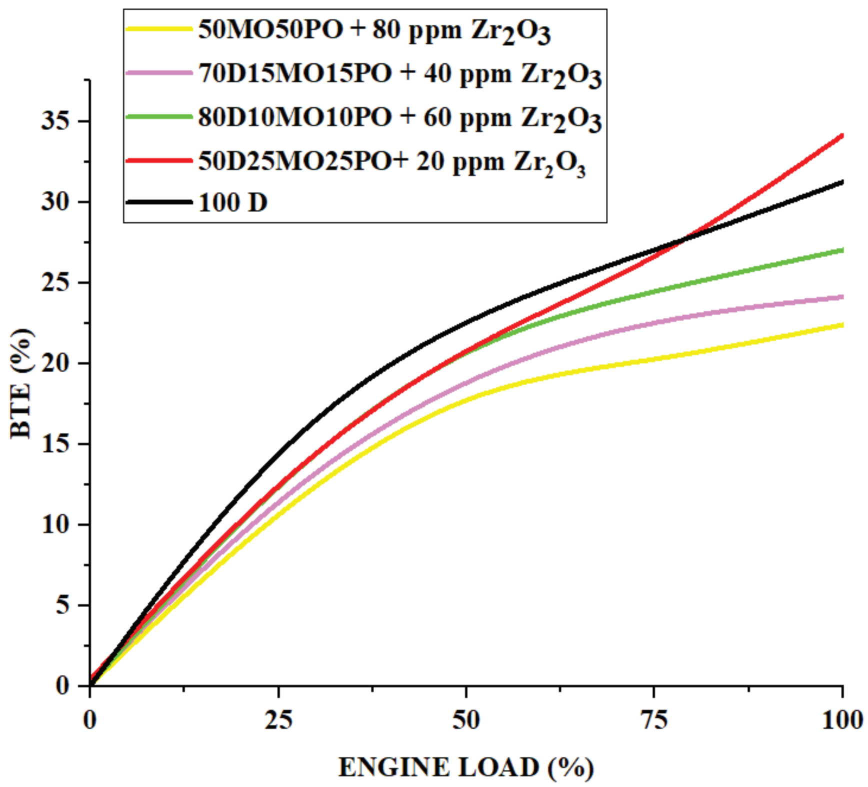

Figure 3. Brake thermal efficiency.

throughout an engine's whole conversion of the highest amount of heat the combustion product delivered [26]. Figure 3 illustrates the brake thermal efficiency of the engine load. 50D25MO25PO+ 20 ppm Zr_2O_3 exhibited the highest brake thermal efficiency of 34.2% compared to all the remaining blends. This is owing to the superior calorific value offered by 50D25MO25PO+ 20 ppm Zr_2O_3, and it was seen that 50MO50PO + 80 ppm Zr_2O_3 fuel attained the lowest BTE followed by (25.5%) due to lower calorific values; this results from the presence of elevated oxygenation concentration and a substantial calorific value [27]. The cheapest brake thermal efficiency found for 50MO50PO + 80 ppm Zr_2O_3 was recorded to possess the lowest calorific value compared to the other blends. Consequently, the 50D25MO25PO+ 20 ppm Zr_2O_3 mix exhibits superior brake thermal efficiency compared to other blends [28]. The higher calorific value leads to a higher brake thermal efficiency. The Zirconium oxide boosts the properties of the blends and acts as the best accelerator for attaining the highest efficiency [29].

Brake Specific Fuel Consumption

The actual energy use of brake power is determined by brake-specific fuel usage. The proportion represents the required fuel consumption for each watt of braking force [30]. Figure 4 illustrates the relationship between individual fuel usage and engine load. The lowest brake specific fuel consumption (BSFC) is seen with 50D25MO25PO+ 20 ppm Zr_2O_3 at full capacity, followed by 0.20 kg/kWh because of its superior calorific value, resulting in enhanced output for the specified fuel quantity. Following 50D25MO25PO+ 20 ppm Zr_2O_3, the fuel model exhibited the lowest brake-specific fuel consumption (BSFC), being 31.43 % less than diesel because zirconium acts as good boosting catalysts to improve the calorific values of the blends [31]. These results are because of superior economic power generation per kW/h achieved by utilizing a minimal amount of fuel for 50D25MO25PO+ 20 ppm Zr_2O_3 compared to diesel [32]. The lowest calorific value for other blends causes the highest fuel consumption in full-load conditions [33].

COMBUSTION CHARACTERISTICS

Inline Cylinder Pressures

The very important factor that describes the performance of the engine owing to the combustion parameters is significantly described by the term cylinder pressures. This parameter defines the working phenomenon of the gases subjected to different trials [34]. Figure 5 expresses the results of mango seed blends and pyrolysis oil subjected to adding zirconium catalysts. The highest inline cylinder pressures are attained for the blend 69 bar for blend 70D15MO15PO + 40 ppm Zr_2O_3. Because of the good cetane number offered by the blends, it quickly evaporates and achieves the combustions subjected to peak pressures [35]. The other blends possess the lowest

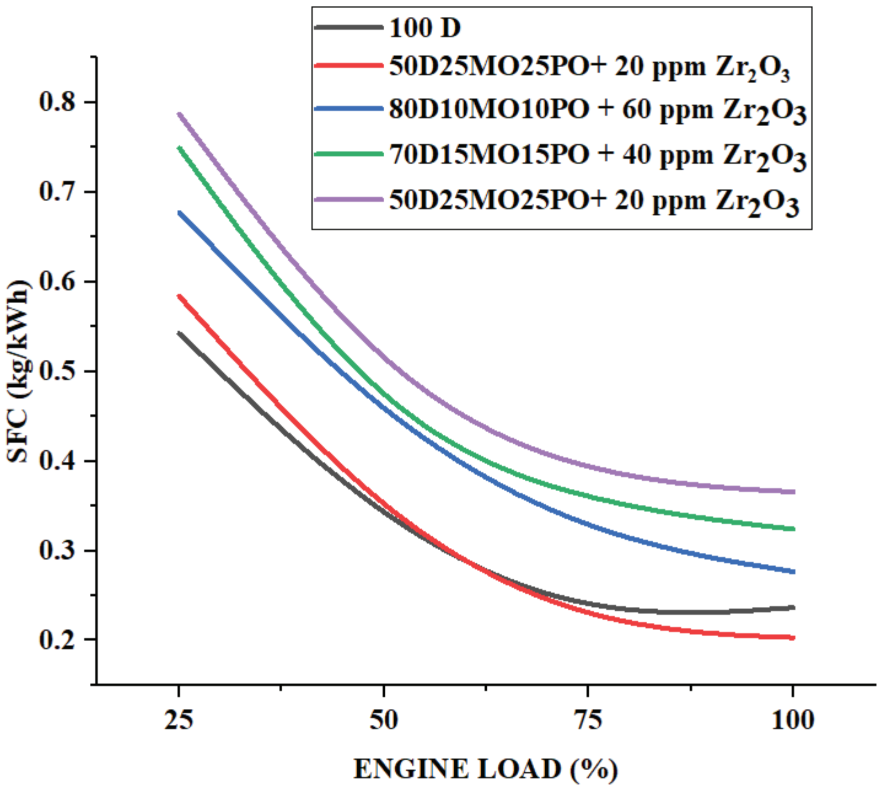

Figure 4. Specific Fuel Consumption.

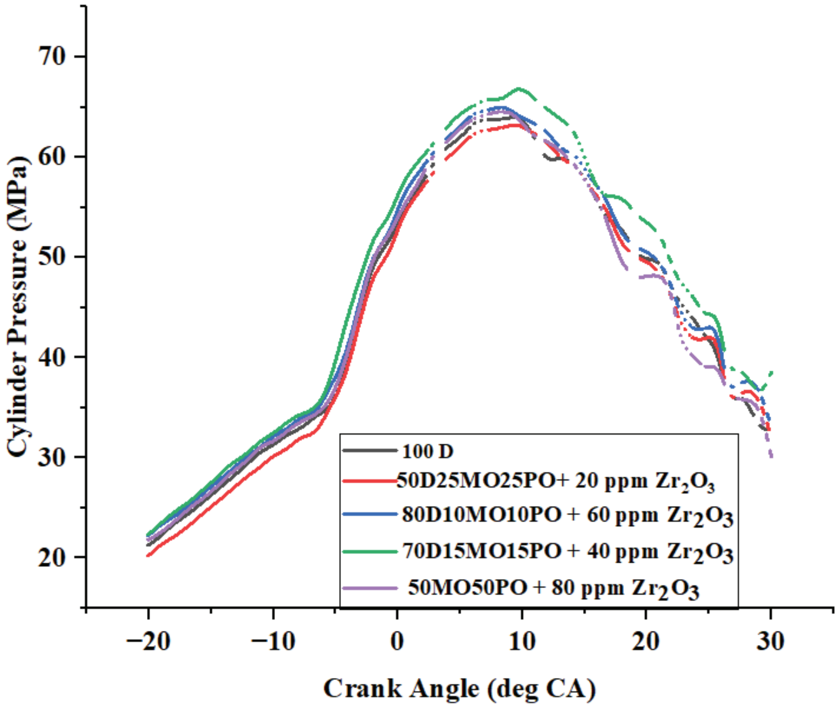

Figure 5. Cylinder pressures.

inline cylinder pressures compared to 70D15MO15PO + 40 ppm Zr_2O_3 and other blends because of the low surface tensions offered for these blends, resulting in low cylinder pressures at elevated pressures and temperatures [36]. The attainment of the lowest cylinder pressures concerning different rpm tends to have the least performance for the lowest pressure rise blends compared to peak pressure rising blends [37].

Heat Release Rate

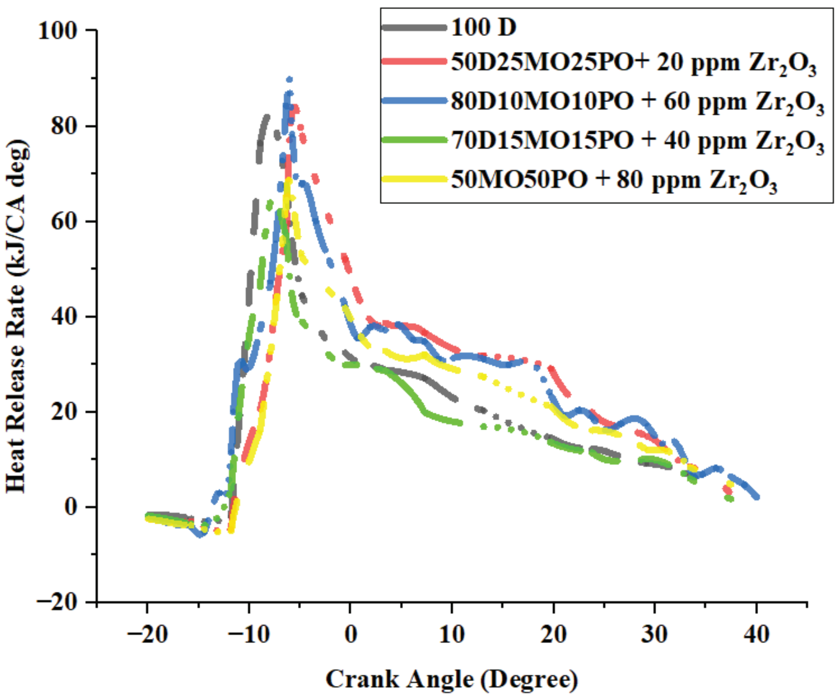

Figure 6. Heat release rates.

The amount of gases evolved during the different blends' peak and moderate loads. When the crank is subjected to different operating pressures and temperatures, it is technically expressed by heat release rates [38]. This term significantly determines the heat-evolving phenomenon for evaluating the combustion rates. Figure 6 demonstrates the Heat release rates offered by different blends. The maximum heat release occurred for the blend 80D10MO10PO + 60 ppm Zr_2O_3, followed by 89 KJ/CA. The phenomenon of this blend occurring with the highest HRR is subjecting to higher surface tensions. Very short ignition delays offered by the blends tend to easy atomization and quicker releasing than other blends [39]. The lower the surface tensions, the lower the heat release rates, resulting in lower performance in terms of efficiency and higher consumption of the fuel [40].

EMISSIONS

CO Emissions

The result of improper combustion is improperly mixing carbon particles with oxygen particulates, which results in peak loads and CO emissions [41]. The continuous emissions of these particulates seriously affect the lungs, and almost 43.5% of people suffer from CO emissions. Figure 7 expresses the CO emissions from different blends used in this analysis. The effect of blend followed by 70D15MO15PO + 40 ppm Zr_2O_3 has significantly less potential at 0.12% and for diesel at 0.18%; the decrease in CO formations is found for the blend 70D15MO15PO + 40 ppm Zr_2O_3 followed by 40% less than diesel. The reason is that adding 40 ppm Zr_2O_3 catalysts potentially decreases density, especially in pyrolysis oil and mango seed blends [42]. This reduced viscosity offers better combustion than diesel and offers low co-emission particulates [43]. The reason for achieving the lowest carbon emissions of all blends compared to diesel is that the catalyst zirconium blends act as the best reagent to react to combustion quickly with available oxygen and emitting particles that are very low compared to diesel [44].

CO_2 Emissions

The combustion occurs due to the inadequate mixing of carbon and oxygen proportions offered by different air-fuel ratios raised by the different blends subjected to load level and engine speed, called carbon dioxide proportions [45]. Figure 8 neatly expresses the CO_2 emissions offered by different blends. The lowest CO_2 emitted for the blend is 70D15MO15PO + 40 ppm Zr_2O_3 blends, followed by 5.6%, but for diesel, the emissions rates are 6.5% at peak loads. The difference in emissions is found by 14.78% for the blend 70D15MO15PO + 40 ppm Zr_2O_3 because the higher ignition delay offered by the blends tends to have

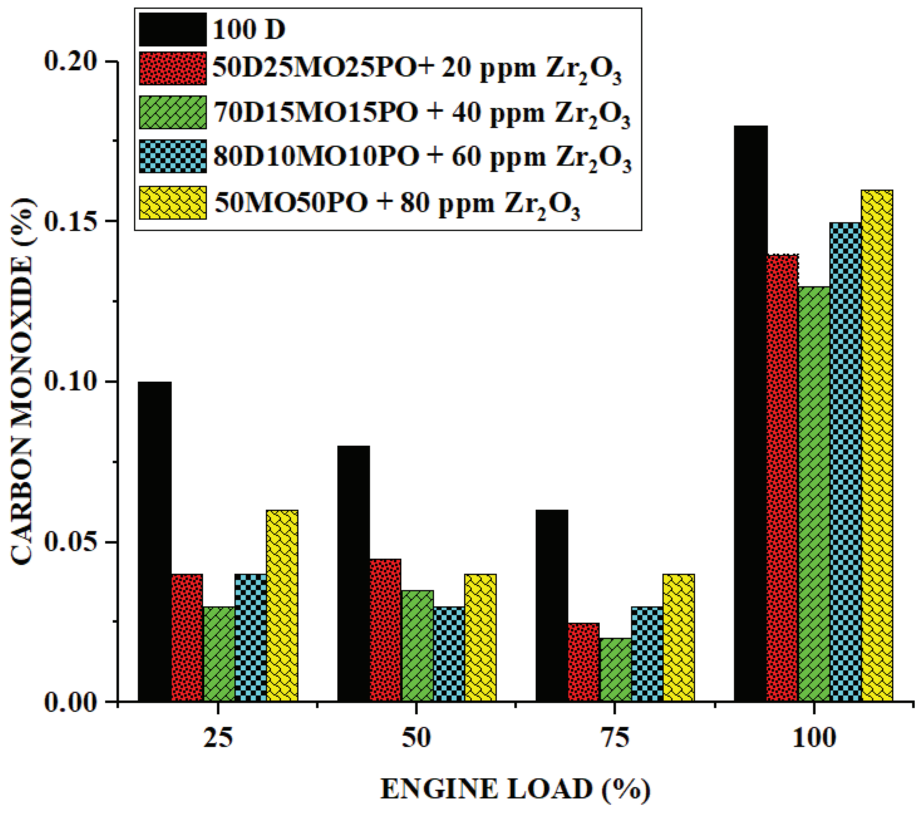

Figure 7. CO emissions.

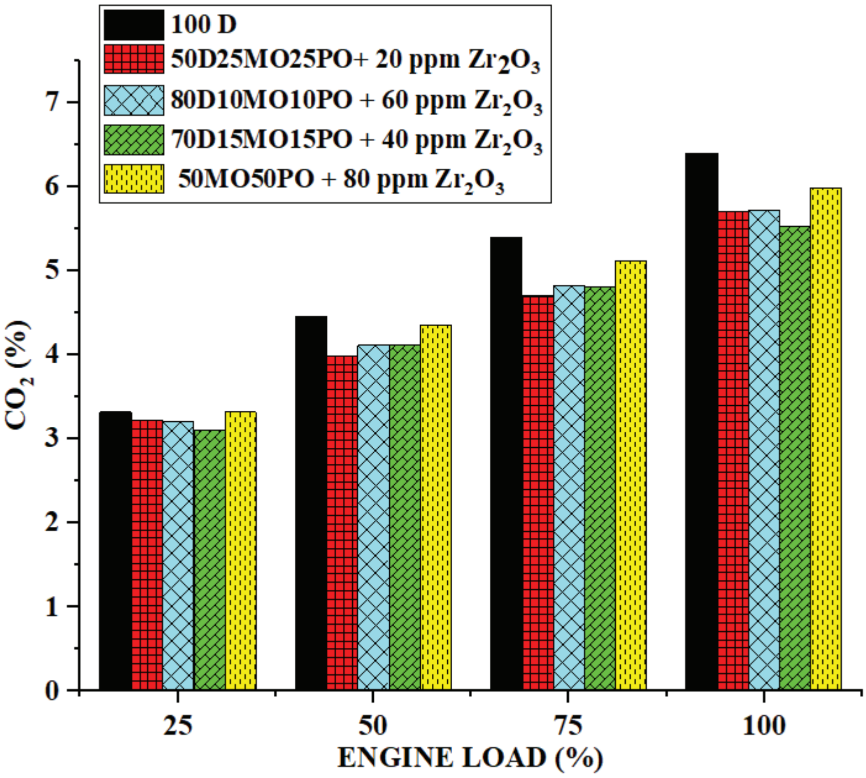

Figure 8. CO_2 emissions.

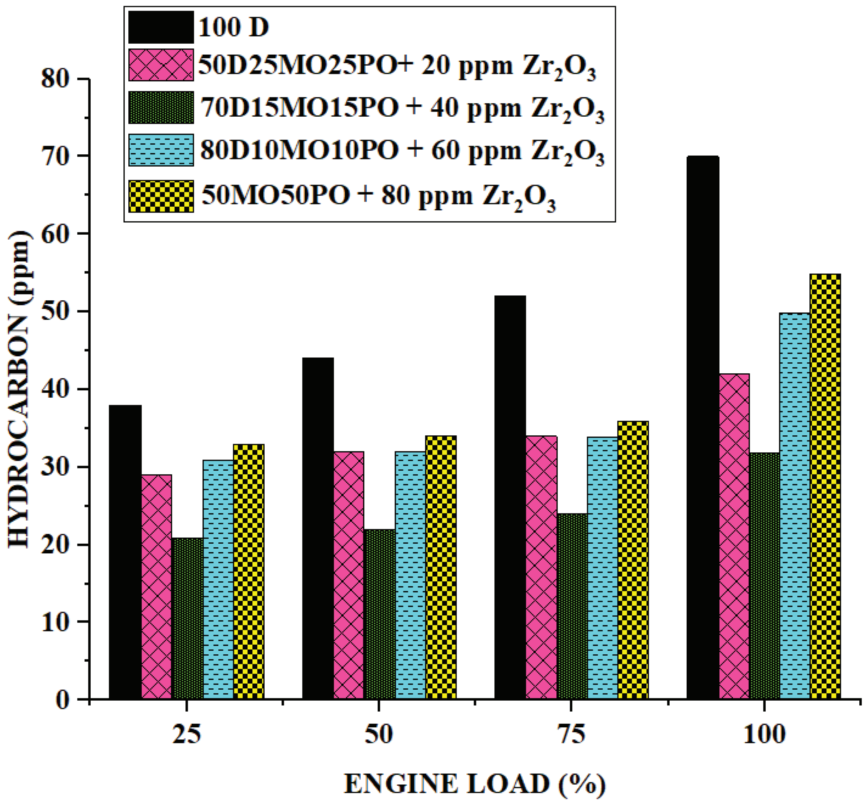

Figure 9. Hydro carbon emissions.

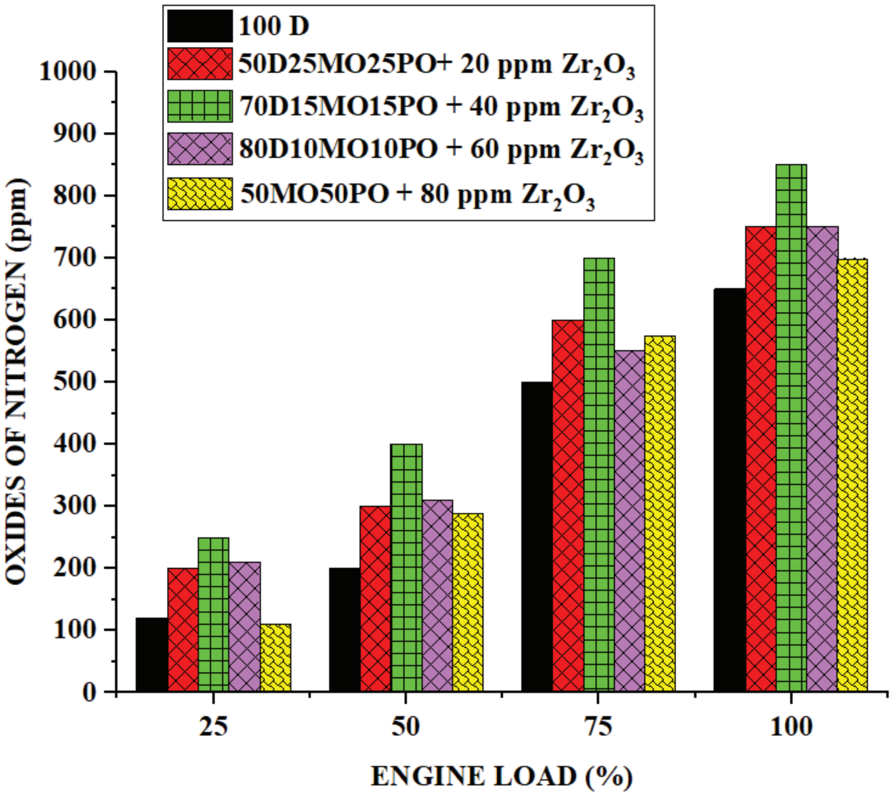

Figure 10. NOx emissions.

more time for oxidizing the carbon atoms with the oxygen atoms, resulting in very least emissions than diesel [46]. The incomplete combustion due to inadequate proportions of oxygen supply emits the particles significantly faster and faster for the different blends than diesel [47].

HC Emissions

The particulates emitted continuously due to inadequate compilation of hydrogen molecules with the carbon molecules owing to the engine piston travelling from BDC to TDC at elevated pressures and temperatures are called hydrocarbon emissions [48]. Figure 9 represents hydrocarbon emissions emitted by the various blends combined with mango seeds and pyrolysis oil. The effect of HC emissions for the blend 70D15MO15PO + 40 ppm Zr_2O_3 is much less effective than diesel. It emits 31 ppm, but diesel emits 70 ppm. The 70D15MO15PO + 40 ppm Zr_2O_3 blend offers very few emissions, followed by 77.7% more than diesel, because of the superior oxidation offered by 40 ppm Zr_2O_3 catalysts to evaporate and atomize the blends very superior way than diesel [49]. Adding the zirconium catalyst with higher proportions up to 60 ppm pushes the combustion acceleration rate to achieve the lowest emissions, and the presence of sufficient oxygenated atoms in mango and pyrolysis blends emits the lowest particulates than diesel [50].

NOX Emissions

The continuous emits of unburnt gases, which are very harmful to the environment, released in the temperature range of 1200 °C to 1300 °C, are called Nitrogen emissions. In other words, at the tail end pipe, the gases that evolved due to incomplete combustion in the temperature range of 1200°C to 1300°C are called NO_X emissions [51]. These emissions in minute forms will cause serious issues for very older adults, causing eye failures. Figure 10. illustrates the NO_X emissions released from the different blends used in this analysis. From the results, it is seen that 50MO50PO + 80 ppm Zr_2O_3 possesses the lowest NO_X emissions, followed by 700 ppm; the reason this blend has lower emissions compared to other blends is lowest viscosity offered by the blend causes it to oxidize and evaporate the blend, in addition to the catalyst of Zr_2O_3 reduces the viscosity for oxidizing the fuel and air very quickly combustion than other blends [52]. The higher temperature formations due to more ignition delay cause the rapid emission formation of nitrogen particles for all the blends compared to diesel.

CONCLUSION

The suitable proportions of mango pyrolysis oil concerned with adding zirconium catalyst with different proportions have been done. The analysis of performance, combustion, and particulate matter on single-cylinder diesel engines has been studied thoroughly with the help of mango and pyrolysis blended with zirconium coatings. The addition of zirconium concentrations from 20, 40, 60, and 80 ppm increases the blends' density, affecting the performance and combustion characteristics. The following results were achieved by these test blends followed by

- 50D25MO25PO+ 20 ppm Zr_2O_3 exhibited the highest brake thermal efficiency of 34.2% compared to all the remaining blends. This is owing to the superior calorific value offered by 50D25MO25PO+ 20 ppm Zr_2O_3, and it was seen that 50MO50PO + 80 ppm Zr_2O_3 fuel attained the lowest BTE followed by (25.5%) due to lower calorific values.
- The lowest Brake Specific Fuel Consumption (BSFC) is seen with 50D25MO25PO+ 20 ppm Zr2O3 at full capacity followed by 0.20 kg/kWh, because of its superior calorific value, resulting in enhanced output for the specified fuel quantity. Following 50D25MO25PO+ 20 ppm Zr_2O_3, fuel model exhibited the lowest brake-specific fuel consumption (BSFC), being 31.43 % less than diesel.
- The highest inline cylinder pressures are attained for the blend 69 bar for blend 70D15MO15PO + 40 ppm Zr_2O_3. Because of the good cetane number offered by the blends, it tends to evaporate and achieve the combustions subjected to peak pressures easily
- The maximum heat release occurred for the blend 80D10MO10PO + 60 ppm Zr_2O_3, followed by 89 KJ/CA. The phenomenon for this blend occurring the highest HRR is subjecting to higher surface tensions and very short ignition delays offered by the blends tend to easy atomization and quicker releasing than other blends
- 70D15MO15PO + 40 ppm Zr_2O_3 has significantly less potential at 0.12%, and for diesel at 0.18%; the decrease in CO formations is found for the blend 70D15MO15PO + 40 ppm Zr_2O_3 followed by 40% less than diesel.
- The lowest CO_2 emitted for the blend is 70D15MO15PO + 40 ppm Zr_2O_3 blends, followed by 5.6%. However, for diesel, the emissions rates are found to be 6.5% at peak loads. The difference in emissions is 14.78% for the blend 70D15MO15PO + 40 ppm Zr_2O_3 because of the higher ignition delay offered by the blends.
- The 70D15MO15PO + 40 ppm Zr_2O_3 blend offers fewer HC emissions, followed by 77.7%, than diesel. Because of the superior oxidation offered by 40 ppm Zr_2O_3 catalysts, the blends evaporate and atomize more efficiently than diesel.
- 50MO50PO + 80 ppm Zr_2O_3 possesses the lowest NO_X emissions, followed by 700 ppm. This blend's lower emissions are due to the lowest viscosity offered, which causes it to oxidize and evaporate.

Future Recommendation

The authors were trying to include other additives, such as decanal and titanium oxide coatings, to determine the performance, combustion, and emission parameters. They were also planning to do work on varying compression ratios. The authors were also willing to do tests concerning propanol as an alcohol with pyrolysis + mango and palm blends with the latest nano additives followed by various proportions.

NOMENCLATURE

BDC	Bottom dead centre
BTE	Brake thermal efficiency
BSFC	Brake specific fuel consumption
TDC	Top dead centre
CA	Crank angle
CE	Conventional Engine
CO	Carbon oxide
CO_2	Carbon dioxide
HC	Hydro carbons
PPM	Parts per minute
Zr_2O_3	Zirconium oxide
50MO50PO	50% Mango oil + 50% Pyrolysis oil
50D25MO25PO	50% Diesel + 25% Mango oil + 25% Pyrolysis oil
70D15MO15PO	70% Diesel + 15% Mango oil + 15% pyrolysis oil
80D10MO10PO	80% Diesel + 10% Mango oil + 10% pyrolysis oil
NO_X	Nitrogen dioxide

AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was not used in the preparation of the article.

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