Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 2): pp. 4102-4113
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.02.425

Investigating The Performance Characteristics Of Ci Engine Using Biodiesel With Petro-Diesel

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Abstract
Biodieselis a clean and harmless to the ecosystem normally accessible fuel from oil that are produces by the trees. It is created by a substance change method known as transesterification, which is completed by a compound handling plant. Biodiesel is like diesel in numerous ways, however it stands apart for its sustainability, high oxygen content, biodegradability, and absence of ozone harming substance emanations attributable to the photosynthetic beginning of the lipid feed stocks. Biodiesel even has a superior lubricity that petro diesel, broadening the existence of a motor and decreasing the requirement for motor part substitution. Neem oil, coconut oil, and waste cooking oil are utilized to make biodiesel, which shows that it very well might be used straightforwardly or in mix with conventional petro diesel. Motor execution and outflow testing are finished to survey the conceivable application. Both the performance of the engine and the pollution levels are within the acceptable range. Biodiesel can scale back emanations of fumes gases. For different mix proportions, the effect of burden on BSFC for diesel as well as each of the three biodiesels is researched. For all diesels, biodiesel, and their mix tasks, BSFC falls as burden increments. Biodiesel produced using waste cooking oil beats neem and coconut oil biodiesels regarding execution and discharges too.

Keywords: Emission, Performance, Transesterification, Petrodiesel

INTRODUCTION
Alternative fuels for diesel engines are being researched by engine researchers. Oxygenated fuel is one of the alternative fuels available. Di ethylene glycol, Di methyl ether , Di Methoxy Methane, Di Methyl Ether, Methyl Tertiary Butyl Ether, Di BUTYL ETHER, Di Methyl Carbonate ,Methanol, Ethanol and Di Ethyl Ether have all played a part in lowering diesel emissions. These fuels can either be used as a single fuel or in combination with ordinary diesel. Oxygen available in the fuel molecule structure aids in the reduction of PM & hazardous emissions produced by diesel engines. Siraj sayyedet al. **[2021]** discussed the influence of dual mixes of different biodiesels on DICI engine characteristics in this work, along with NOx modeling using ANN. On a volume basis, six sets of the dual bio - diesel blends (10% and 90%) are created utilizing four distinct biodiesels: Neem, Jatropha, Karanja & Mahua. **Pardeep kumaret al. [2021]** conducted tests on a single cylinder water-cooled CI diesel engine at various speeds and a load of 50% .Soybean biodiesel and its blends with solketal had a higher BSFC than pure diesel. For all blends, adding solketal to biodiesel increased emission of carbo dioxide (CO2 and nitrogen oxide (NOx). **Jayan sentanuhady et al. [2022]** research examines the usage & growth of biodiesel as a source of fuel for sustainable energy generation from natural resources. The creation of diverse combinations of biodiesel

blends and their use in many types of industry is an important component of this research. **Belachew cekene tesfa et al. [2021]** studied Transient performance parameters of a CI engine for several biodiesel mixes. Also their impacts on performance behavior were measured. In addition, the emissions footprints of Compression ignition engine were measured under a variety of transient working situations. **Pradeep t. Kale [2017]** used the Taguchi approach to examine the feasibility of the best combination of compression ratio (CR) with blend (%) at constant speed. Because maximal engine efficiency is required, the performance metric investigated in this study was BTE. Maximum CO_2 emission indicates a reduction in HC & CO, therefore carbon dioxide & nitrogen oxides were chosen as emission output responses. **Rafael estevez et al. [2022]** study shows that some advanced bio fuels have been created that do not produce glycerol and have qualities similar to fossil diesel. As a result, "green diesels" have evolved as byproducts of several processes, including vegetable oil cracking or pyrolysis, and also catalytic (hydro) cracking. **C.h. Ravi kiran et al. [2021]** study is centered on the usage of biodiesel in CI engines. The current rate of fossil fuels depletion has increased the demand for renewable energy sources. Biodiesel is among the finest alternative energy supplies for making up for diesel fuel shortages. Biodiesel has similar characteristics & combustion parameters to petroleum fuels and may be combined with diesel. **Dilip sutrawayet al.[2019]**study shows that Vegetable oils are presented as viable alternatives to diesel in this context, since they are sourced in remote rural areas. Methanol & sodium hydroxide are used in the process of transesterification of plant based oils. **D.d. Nagdeotel, m.m. Deshmukh [2016]** conducted a experiment to see how the addition of ethanol and diethyl ether to biodiesel and its blends affects the performance and emissions of a Direct Injection diesel engine. DI (100 % diesel), BD (20 % biodiesel & 80 % diesel) and DI (80 % diesel plus 5 % ethanol in vol.) are the test fuels, respectively. According to the findings, BDET has a little lower Brake Specific Fuel Consumption -BSFC than BD. At greater engine loads, BDET and BDE result in a significant reduction in smoke. In comparison to BDE and BD, BDET represents engine performance & emission parameters. **Panneer selvam et al. [2015]** studied the influence of injection time and biodiesel in diesel engines .By Increasing the injection time improves BTE-brake thermal efficiency & reduces NOx while also lowering hydrocarbon, carbon monoxide, & smoke emissions. When injection time is delayed, the opposite occurs. **Jitode et al. [2017]**examined the in-cylinder combustion, spatial soot, and spatial flame temperature distribution of diesel, JB20, and JB100 blends in a constant speed diesel engine with various engine loads using an endoscopic imaging technique. In comparison to JB20 & diesel fuel, they discovered that JB100 mix combusted quickly due to its increased fuel oxygen concentration, resulting in higher peak in-cylinder pressure as well as HRR. **Sivakumar et al. [2018]** looked at the impact of 50ppm & 100ppm additives of alumina nano in a B25 (25 percent Pongamia biodiesel +75 percent diesel) mix in a single-cylinder CI engine. B25AL100 (100ppm alumina doped in B25 blend) has a lower BSFC and a greater BTE than B25 due to the combined effects of physical ignition timing, a higher rate of evaporation, prolonged flame sustenance, and higher flame temperatures of alumina nanoparticles hence improve engine performance. **Mohammed et al. [2013]** tested a four-stroke diesel engine using Jatropha biodiesel blends B10, B20, B30, &B50, comparing performance & emission characteristics to pure diesel fuel (B0). Without any engine modifications, the performance parameters of Jatropha biodiesel blends were equivalent to pure diesel. **Sanjid et al.[2014]** tested PBJB5 (5 percent palm biodiesel+5 percent Jatropha biodiesel+90 percent diesel), PBJB10 (10 percent palm biodiesel+10 percent jatropha biodiesel+80 percent diesel) & plain diesel in a single cylinder CI engine. **Rahman et al. [2014]** investigated the impact of idling on diesel engine fuel usage while using jatropha bio diesel, diesel mixes. Experiments were carried out under greater idling circumstances when the engine could not operate at full efficiency. When a diesel engine is run at a high idle speed, HC & CO emissions rise incomplete burning as well as the accumulation of fuel residues. **Shahir et al. [2015]** reviewed the performance parameter and exhaust of diesel engines when fueled with ternary mixes of diesel, biodiesel, & ethanol. It was demonstrated that adding biodiesel to diesel ethanol blends serves as a mixture stabilizer, improves the physiochemical characteristics of the ternary blends, and has the potential to replace fossil fuels in significant amounts. **Avulapati et al. [2016]** investigated the micro-explosion & puffing of a ternary mix of rapeseed biodiesel, diesel& ethanol at varied compositions using a high speed backlight imaging approach. This method uses a glow plug heater to ignite fuel droplets suspended on a thermocouple, which classify the fuel as smooth burning, puffing, or micro-emulsion based on temporal changes in the projected droplet area. **Daming huang et al. [2012]**study examines the history and contemporary advances of biodiesel, along with many forms of biodiesel, its features, processing, & economics. The uses of biodiesel in the automotive industry, as well as the challenges facing the growth of the biodiesel industry, including biodiesel legislation are also discussed. **M. A kalam et al. [2003]**studied found by an experiment to examine the exhaust emissions properties of regular Malaysian coconut oil -COCO combined with conventional diesel oil (OD) fuelled in a diesel engine. This effort is in line with the Malaysian government's bio fuel research agenda. Keshin etal.[2014]research focus onto determine the lipid content &, as a result, the biodiesel potential of various microalgae found in Mauritian maritime water. The proportion of micro-phytoplankton species in the surrounding water has been calculated. RFLP was used to characterize the cyano-bacterial mats & endo-symbiotic din flagellates visually and genetically. The samples were gravimetrically weighed &analyzed with 1H and 13C NMR spectroscopy.

AIM OF MY RESEARCH WORK

- To analyze & assess potential sources for biodiesel production, such as **neem**, **coconut**, &**waste cooking oil** biodiesel, as well as to define the specifications for biodiesel production using the transesterification process, trying to test its quality by figuring out it's parameters.
- To determine an economical & simple procedure for producing biodiesel with regard to oil content & also to create biodiesel using two-step acid-alkali catalyzed transesterification processes.
- The experimental work will be compared to the engine's output performance while operating on regular diesel vs. its effectiveness when running on biodiesel.
- To assess the engine's performances on key characteristics such as Brake Specific Fuel Consumption –BSFC, Brake Thermal Efficiency- BTE& exhaust gas temperature-EGT.

EXPERIMENTAL METHOD

A 100 Liters per Day capability Bio-Diesel producing setup was established at MANIT Bhopal to create Bio-Diesel from various feedstock materials such as Jatropha Curcas, Neem, coconut, waste frying oil, and so on.

FEEDSTOCK PREPARATION

The removing of the seed coat, can be done manually is part of the shelling process. Using an impact crusher machine (FIG 3.3), the unshelled seeds also crushed into dough.

NEEM SEED (NEEM TREE)

The current worldwide neem oil supply level cannot meet all of the population's needs, including industrial and residential use.

Fig. 1 (a) neem fruits

Fig. 1 (b) neem seeds

COCONUT SEED (COCONUT TREE)

Cocosnucifera is a big palm that may reach a height of 30 meters with pinnae 60 to 90 cm long and pinnate leaves 4 to 6 m long; old leaves Brake smoothly, leaving the trunk unblemished.

Fig 2 COCONUT SEEDS

Fig 3 IMPACT CRUSHER MACHINE

EXTRACTION METHOD

This type of apparatus is flexible equipment that can recover 100% of the oil present in a sample

SOXHLET

The condenser's job is to chill the solvent vapour & condense it back into the distillation pot.

Relation for calculating oil yield is

Oil yield (wt%) = mass of oil extracted (in gram)/ mass of seed (in gram)*100

MECHANICAL EXTRACTION

Oil extraction from seeds or plant parts is achieved by mechanical pressing, which is occasionally followed by chemical extraction. The oil in the seed is not completely removed by mechanical pressing.

Mechanical Extraction is a process in which sufficient force applied to a restricted seed. The pressure is strong enough in this circumstance to break the cells & cause oil from of the seed to "escape."

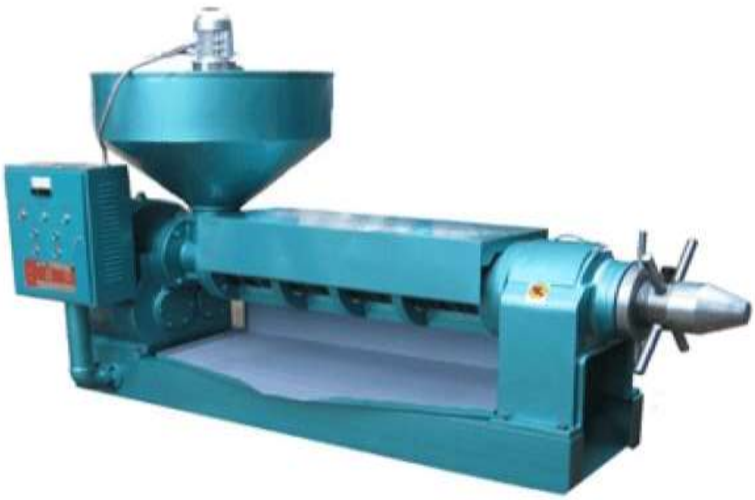

Fig 4 EXTRACTING PROCESS BY MECHANICAL EXTRACTOR

Table 1. Mechanical extractor parameters

Extractor hopper	**MECHANICAL DATA**
Hopper surface area	5 m^2
Height	2.1 m
Wall thickness	0.05 m
Stress on hopper cylinder	3.5 N mm^2
Stress due to weight and load on hopper cylinder	0.0002 N mm^2
Extractor type	Spiral oil press extractor
Model	140CJX
Processing capacity	350 kg h^1
Oil content of dry cake	≥ 8 percentage
Measurement	230 X700X 125 cm
Spiral axis rotation speed	30 RPM
HOPPER CONE	
Hopper cone thickness	5 mm
Stress due to weight and load on hopper cone	7.2 $x10^5$ N mm^2
Stress on hopper cone	25.98 N mm^2

VEGETABLE OIL WASTE

The handling of such oils & fats is a substantial difficulty due to disposal issues and the potential pollution of land & water resources.

Following steps are required to make waste cooking oil useable for our experiment:

- **Oil Analysis:**
  These include analysis of saponification value, refraction index, density, iodine value. After that GC analysis is performed.
- **Pretreatment:**
  The oil utilized in this study couldn't be used straight away, so it had to be pre-treated.
- **Esterification:**
  The creation of alkali salts of fatty acids results from the transesterification of high acid value oil with just an alkali catalyst or soap.
- **Trans esterification Process:**
  The transesterification took place in a heterogeneous alkali media, & to do so, a precisely weighed catalyst was combined with methanol beforehand.
- **Post Treatment Process:**
  Petroleum ether was added to the top layer of alkali transesterification product. The biodiesel & unreacted oil easily combine with petroleum ether, leaving a coating of glycerol behind.

ENGINE PERFORMANCE TESTING FOR DIFFERENT BIODIESEL BLENDS

The four fuels listed below were used in the first round of testing:

- Diesel (standard Ultra Low Sulphur Diesel fuel compliant with EN590)
- Methyl Ester blend Coconut oil
- Methyl Ester blend Waste cooking oil
- Methyl Ester blend Neem oil

The engine used in my research work is a commercial Kirloskar, AV1 Make engine. It is a single cylinder DI diesel engine. Brake Specific Fuel Consumption (BSFC), Brake thermal efficiency (BTE)& exhaust gas temperature (EGT) calculated for finding out the performance of engine for variable fuels.

Table 2 TECHNICAL SPECIFICATIONS OF THE ENGINE

Make & Model	KIRLOSKAR(AV1)
Features	4 stroke, CI,vertical, Water cooled method , Direct injection(DI), constant speed
No. of cylinders	Single
Stroke*bore	80*110mm
Swept volume	661 cc
Output	5.2 kW
Clearance volume	38.35 cc
R.P.M	1500
Fuel injection timing	23° CA b TDC
Nozzle opening pressure	210 bar
Connecting rod	238 mm long
Combustion chamber	open Hemispherical
Fuel	Diesel (Diesel cycle)
Lubricating oil	SAE 40
Compression ratio	17.5:1
Diameter of Valve	34.2 mm

Fuel injection pump	MICO inline
Valve lift (Max)	10.1 mm

Fig 5 Engine with dynamometer and Gas analyzer

Type of dynamometer used: Eddy current (AG20Model)
Type of gas analyzer used: DI Gas 444(AVL)

RESULTS & DISSCUSSION

PERFORMANCE & EMISSION TEST OF NEEM OIL

Following are the Experimental & Observed Values for Neem Oil under varying load conditions on commercial Kirloskar four stroke CI engine.

- When the load is 20%-

Fuel Blends	Compression Ratio	BSFC (in kg/kW-hr)	BTE (In %)	CO (in % vol)	HC (ppm)	Smoke Density (HSU)	NO (ppm)
diesel	14	0.57	15	0.04	10	18	230
25	15	0.58	14	0.045	16	27	232
50	16	0.59	13.5	0.046	21	32	245
75	17	0.6	13	0.046	19	37	264
100	18	0.62	12	0.05	15	43	278

- When the load is 40%-

Fuel Blends	Compression Ratio	BSFC (in kg/kWhr)	BTE (In %)	CO (in % vol)	HC (ppm)	Smoke Density (HSU)	NO (ppm)
diesel	15	0.35	24.6	0.03	22	25	400
25	16	0.36	23.3	0.035	21	37	420
50	17	0.37	22.4	0.036	23	41	430
75	18	0.38	21.3	0.037	20	50	446
100	14	0.41	19.6	0.04	17	60	452

- When the load is 60%-

Fuel Blends	Compression Ratio	BSFC (in kg/kW-hr)	BTE (In %)	CO (in % vol)	HC (ppm)	Smoke Density (HSU)	NO (ppm)
diesel	16	0.31	30	0.02	30	35	552
25	17	0.32	28	0.025	22	43	570
50	18	0.33	26.5	0.026	26	47	597
75	14	0.35	25.5	0.026	22	55	614
100	15	0.39	24	0.03	18	67	636

- When the load is 80%-

Fuel Blends	Compression Ratio	BSFC (in kg/kW-hr)	BTE (In %)	CO (in % vol)	HC (ppm)	Smoke Density (HSU)	NO (ppm)
diesel	17	0.29	33	0.04	35	42	702
25	18	0.3	31	0.045	27	49	734
50	14	0.31	29	0.046	32	55	762
75	15	0.34	27.5	0.046	25	60	804
100	16	0.38	26	0.05	20	72	846

- When the load is 100%-

Fuel Blends	Compression Ratio	BSFC (in kg/kW-hr)	BTE (In %)	CO (in % vol)	HC (ppm)	Smoke Density (HSU)	NO (ppm)
diesel	18	0.28	34	0.07	42	53	862
25	14	0.29	32	0.085	36	57	858
50	15	0.31	30	0.1	39	62	912
75	16	0.33	28.5	0.12	30	68	936
100	17	0.37	27	0.25	29	85	935

BSFC:

BSFC is known as Brake Specific Fuel Consumption of an engine. Figure shows the BSFC analysis of diesel, neem oil biodiesel & blended fuels.

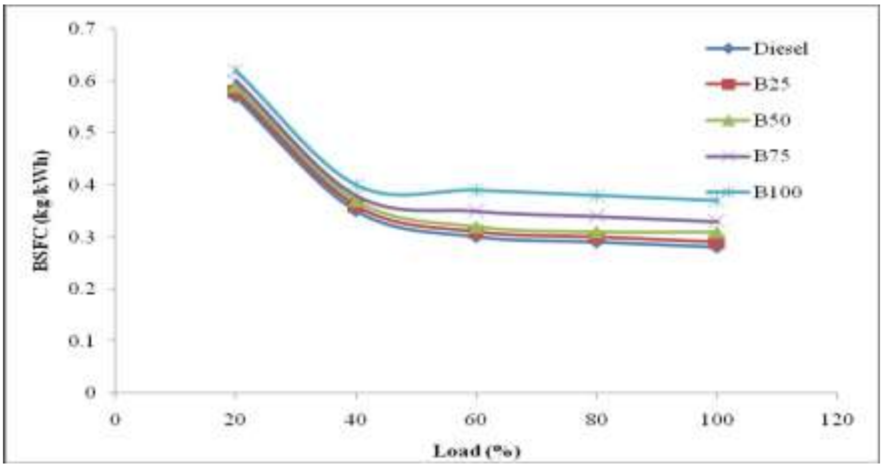

Fig.6 BSFC ANALYSIS OF DIESEL, NEEM OIL BIODIESEL & BLENDED FUELS

Fig. 6 depicts a study of the impacts of load on BSFC for diesel, Neem oil biodiesel as well as its blends. Whenever the load was raised, the BSFC was found to decrease. However, the rate of decline in BFSC was greater with low load conditions up to 50% than during larger loads beyond 50%. This can also be seen that as the quantity of neem oil biodiesel in the blend grows so does the BSFC.

BTE:

BTE is known as Brake Thermal Efficiency of an engine. Figure shows the BTE analysis of diesel, neem oil biodiesel, & blended fuels.

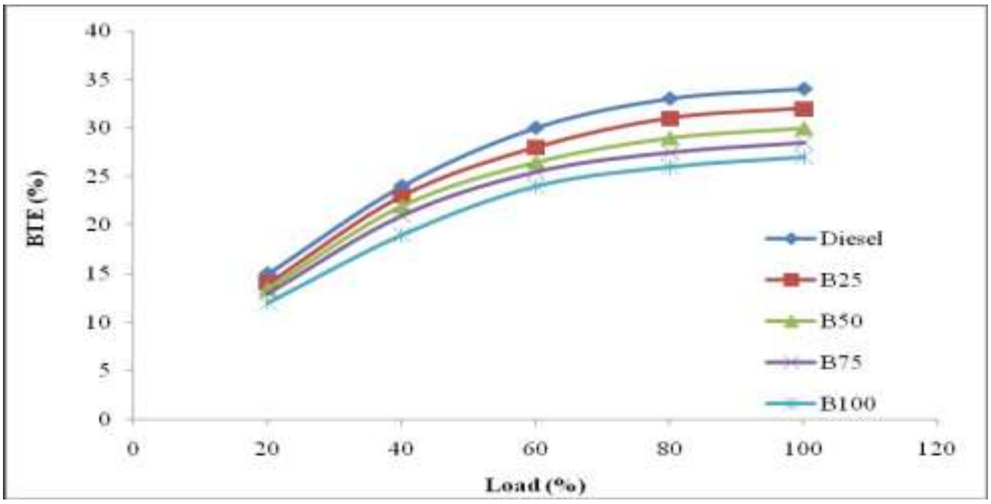

Fig.7 BTE ANALYSIS OF DIESEL, NEEM OIL BIODIESEL & BLENDED FUELS

The general patterns of BTE properties of neem biodiesel, diesel, & their blends were virtually same in nature, as shown in Fig. 7. Diesel operation has a greater BTE than neem biodiesel & its blends at any given load state. In comparison to diesel fuel BTE lowers as the proportion of biodiesel in the mix increases. This really is due to the combination of neem biodiesel's increased viscosity, higher density & reduced calorific value. For 100 percent load, the highest brake thermal efficiency was 35.2, 32, 30, 28.5, & 27 percent for diesel, B-25, B-50, B-75 & B100, correspondingly.

CO (CARBON MONO OXIDE) EMISSIONS

Figure 8 shows the impact of load on CO emissions of diesel, plain neem oil biodiesel & their blends.

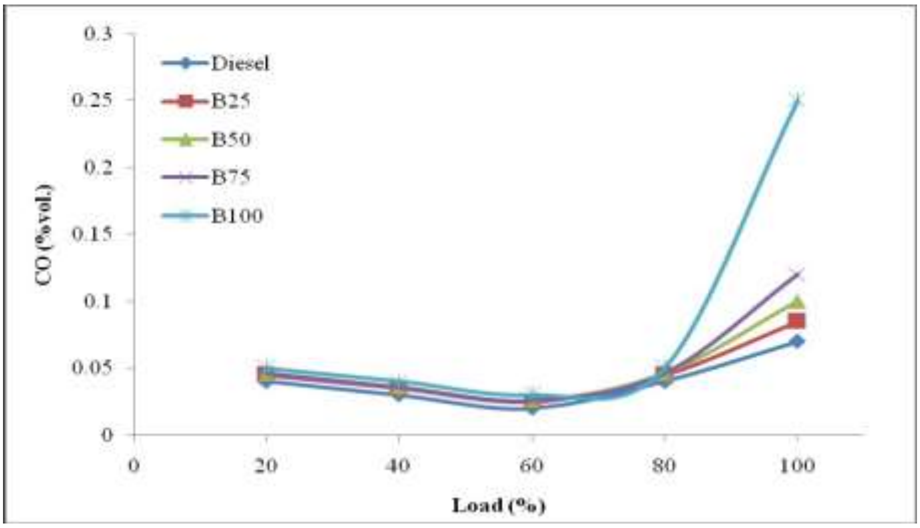

FIG. 8 IMPACT OF LOAD ON CO EMISSIONS OF DIESEL, PLAIN NEEM OIL BIODIESEL & THEIR BLENDS

It was discovered that blends of biodiesel, diesel, & biodiesel produced increased CO emissions. At 100 percent load, CO is 0.11, 0.16, 0.15, 0.15, and 0.26 percent for diesel, B25, B50, B75, & B100, respectively. Increased CO emissions in engine exhaust gas may be due to the polymerization that occurs at the spray's centre. These polymers have an effect on the atomization & also the blending of air and fuel, resulting in a regionally rich mixture that makes atomization & vaporization of plain neem oil biodiesel problematic owing to the incorrect spray pattern created. This characteristic enhances the incomplete combustion & consequently higher is the CO emission.

CONCLUSION AND FUTURE SCOPE

CONCLUSION

Experimental research has been done in the current study to examine the feasibility of biodiesel made using neem seed, coconut & also waste cooking oil and their blends.Then a single-cylinder diesel engine test utilizing diesel, neem seed oil, coconut oil, waste cooking oil biodiesel plus their mixtures with diesel fuel is conducted to assess performance and emission properties.

- The biodiesel made from coconut oil, waste cooking oil, & neem oil demonstrates that it could be used as a bio fuel either alone or in combination with regular petroleum diesel.
- Because neem oil has a large proportion of unsaturated fatty acids, neem oil bio fuel generated the lowest BTE.
- Due to a right blend of saturated & unsaturated fatty acids, waste cooking oil was found to emit the least amount of carbon monoxide. When contrasted to coconut & used cooking oil, neem seed oil had the highest CO emission.
- When compared to diesel, all plain oils & their mixes have worse engine performance metrics such as BTE and higher BSFC. This is brought on by the fuels' low heating value & high viscosity. When compared to coconut oil & neem seed oil, waste cooking oil has a greater thermal efficiency of between 30 and 32 percent.

FUTURE SCOPE

Biodiesel & biodiesel mixes are theoretically conceivable as an alternate fuel for diesel engines with little or modest modifications. Their appeal may soon increase for economic &environmental reasons. More scientific research in biodiesel sources & engine design, however, is required. Following suggestions should be considered for future research in biodiesel production:

- Research on bio fuel engine durability testing & driver's test should be conducted to determine the cause of wear mechanisms.
- Future improvements to the biodiesel manufacturing process are required to boost biodiesel characteristics.
- Because bio fuel has a higher viscosity over diesel & might impact emissions owing to variable sized droplets without changing the fuel nozzle, minimum temperature efficiency of biodiesel engines should be examined.
- The suggestion was made that future investigations will use computational models or computer simulations for appreciatively verifying experimental data.
- Development of additives that boost biodiesel consumption is required for energy recovery & emissions, particularly NO emissions.

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