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Use of Neem Vegetable Oil Blends with Diesel Fuel on Variable Compression Ratio Engine-an Experimental Approach

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ABSTRACT

This unique research was carried out to make rural areas in underdeveloped countries self-sufficient in energy production. The compression ignition engine plays an important role in the case of automotive and defence industries. Vegetable neem oil, which is inedible and has a low volatility and high viscosity, was used as fuel in a CI engine in this work. Instead of using trans-esterification, which requires chemical analysis for production of bio-diesel and is impractical in rural areas, neem oil's viscosity can be minimized by mixing it with diesel and heating it using waste heat from engine exhaust fumes. An investigation of the efficiency and emission properties of different mixes of heated and unheated neem vegetable oil with diesel was conducted using a diesel engine. The work aimed to enhance the performance and emission characteristics using blends of neem oil with diesel. Researchers have discovered that the warmed neem oil B-30 mix (30% neem oil + 70% diesel) outperforms all other blending combinations of preheated and unheated neem oil and diesel, resulting in superior performance and reduced emissions. In this research study instead trans-esterification preheated neem oil blends were utilized for investigation to enhance its thermodynamic properties namely calorific value, viscosity to get better results. There were very few studies on preheating of vegetable oil. Hence it is a novelty research work, which is very useful in future because diesel fuel will be finished by 2040 approximately. So, we must go for alternative fuels. Brake thermal efficiency increases by 5.07% when the ideal Neem blend is preheated. Moreover, it lowers CO, HC, and smoke opacity by 7.85%, 0.6%, and 8 ppm, respectively.

1. INTRODUCTION

In a few decades, conventional fuels will run out rapidly. Due to limited petroleum reserves and ongoing environmental damage, there is an urgent need to discover alternatives to conventional fuel. Alternative fuels should be green, clean, sustainable, affordable, accessible and safe for the environment.

Vegetable oil is a clean, renewable, green, and eco-friendly energy source. Oil blends have almost the same energy density, cetane number [1, 2]. Oil blends have the potential to drastically lower pollution levels because they are renewable, biodegradable, and contain more oxygen. Oil blends with diesel significantly reduce pollutants in diesel engines [3]. Use of edible vegetables are banned in India due to limited production and utilization in food items. Non edible vegetable oils are having lot of potential in India.

Some researchers were able to successfully study the short-term direct use of oil blends in CI engines, even though long-term endurance tests revealed problems with engine durability, including gum formation, severe engine deposits, piston ring sticking, injector coking, and thickening of lubricating oil [4]. Vegetable oils have about ten times the viscosity of mineral fuel. Furthermore, research indicates that reducing the viscosity of pure oil blends is necessary before utilizing them [5, 6]. Reducing viscosity enhances atomization and flow characteristics [7, 8].

Transesterification is popular technique for reducing the viscosity of these oils but it requires lot of glassware, chemicals, processing heat, biodiesel conversion plant. This technique is unaffordable in rural area and logistic issues are also there; Thus, in rural areas, blending and preheating with waste heat from engine exhaust gases may be the most effective method for bringing the characteristics of vegetable oils closer to those of petroleum diesel [9]. Keeping in view of these facts Neem oil which is abundantly available in India is assessed through experimentation to check the feasibility as a fuel in diesel engine in blended and straight form.

Reducing viscosity is usually enough to improve flow characteristics and atomization. Heating, transesterification, emulsification, and mixing are the primary processes used to reduce the viscosity of these oils [5, 8].

The most effective method for improving the properties of vegetable oil to more closely resemble mineral diesel is to transesterify it into biodiesel. However, this process is more expensive and time-consuming because it requires additional chemicals and process heat [6, 7, 9, 10].

Although economic limitations have restricted their extensive use, Compression Ignition engines are nevertheless widely employed in rural developing countries for agricultural equipments such as agricultural machinery, and D.G. Sets [11]. Due to high costs and a lack of energy resources, people in rural areas consume less energy. However, they can meet their needs by producing their own electricity using VO in base engines [4, 12, 13].

In a diesel engine, the enhancement in mechanical efficiency and gases coming out from exhaust manifold have been examined [14]. The best blend, according to this research study, is B20 Blend (20% oil blend and 80% diesel).

Transesterification is popular technique for reducing the viscosity of these oils but it requires lot of glassware, chemicals, processing heat, biodiesel conversion plant. Because this method is costly and logistically complex, blending and preheating with waste heat (engine exhaust gasses) may be the most effective way to improve the properties of vegetable oils in rural areas [14-16].

1.1 Vegetable oil

Vegetable oils are produced locally, however producing biodiesel through chemical processing is not practical nor economical in rural poor nations due to logistical issues. In light of these findings, heating and mixing in tandem could be a practical method for lowering the viscosity of vegetable oils. We use this fuel in an experiment to study the potential of neem vegetable oil and blends with diesel in CI engines that have been preheated by engine waste exhaust gasses [17-20].

1.2 Vegetable neem oil

The plant neem (Azadirachta indica), which is native to the Indian subcontinent and has spread to many other tropical regions, yields neem oil, also referred to as Margosa oil. Due to its chemical makeup, it is the most significant neem product that is commercially accessible and is frequently employed as a pesticide in organic farming [21-23].

An experimental investigation has been carried out to evaluate the effect of using ethanol as additive to neem oil methyl ester on the combustion, performance, and emission characteristics of a diesel engine at different loads and constant engine speed. From the combustion analysis, it is found that the ignition delay increased with higher proportion of ethanol in the blends; maximum cylinder pressure and maximum rate of heat release increased with the increase of ethanol proportion in the blends [24-26].

Neem is a priceless gift from nature and an all-powerful tree. The most important and useful medicinal plant grown mostly in the Indian subcontinent is the neem tree. Neem is an old herb that comes from the same family as mahogany, Meliaceae. Azadirachta indica is the botanical name by which it is currently known [27-29].

The performance and emission characteristics of CI engine are studied when fuelled with neem oil with diesel blends of ratios B10, B20 and B30 and also with M10% & M20% where methanol is used as the blending agent. The tests were carried out in the 4 stroke, single cylinder diesel engine by varying the load from 25% to 100% [30-32].

The testing results show without any modification to diesel engine, under all conditions dynamical performance kept normal, and the B20, B50 blend fuels (include 20%, 50% crude biodiesel respectively) led to unsatisfactory emissions whilst the B′20 blend fuel (include 20% refined biodiesel) reduced significantly particles, HC and CO etc. emissions. For example CO, HC and particles were reduced by 18.6%, 26.7% and 20.58%, respectively [33].

Neem is a tall, evergreen tree with a 2.5-meter circumference that grows quickly. Its fragrant blooms and lush green foliage form a gorgeous crown. About 100 distinct bioactive compounds found in neem have potential uses in public health, agriculture, animal care, and maybe even the management of human reproduction. Because it comprises extracts from herbal medicines that have been used for centuries to treat illnesses due to their low side effects and environmental friendliness, these pharmaceuticals offer a wide range of possible applications [34, 35].

According to prenius studies, VO is biodegradable, and have the potential to drastically lower pollution [36, 37]. According to Forsion et al. [38], they also resemble mineral diesel in terms of energy densities, cetane numbers, temperatures of vaporization, and stoichiometric air/fuel ratios. In diesel engines, the use of vegetable oils and their derivatives greatly lowers the emissions of smoke, particulate matter (PM), carbon monoxide (CO), and sulfur oxides. According to previous studies, pure oil blends cannot be used without being modified to more closely mimic petroleum fuel, like diesel [39-41].

The review of the literature reveals that the majority of the studies were conducted for analytical, experimental, and numerical inquiries by previous researchers. In this work, mixtures of vegetable neem oil and diesel are used to experimentally investigate a diesel engine with a variable compression ratio. The majority of researchers have made use of biodiesel made by the transesterification method. However, in this case, heat from engine exhaust fumes is employed in a preheater to heat neem oil mixtures rather than trans-esterification to enhance the Reynold's number by decreasing it's viscosity. In this research study instead of trans-esterification preheated neem oil blends were utilized for investigation to enhance it's thermodynamic properties namely calorific value, viscosity to get better results. There were very few studies on preheating of vegetable oil.Hence it is a novelty research work, which is very useful in future because diesel fuel will be finished by 2040 approximately. So we must go for alternative fuels. The mixes of neem oil reached 90-95℃, because no prior research of this kind has been done, this study is innovative and novelty research [42-44].

In this innovative and novelty study the neem vegetable oil was utilized on the engine.The optimum blend was found to be B30, or 30% neem oil and 70% diesel. Thirumalai and his team researched biodiesel and neem oil and found that a blend of 10% neem oil butyl ester in diesel resulted in enhancement in mechanical efficiency and lowered the percentage of emissive gases [45]. Researcher has put up the theory of Single-sample uncertainty analysis [46].

To improve performance, they have also looked at how the fuel mixture behaves in the Cl engine. The goal of this study is to assess how next generation fuel affects diesel engine performance 40. This study is a component of that goal. More et al. [47] have done experimental study using biodiesel blends produced from cooking oil. They were studied the performance as well as emission characteristics of single cylinder diesel engine. They found better results. They also studied thermodynamic properties of cooking oil. They were observed that the physical properties (density and viscosity), chemical properties (cetane number and heating value) and thermodynamic properties were enhanced by addition of Di-ethyl ester (DEE).

More et al. [47] have studied effect of CR on mechanical efficiency of diesel engine using biodiesel produced from waste cooking oil. They observed enhancement in BTE by 16.06% and decrease in fuel consumption by 4.12%. More et al. [48] investigated the combined effect of compression ratio on performance.This study provides ecofriendly working conditions which results in fewer emissions and improved performance. In this investigation it was also observed that at higher compression ratio Nitrogen dioxide was reduced and at lower compression ration carbon monoxide percentage were reduced %. More et al. [49] characterized biodiesel blends using chromatography, infrared spectroscopy, and element analysis. This study found improvements in both thermodynamic characteristics and thermal behavior. In this experiment, combustion characteristics were also shown to be enhanced.

More et al. [49] have done study of mixed dairy waste and Karanja oil, bio-diesel production using Taguchi L9 orthogonal array and charaterization of Karanja oil bio-diesel blends to study it’s suitability as a renewable alternative fuel through gas chromatography, infrared Spectroscopy element analysis.

Alahmer et al. [50] have utilized 20% biodiesel produced from vegetable oil and 80% diesel on single cylinder diesel engine. In this study it was concluded that emission characteristics observed are good using bi-diesel as compared to that of 100% diesel. So carbon monoxide percentage was reduced and carbon dioxide percentage was increased. Using 20% biodiesel with 80% diesel, BTE was observed to be improved [51].

2. EXPERIMENTAL SETUP

We used a Single cylinder diesel engine for our research Work. The experimental equipment consists of a calorimeter, rotameter, and thermocouples to measure temperatures at different locations and the amount of water used to cool the engine. To get different measurements, we use a control panel that has a measuring instrument, an air and fuel tank, and other components. The engine specs and other equipment and gadgets are shown in Table 1 and properties of neem oil are shown in Table 2. A photographic view of the arrangement is displayed in Figure 1. A snapshot of different neem oil blends may be found in Figure 2. A block diagram of the experimental setup is shown in Figure 3.

Figure 1. A photographic view of the engine with dynamometer set up

Figure 2 represents photograph illustrates the development of different neem oil blends.

1. Engine Base
2. Exhaust Gas Analyser
3. Exhaust Gas Analysing Probe
4. VCR Engine
5. Load Cell
6. Dynamometer
7. Speedometer
8. Control Unit
9. Burette
10. Fuel Thank

Figure 2. Development of different neem oil blends

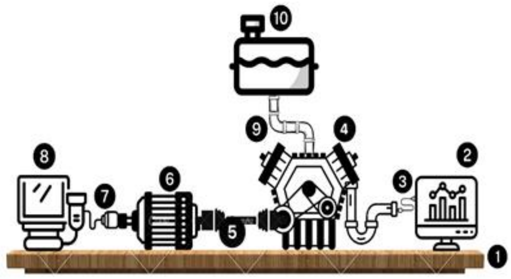

Figure 3. Block diagram

Table 1. Engine specifications

Sr. No.	Description	Specification
1	Engine Model	M/S KOEL, Pune
2	Type	Single cylinder, Naturally Aspirated,diesel engine
3	Cylinder Bore	8.75 cm
4	Engine Stroke	11 cm
5	CC of Engine	661 CC
6	Mean Effective Pressure	77.5 bar
7	RPM	1500 rpm
8	CR of Engine	Minimum-12:1 , Maximum- 22:1
9	Minimum Operating speed	1200 rpm

Table 2. Properties of neem oil

Sr. No.	Name of Thermodynamic Properties of Neem Oil	Value
1	Kinematic Viscosity (cSt 40°C)	57
2	Heating Value (MJ/kg)	39.4
3	Cetane Number	47
4	Carbon Residue(w/w)	0.96

2.1 Methodology

Experimental set up shown in figure was utilized for investigation. In that waste exhaust heat was used for preheating of Neem oil blends along with diesel instead of trans-esterification. Due to preheating thermodynamic properties of Neem oil blends and diesel namely calorific value, Reynold's number got improved and viscosity were reduced. Neem oil and diesel were compared for attributes in the institution's laboratory. The institute's workshop designed and produced a set up. To finish the trial setup, the engine was fitted with the designed preheating mechanism. The range of neem-diesel blends is B10 to B100, with a 10% variation in neem oil. The several Neem vegetable mixes that were created are shown in Figure 3. The engine is first tested using diesel fuel to get baseline data. Afterwards, trials are conducted using different neem oil blends that have been preheated using waste exhaust gasses. For better engine performance and emission characteristics, the Neem oil blend was adjusted. Another test was conducted using the same neem oil combination without any heating. Lastly, the identical neem oil blend and diesel fuel without heating were contrasted with the performance and emission characteristics of the optimum preheated neem blend.

2.2 Uncertainty analysis

During experimentation some readings are taken that may be inaccurate or uncertain due to a variety of factors, including operating conditions, environmental factors, human observations, test case planning, accuracy and precision of the equipment, and more [23, 24]. Table 3 displays the calculated uncertainty of several values.

Table 3. Uncertainty of various parameters

Measured Quantity	Range of Experimentation	Resolution	% Uncertainty
BTE	0-33.25	-	± 0.11
BSFC	0.29 - 3.08	-	± 0.117
Smoke	15-100	0.1 %	± 0.108
CO	0.035-0.25	0.01%	± 0.16
CO_2	0.98-3.75	0.1%	± 0.08
HC	8-42 PPM	1 PPM	± 0.009
NO_X	210-445 PPM	1 PPM	± 0.009

3. RESULTS AND DISCUSSION

Numerous tests including diesel, preheated neem oil blends, and an unheated optimal blend were conducted as part of the current inquiry. Diesel and several neem oil combinations were used in engine tests after diesel and neem oil were first documented.

3.1 Analysis of neem oil and diesel fuel

The analysis findings for both preheated and unheated neem oil and diesel are displayed in Table 4. The properties of heated neem oil start to resemble those of diesel about 80-90°C. Neem oil loses a significant amount of viscosity as it reaches temperatures above 60°C. In the institute laboratory, each of these attributes was evaluated. Neem oil's viscosity increases to nearly that of diesel after heating, although its specific gravity and calorific value remain relatively unchanged.

Table 4. Analysis findings for both preheated and unheated neem oil and diesel

Parameter	Diesel	Unheated Neem Oil	Preheated Neem Oil
BTE	32.85%	29.92%	34.99%
BSFC	0.31 g/Wh	0.33 g/Wh	0.29 g/kWh

3.2 Performance characteristics

Testing was done on different neem oil blends mixes with diesel after the engine's performance was examined using diesel fuel as a baseline. Two phases of analysis were conducted on these results for every emission parameter and performance. The performance of different warmed blends was compared in the first step. In the second phase, the outcomes of an unheated similar blend (B30), diesel fuel, and an optimal warmed blend (B30 in this study, which is a first-phase finding) were compared.

3.2.1 Brake thermal efficiency

The Calorific value of the fuel and the amount of load applied to the engine determine an engine's thermal efficiency. The brake thermal efficiency (BTE) change with load for various neem oil blends is displayed in Figure 4.

All neem oil blends exhibit an increase in brake thermal efficiency (BTE) as the load increases. As the mix proportion of neem oil increases, Figure 4 illustrates that BTE decreases. Compared to other neem oils, the BTE of the B30 neem oil combination is higher. The outcomes for B20, B10, and B30 are comparable. At full load, the BTEs for the blends B10, B20, and B30 are 26.73%, 28.18%, and 34.99%, in that order.

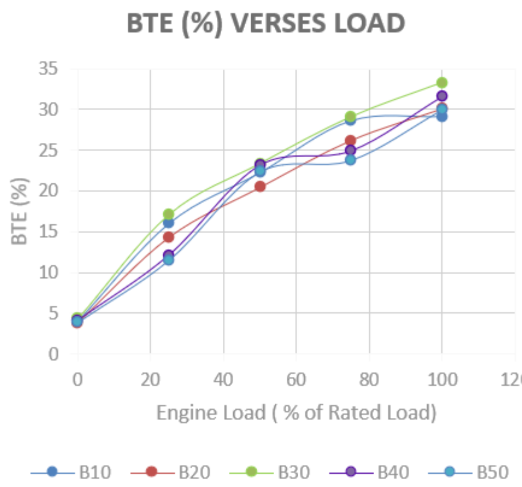

Figure 4. BTE v/s load for various preheated neem oil

The presence of oxygen in the fuel improves the characteristics of combustion; however, the poor atomization and combustion characteristics caused by the increased viscosity of the oil result in lower thermal efficiency of higher blends of vegetable oils when compared to diesel and lower concentration blends.

Figure 5 compares the brake thermal efficiency at various loads using diesel fuel, an optimal preheated neem oil blend (B30), and the same blend without heating. Under all load scenarios, diesel has a higher BTE than both unheated and preheated neem mixes.

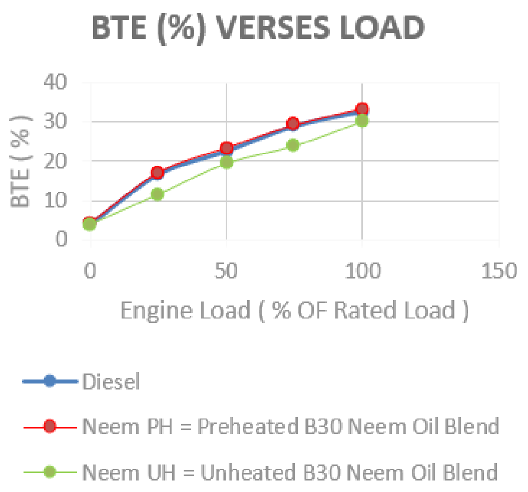

Figure 5. BTE v/s load for various preheated, unheated B30 & diesel

It might be because the preheated and unheated neem B30 mixture is more viscous than diesel, and more viscous fuel results in poorer atomization and insufficient fuel and air mixing. At full load, the BTE for the warmed optimum neem B30 mix (34.99%) exceeds that of diesel (32.35%). Preheating with waste heat from exhaust gasses improves the B30 neem blend's thermal efficiency by 5.07%. Preheated neem blends have a lower viscosity than unheated blends.

3.2.2 Brake specific fuel consumption

Figure 6 illustrates the Break Specific Fuel Consumption (BSFC) for several preheated neem blends, ranging from B10 to B100. As the load grows and the mix percentage of warmed neem oil rises, BSFC decreases. Preheated neem oil blend B30 is the best combination because it has a lower BSFC than other blends. The warmed B20, B30, and B10 neem oil blends have corresponding BSFC values of 0.30 g/Wh, 0.29 g/Wh, and 0.31 g/Wh.

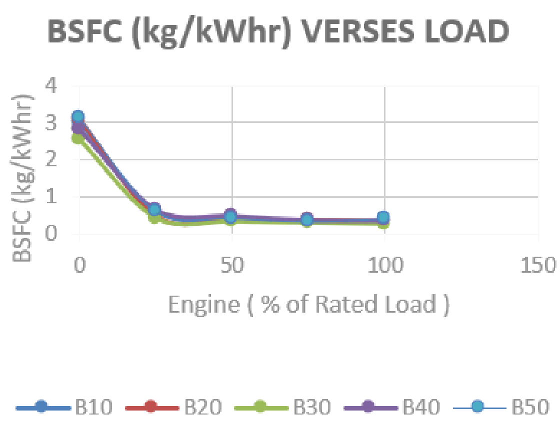

Figure 6. Curves of BSFC and % load

A comparison of BSFC for diesel, preheated B30 neem blend, and unheated same neem blend is presented in Figure 7. As the load increases, BSFC decreases until it hits 100% load, when it is at its lowest. In comparison to the unheated B30 neem blend (0.41 kg/kW h), the BSFC for diesel fuel and preheated neem B30 blend (0.29 kg/kW h) is the found to be same (Figure 7). Fuel savings from preheating the B30 blend are 0.18 kg/kW hour. Lower BSFC is the result of improved fuel atomization and mixing during preheating.

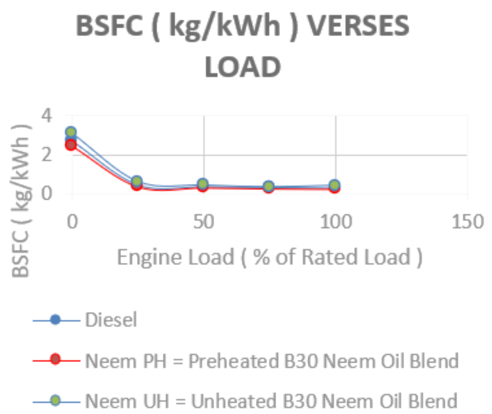

Figure 7. Curves of BSFC verses load for preheated and unheated NMO30

3.2.3 Exhaust gas temperature

Exhaust gas temperature (EGT) varies with load for warmed varying neem blends B10-B100 (Figure 8). EGT increases with load for each neem oil blend and diesel fuel. The temperature of the exhaust gas increases as the percentage of warmed neem oil in the blend increases (it is highest for B100 and lowest for the B10 warmed blend).

EGT is higher for warmed and unheated neem B30 blends than diesel, with the exception of full load, as shown in Figure 9.

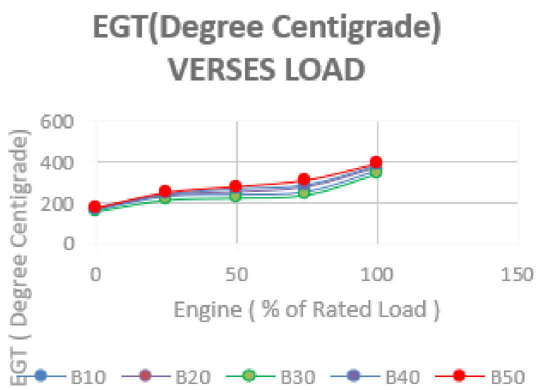

Figure 8. EGT verses load for various neem oil blends

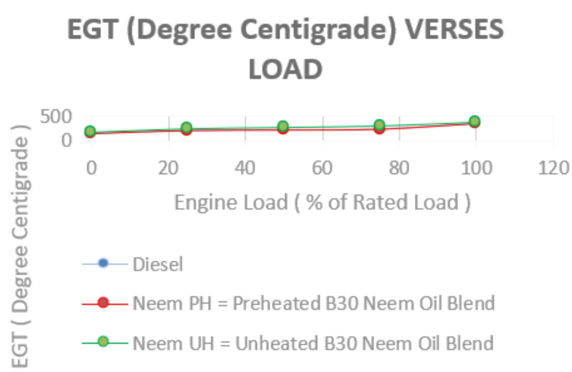

Figure 9. Curves of EGT verses load for diesel and neem oil blends

3.3 Emission characteristics

3.3.1 Carbon monoxide emissions

Five gas analyzers, which are small diagnostic devices, were used in conjunction with smoke meters to examine exhaust gas emissions. Diesel and both heated and unheated neem mixtures were studied for smoke opacity, CO, CO_2, HC, and NOx levels. The comparison of emissions and performance outcomes was similar.

Carbon monoxide is one of combustion's intermediate products. Every bit of CO will turn into CO_2 if combustion is complete. Figure 10 displays the variation of carbon monoxide with variation in engine % load at various blends of neem oil. It is evident that carbon monoxide emissions rise with load because of greater fuel consumption and fall with higher compression ratios because of better combustion. In comparison to the other ratios, it is lowest for NOB30 (30% neem oil and 70% diesel) under all loading conditions. Preheated NOB30 emits the least amount of carbon monoxide when compared to diesel and unheated blends, as seen in Figure 11, which compares carbon monoxide emissions for diesel, unheated, and warmed NOB30 blends with diesel at different load conditions.

Figure 9 depicts carbon monoxide (CO) emissions caused by incomplete fuel burning, as well as CO emissions from various warmed neem mixtures. With the exception of B30 warmed neem blend, which has constant emission at 50% rated loading, all neem blends have CO emission that decreases at first loading and increases with each loading. Out of all the blends, the B30 preheated neem blend has the lowest CO emission at maximum load.

A comparison of the CO emissions from preheated diesel and unheated B30 blends is shown in Figure 10. Diesel (0.17%) and unheated B30 blend (0.23%) had higher CO emissions than preheated B30 mix (0.15%). Compared to the diesel and unheated mixes, the optimum blend that has been preheated has superior combustion.

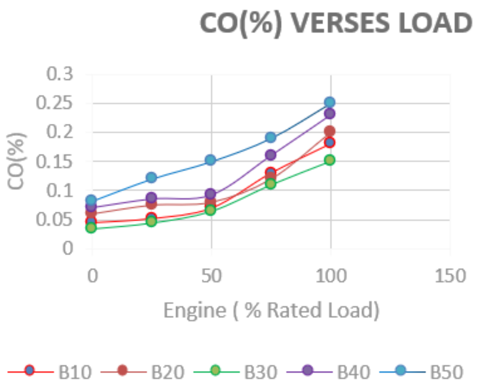

Figure 10. Curves of CO emissions verses load

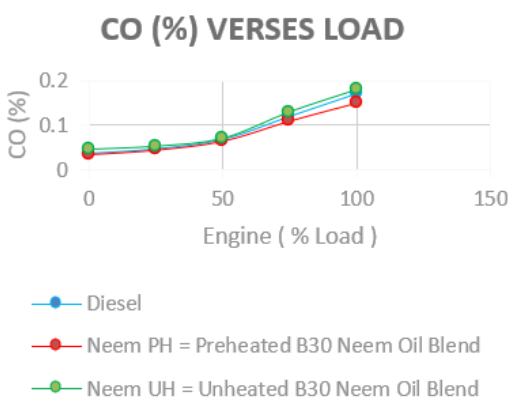

Figure 11. Curves of CO emissions verses load

3.3.2 CO_2 emissions

The amount of CO_2 released in exhaust fumes is a good indicator of the quality of the combustion process because full combustion produces more CO_2 and less CO. Compared to other warmed blends, the B30 preheated neem mix had greater quantities of carbon dioxide in its exhaust emissions (Figure 11). As seen in Figure 11, blends B50 and B100 have lower CO_2 emissions than other mixes. As the load increases, these emissions are observed to increase. The CO_2 emissions of diesel, warmed, and unheated neem mixes are contrasted in Figure 12. Emissions from warmed B30 blend are higher (2.95%) but lower (3.75%) than those from diesel (2.65%).

Figure 13 represents curves of CO_2 emissions.

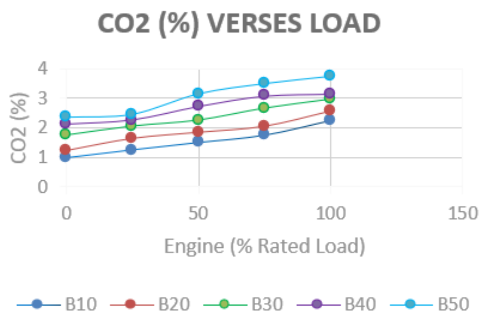

Figure 12. CO_2 emissions curves verses load

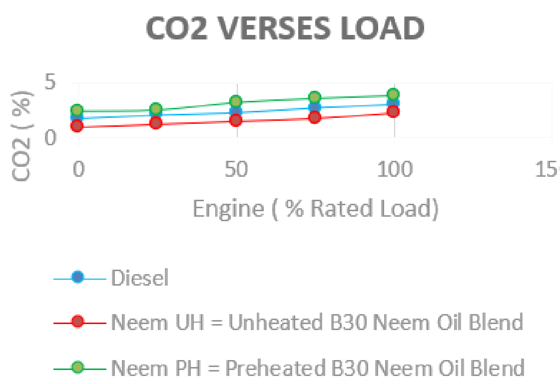

Figure 13. Curves of CO_2 emissions

3.3.3 HC emission

This study assessed hydrocarbon emissions in parts per million (ppm). Figure 14 illustrates that HC emissions decrease with initial loading and increase with subsequent loading. The Preheated B30 neem oil blend emits less hydrocarbon than other neem blends.

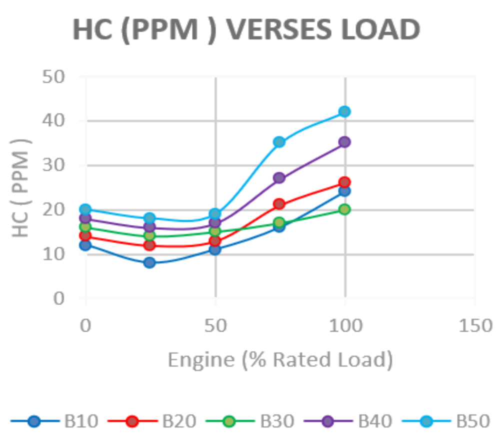

Figure 14. HC emissions verses load

A comparison of the HC emissions is presented in Figure 15. Preheated B30 neem blend (20 PPM) emits fewer hydrocarbons than unheated neem mix (42 PPM) and diesel (23 PPM).

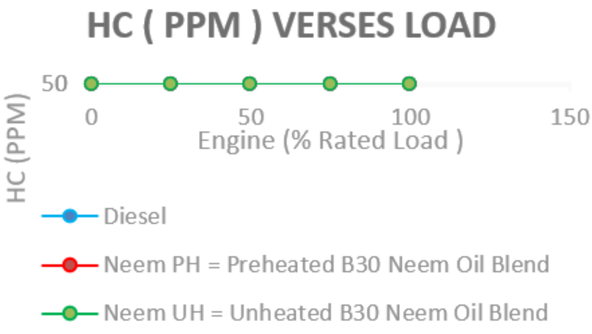

Figure 15. Curves of HC emissions verses load

3.3.4 NOx emissions

NOx emissions for a number of blends, from B10 to B50, is displayed in Figure 16. When all neem mixtures and diesel fuel were loaded to 50%, NOx emissions rose at first but then fell. The maximum NOx emission for all blends happens at 50% load. Compared to other neem blends, the warmed B30 neem oil mix releases less NOx. Because there is more oxygen in vegetable oils, NOx emissions are generally higher; however, because neem mixing has a shorter burning time than diesel, NOx emissions are reduced. Figure 17 represents NOx emissions curves verses load.

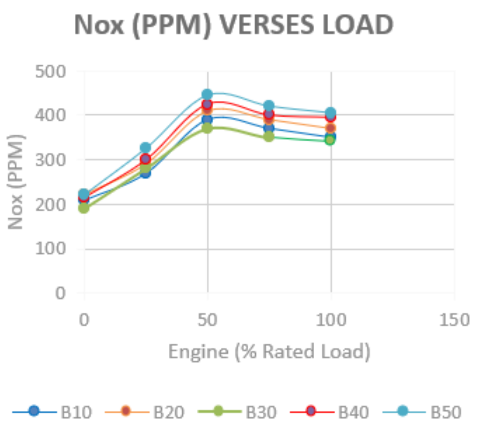

Figure 16. NOx emissions curves verses load

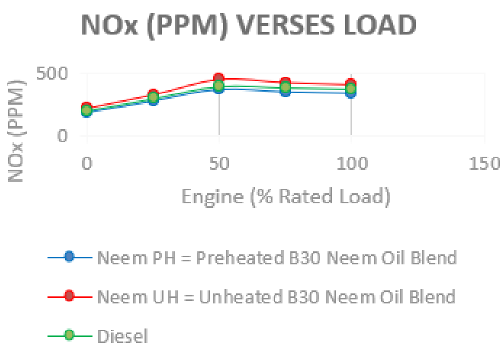

Figure 17. NOx emissions curves verses load

As illustrated in Figure 16, at full load the preheated neem B30 mix emits less NOx than diesel, but at medium load (50-75%) it emits more NOx than both diesel and the unheated identical blend. Because preheated neem blend burns at a greater temperature than unheated neem blend, it emits more NOx. More NOx is produced at higher combustion temperatures.

3.3.5 Smoke opacity

The smoke variation with load for various preheated neem blends is shown in Figure 18, which also represents an increase in smoke emission with load and blend percentage of warmed neem. A comparison of the smoke emissions from diesel, warmed, and unheated B30 neem mixes is presented in Figure 19. It indicates that while smoke emissions increase with load, B30 preheated neem blend produces less smoke than both diesel and unheated B30 mix oil. When the smoke opacity was expressed as a percentage of volume, the warmed B30 neem oil combination had the lowest percentage.

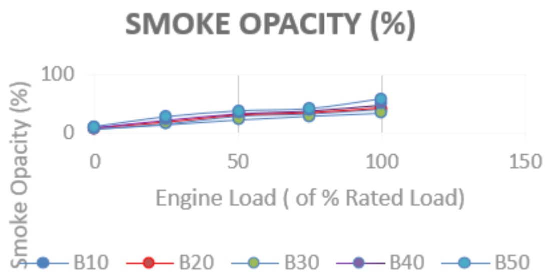

Figure 18. Curves of smoke opacity verses load

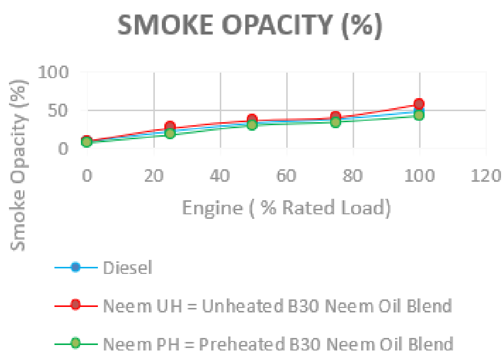

Figure 19. Curves of smoke opacity verses load

A comparison of the smoke emissions from diesel, warmed, and unheated B30 neem mixes is presented in Figure 19. It demonstrates that smoke emissions increase with load and that the B30 neem mixture when it is warmed emits less smoke than when it is diesel and unheated.

Preheating lowers smoke emissions by 3% as a result of enhanced combustion. Because neem oil burns more efficiently and contains more oxygen than vegetable oil, it produces less smoke when heated or not.

4. ECONOMIC ANALYSIS

Plant seeds are the source of vegetable oils, and the costs involved in production include those related to seed cultivation, seed collection, and oil extraction. One result of it is oil cake, which is sold on the market and fed to animals. Neem plants produce between 2500 and 3500 kg of seeds per hectare, with an oil content of 19-25% by mass; the yield considered in this study is 20% of this output. This plant grows naturally in the fields of Maharashtra, Kerala, and Karnataka, two large states in our country, without deliberate cultivation. When compared to other vegetable oil plant cultivation methods, such as thumba, jatropa, and karanj, which have cultivation expenses of roughly Rs. 2800/hectare, planned cultivation can lower culture costs to about Rs. 300-800/hectare [14].

The cost of neem seed is influenced by soil type, planting density (the number of plants per hectare), and the quantity of post-planting activities. Improved feedstock cultivation can lead to lower neem oil production costs.

Our research study has more potential because in this study we have utilized waste heat for preheating of neem vegetable oil blends. Due to that we found enhancement in Reynold's number and Calorific value which were responsible for better performance of single cylinder diesel engine. We have found B-30 as optimum blend, that was mixed with 70 % diesel. So, we saved 30% diesel by use of optimum neem vegetable oil blend. Hence diesel stock in the world is to be maintained up to 2050 instead of 2040 in the World. That is major advantage for the World to maintain the stock for very long time. Neem vegetable oil is easily available because in the India there are more neem trees. In Maharashtra particularly in Osmanabad district neem trees are available in bulk quantities and process of producing neem oil from neem seed is also easy. So, our research study having more potential than other researches. It is also useful in many industries, malls, colleges, etc. for operating D.G. sets. And our research is novelty research which was carried out without engine modifications. Also, we have got the best results and we have achieved our outcomes.

5. CONCLUSIONS

The novel alternative fuel's performance and emission characteristics were evaluated and contrasted with diesel in the current investigation. In order to make neem vegetable oil appropriate for use in a CI engine, its viscosity was reduced by preheating of neem oil blends by best utilization of engine exhaust heat to enhance thermodynamic properties of neem oil blends and diesel. In other researches this was not done. Better results were obtained both for performance and emission characteristics without engine modifications. The conclusions drawn from the previously provided data were as follows:

- It just takes 80-100°C to raise neem oil's viscosity to that of diesel. Also, calorific value of neem oil blends was observed to be improved.
- Out of all the preheated neem blends, the B30 blend has the lowest brake-specific fuel consumption and the maximum thermal efficiency.
- Out of all the preheated neem blends, the B30 neem mix has the least emissions.
- The best blend is the preheated neem B30 mix since it yields better results than other blends.
- In comparison to the unheated blend, preheating the improved neem B30 blend lowers its specific fuel consumption by 0.02 kg/kWh (0.29 kg/kWh) and boosts thermal efficiency by 3.33% (33.25%).
- 5.68% less smoke, 0.08% less CO, 22 PPM less HC, 0.8% more CO_2, and 65 PPM more NOx are produced by the preheated optimized neem B30 mix compared to the unheated blend.
- Compared to diesel fuel, the warmed neem B30 blend releases substantially less pollutants.
- As compared to previous studies we have got more satisfactory results which are very useful in future because diesel stock will be decreasing day by day and it will become nil in 2040. So, in future we will run D. G (Diesel Engine Generator sets) sets using neem oil blends along with diesel with better performance. So, it is very much useful industries.
- Energy independence refers to the country's ability to meet its own energyneeds without relying on imports. Energy security is having enough energy to meet demand while also protecting the power system and infrastructure from physical and cyber attacks. Together, energy independence and energy security improve National security.
- So, by our research energy demand can be fulfilled in rural areas and having more implications in the industries. So, we conclude that our novelty research having more potential for fulfilment of energy demand in the India as well as in the World.
- A litre of Neem oil costs Rs. 65.5 to produce, which is less than diesel cost in India. Compared to the current diesel price of Rs. 93 per litre, the net cost of generating B20 and B30 Neem blends is Rs. 78.85 and Rs. 76.15 per litre, respectively. According to the experiment's results, neem oil can be used as a substitute fuel in compression ignition engines.

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NOMENCLATURE

BTE	Brake thermal efficiency
BSFC	Brake specific fuel consumption
EGT	Exhaust gas temperature
CO	Carbon monoxide
CO_2	Carbon dioxide
HC	Hydro carbon
NOx	Oxides of nitrogen
NBO30	Neem Oil blend 30% + 70% diesel
B20	Blend of 20% neem Oil
B30	Blend of 30% neem Oil
D.G sets	Diesel engine generator sets