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"INVESTIGATING THE PERFORMANCE CHARACTERISTICS OF CI ENGINE USING BIODIESEL WITH PETRO-DIESEL"

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ABSTRACT

Biodiesel is a clean, environmentally friendly natural fuel derived from tree-born oils by a chemical transformation process known as Transesterification, which is carried out at a Chemical Processing Plant. Biodiesel is similar to diesel in many ways, but it stands out for its renewability, high oxygen content, biodegradability, and lack of greenhouse gas emissions owing to the photosynthetic origin of the lipid feed stocks. The biodiesel made from neem oil, coconut oil & also waste cooking oil demonstrates that it could be used as a bio fuel either directly or in combination with traditional petro diesel. Engine performance & emission testing are done to assess the possible application. The engine's performance has changed just little, as well as the pollution levels are within the acceptable limit. Biodiesel can cut back on emissions of exhaust gases. For various blend ratios, the impact of load on BSFC for diesel as well as all three biodiesels is investigated. For all diesels, biodiesel, & their blend operations, BSFC falls as load increases. Biodiesel made from waste cooking oil outperforms neem & coconut oil biodiesels in terms of performance & emissions also.

KEYWORDS: Emission, Performance, Transesterification, Petro diesel.

1. INTRODUCTION

The usage of fossil fuels with in vehicle industry has resulted in increasing pollutants & greenhouse gas emissions, both of which have had a significant effect on the environment. CO_2 emissions have also increased, necessitating the development of alternative green fuels. Fossil fuels are a one-time energy gift to the humankind; once they are gone, they are gone forever. They've been around in some form or the other for more than a century. As a result of the limitation of petroleum supplies, it is critical to investigate alternative energy sources, which has prompted research into bio fuels, fuel cells, & solar cells.

II.REQUIREMENT FOR ALTENATIVE FUELS FOR IC ENGINES

The urgent need for a suitable sustainable fuel for current IC engines is being felt these days, as petroleum sources are rapidly depleting on the planet's surface. In recent years, non-renewable sources of energy have provided around 90% of the fuel essential for energy production & transport. Alternative energy sources are in significant demand due to rapid urbanization, rising population, & rising living standards. Consumption of diesel can be minimized by implementing biodiesel program expeditiously. More research work in this field will help the country in saving precious foreign currency, which otherwise is wasted in purchasing petroleum products instead of helping poor for their pure drinking water & meals.

III.FEATURE OF BIO DIESEL

The development of transportation fuels made from biomass, such as bio ethanol, biodiesel, biogas, as well as bio hydrogen, has resulted from a combination of the demand for affordable fuel energy sources with concern about environmental implications such as climate change. Biodiesel is created from mono alkyl esters derived either vegetable oils, animal fats or discarded cooking fats. Biodiesel from waste vegetable oil is a fuel replacement made from soybean oil. Biodiesel does not include petroleum diesel, although it can be combined with it. Biodiesel is a clean, environmentally friendly natural fuel derived from tree-born oils by a chemical transformation process known as TRANSESTERIFICATION, which is carried out at a Chemical Processing Plant. Solketal & soybean biodiesel blends have greater ash points, which aid in good fuel management [2]. Vegetable oil is a more viable alternative fuel since it is renewable, eco-friendly, yet easily farmed in rural regions where there is a high need for contemporary sources of energy. The research focuses on the evaluation of single and dual biodiesel performance, combustion, including emission characteristics.

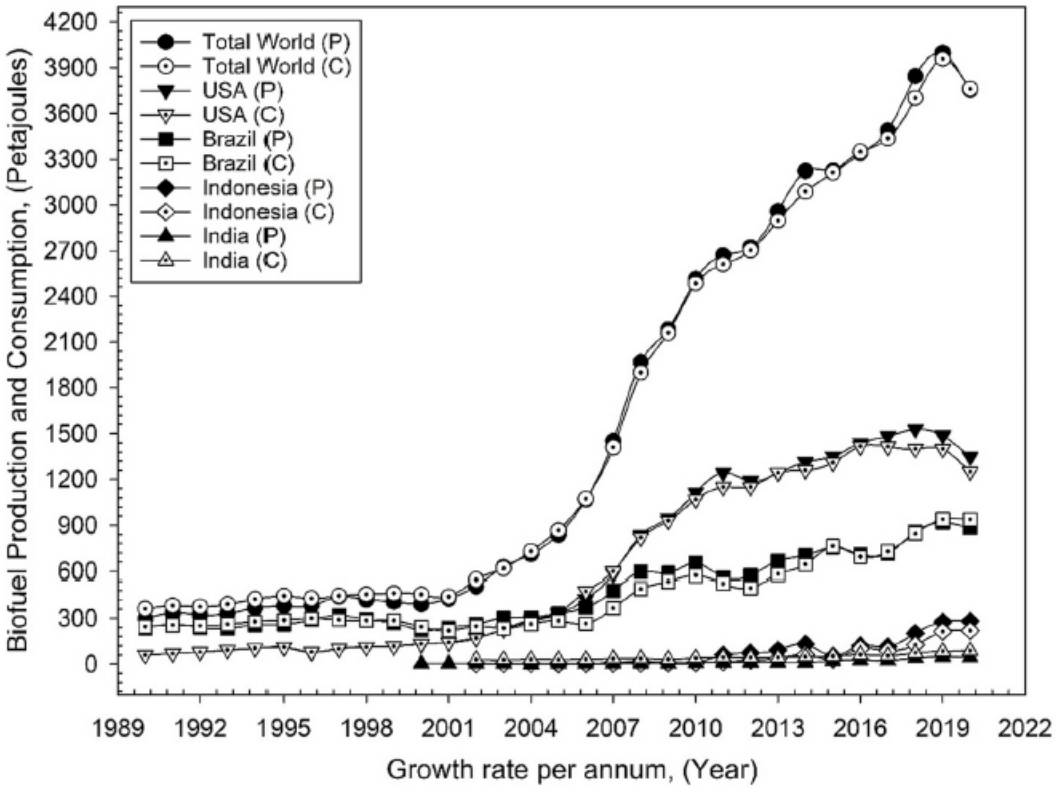

Fig1. GRAPH BETWEEN GROWTH RATE PER YEAR & BIOFUEL PRODUCTION [16]

IV. REVIEW OF PAST STUDIES

Alternative fuels for diesel engines are being researched by engine researchers. Among the several alternative fuels, oxygenated fuel is one of them. 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 also be used as mix with regular diesel or as a standalone fuel. The availability of oxygen in the fuel molecule structure aids in the reduction of PM & hazardous emissions produced by diesel engines.

SIRAJ SAYYED et al. [2021] [1] discussed the influence of dual mixes of different biodiesels on DICI engine characteristics in this work, along with NOx modeling using ANN. The physicochemical characteristics are determined to be within the ASTM permitted ranges. The reduction in BTE performance parameters, AFR, ranges from 0.77 to 5.60 percent. There are differences in BSEC (8.91%) & EGT (11.95 percent). Biodiesel mixes have comparable combustion properties to plain diesel (CP, MGT, MFB, NHR, & RPR).

PARDEEP KUMAR et al. [2021][2] conducted tests on a single water-cooled diesel engine at various speeds as well as at 50% load. In contrast to pure diesel, soybean biodiesel and also its mixes with solketal had a higher BSFC. Total hydro carbon (THC) & carbon mono-oxide (CO) emissions were shown to be lower for soybean biodiesel and all four blends when compared to pure diesel, and this lowers further as the amount of solketal in a mix increases. With an increase in the proportion of Solketal fuels, CO & THC emissions also were reduced. Solketal was discovered to be a suitable and effective biodiesel additive.

JAYAN SENTANUHADY et al. [2022][3] 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. The availability of energy and the consequences of climate change has become a major worry for experts in a variety of countries. This situation allows for the development of newer and more sustainable alternative energy sources.

BELACHEW CEKENE TESFA et al. [2021].[4] 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].[5] 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.

V.PRESENT RESEARCH WORK

The goal of MY RESEARCH WORK is to look at the performance of engines when running on petro diesel & biodiesel. This will be done experimentally. Thermodynamic tests will be performed based on engine performance assessment. To analyze & assess potential sources for biodiesel production, such as **neem**, **coconut**, & **waste cooking oil** biodiesel. The experimental work 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 Thermal Efficiency -BTE, Brake Specific Fuel Consumption –BSFC.To evaluate the emissions of various biodiesel mixes in diesel engines & compare them to petro diesel. CO, HC, NO emissions & smoke density are among the emissions monitored. The engine used in my research work is a commercial Kirloskar, AV1 Make engine. It is a single cylinder DI diesel engine.

VI.EXPERIMENTAL SET UP

i. **FEEDSTOCK PREPARATION:** It is primary step for generation of biodiesel. In our methodology seeds of neem & coconut oil are used. The seeds should be properly dried in the sun before use, which caused the interior seeds to separate from the outer shell. The removing of the seed coat, can be done manually is part of the shelling process. Using an impact crusher machine, the unshelled seeds also crushed into dough. An oven used for removing excess moisture from the seeds. The coarse & bigger particles were removed from the crushed seeds using a mechanical roto tap sieve shaker .For subsequent research, particles kept on 30 meshes to 60 mesh was employed.

Fig.2 neem seeds

Fig. 3 coconut seed

ii. **EXTRACTION METHOD**: Extraction method is used to determine the total oil content of the feedstock. Apparatus like Soxhlet is a user friendly system that enables for approximately 100% oil recovery. This type of apparatus is flexible equipment that can recover 100% of the oil present in a sample.

iii. **TRANSESTERIFICATION PROCESS:** It is a time-tested technique of converting vegetable oils or fats into biodiesel (Alkyl Esters of Fatty Acids) and glycerin, as well as certain soaps as well as other products. Transesterification is the process of creating biodiesel. Introducing methanol to vegetable oil achieves this result. To speed up chemical reactions between methanol and vegetable oil, the process requires a catalyst. An alkaline catalyst is employed in the production of biodiesel. Potassium Hydroxide or Sodium Hydroxide might be used. The goal of transesterification is to lower the oil's viscosity & make it more similar to the standard diesel used in CI engines. Because it is the cheapest and also most commonly accessible alcohol for making biodiesel, methanol is the chosen option. Vegetable oils have to be modified in order to be used in place of biodiesel fuel in conventional diesel engines. The difficulty in replacing pure vegetable oil for diesel fuel is mostly due to their high viscosities. Any procedure, such as transesterification, can cause a reduction in viscosity.

TABLE 1. TECHNICAL SPECIFICATIONS OF THE ENGINE

Make & Model	KIRLOSKAR(AV1)
features	4 stroke, CI, Constant speed ,vertical, Water cooled method , Direct injection(DI)
NO of cylinders	Single
Stroke(bore)	80*110mm
Swept volume	661 cc
output	5.2 kW
Clearance volume	38.35 cc
output	5.2 kW
R.P.M	1500
Compression ratio	17.5: 1
Nozzle opening pressure	210 bar
Fuel injection timing	23° CA b TDC
combustion chamber	open Hemispherical
Fuel	Diesel (Diesel cycle)
Lubricating oil	SAE 40

Connecting rod	238 mm long
diameter of Valve	34.2 mm
Fuel injection pump	MICO inline
valve lift (Max)	10.1 mm

Type of dynamometer used: Eddy current (AG20 Model)

Type of gas analyzer used: DI Gas 444(AVL)

TABLE II CHARACTERISTICS OF NEEM OIL BIODIESEL & ITS BLENDS

FUEL PROPERTIES	**B-25**	**B-50**	**B-75**	**B-100**	**PETRODIESEL**
Sp. gravity	0.648	0.	0.767	0.883	0.853
Kinematic viscosity(at temp. of 40^0C)	3.85	4.07	5.24	6.81	4.1
Density(IN Kg/m^3)	826	840	853	910	816
Cal. value (IN KJ/KG	41865	39422	37542	36483	43782
Flash Point(IN ^{0}C)	62	71	79	169	53
Fire Point(IN ^{0}C)	75	77	85	186	61

TABLE III CHARACTERISTICS OF COCONUT OIL & ITS BIODIESEL BLENDS

FUEL PROPERTIES	B-25	B-50	B-75	B-100	PETRODIESEL
Sp. gravity	0.649	0.721	0.767	0.883	0.853
Kinematic viscosity(at temp. of 40^0C)	3.7	3.93	4.72	4.8	4.1
Density(IN Kg/m^3)	848	871	879	927	816
Cal. value (IN KJ/KG	43212	42761	40525	37122	43782
Flash Point(IN ^{0}C)	65	77	93	130	53
Fire Point(IN ^{0}C)	68	87	105	141	61

TABLE IV CHARACTERISTICS OF WASTE COOKING OIL & ITS BIODIESEL BLENDS

FUEL PROPERTIES	B-25	B-50	B-75	B-100	PETRODIESEL
Sp. gravity	0.648	0.721	0.767	0.883	0.853
Kinematic viscosity(at temp. of 40^0C)	3.71	3.92	4.72	4.83	4.1
Density(IN Kg/m^3)	848	870	879	927	816
Cal. value (IN KJ/KG	43212	42761	40525	37122	43782
Flash Point(IN ^{0}C)	65	77	93	130	53
Fire Point(IN ^{0}C)	68	86	105	141	61

VII. RESULTS & DISSCUSSION

This section discusses biodiesel engine performance & emission testing for three different types of bio diesel.

I.PERFORMANCE & EMISSION TEST OF NEEM OIL

II. PERFORMANCE & EMISSION TEST OF COCONUT OIL

III. PERFORMANCE & EMISSION TEST OF WASTE COOKING OIL

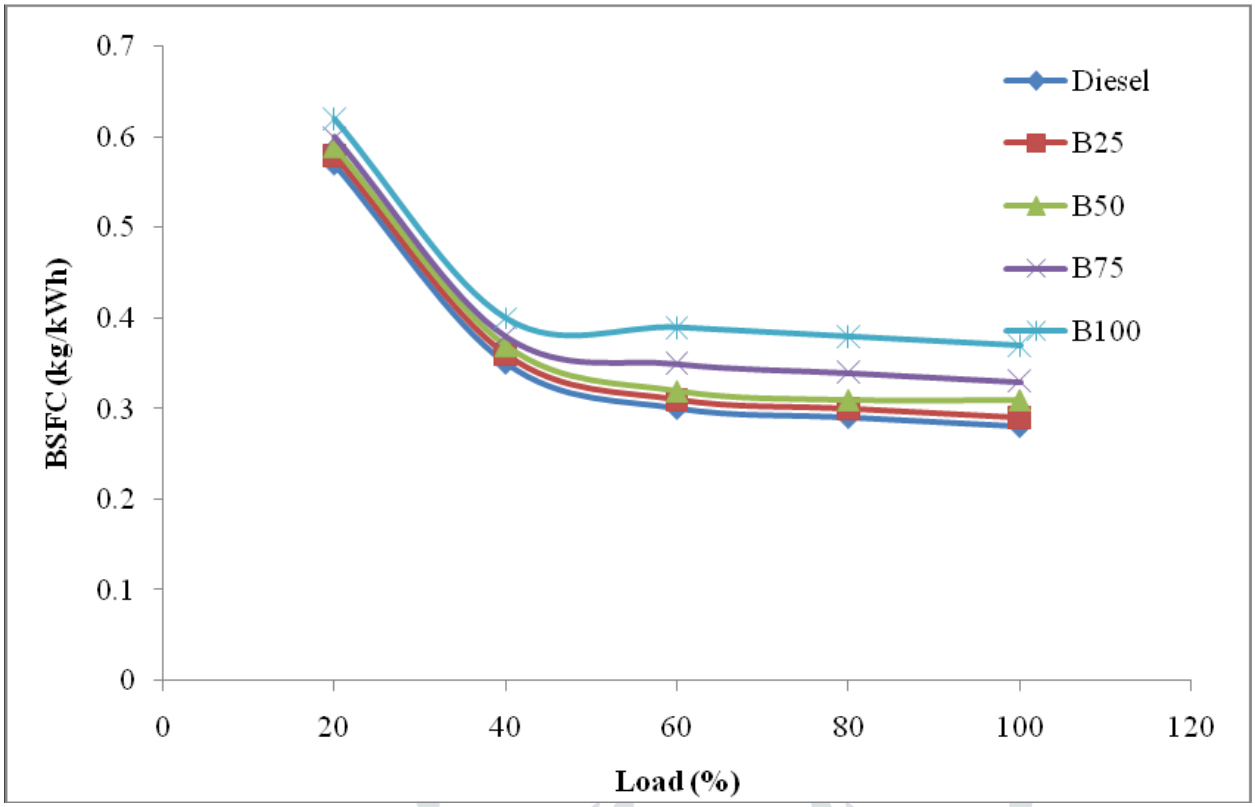

Fig.4. BSFC ANALYSIS OF DIESEL, NEEM OIL BIODIESEL & BLENDED FUELS

Performance and emission parameters comparison between petro diesel, biodiesel & their blends are given here:

1. **BSFC:**

The engine performance parameters of 3 different types of biodiesels & their mixes, as well as diesel fuel, were compared in the current work. Figure 5 shows a comparison of the BSFC of waste cooking oil, diesel, neem & coconut oil and their blends.

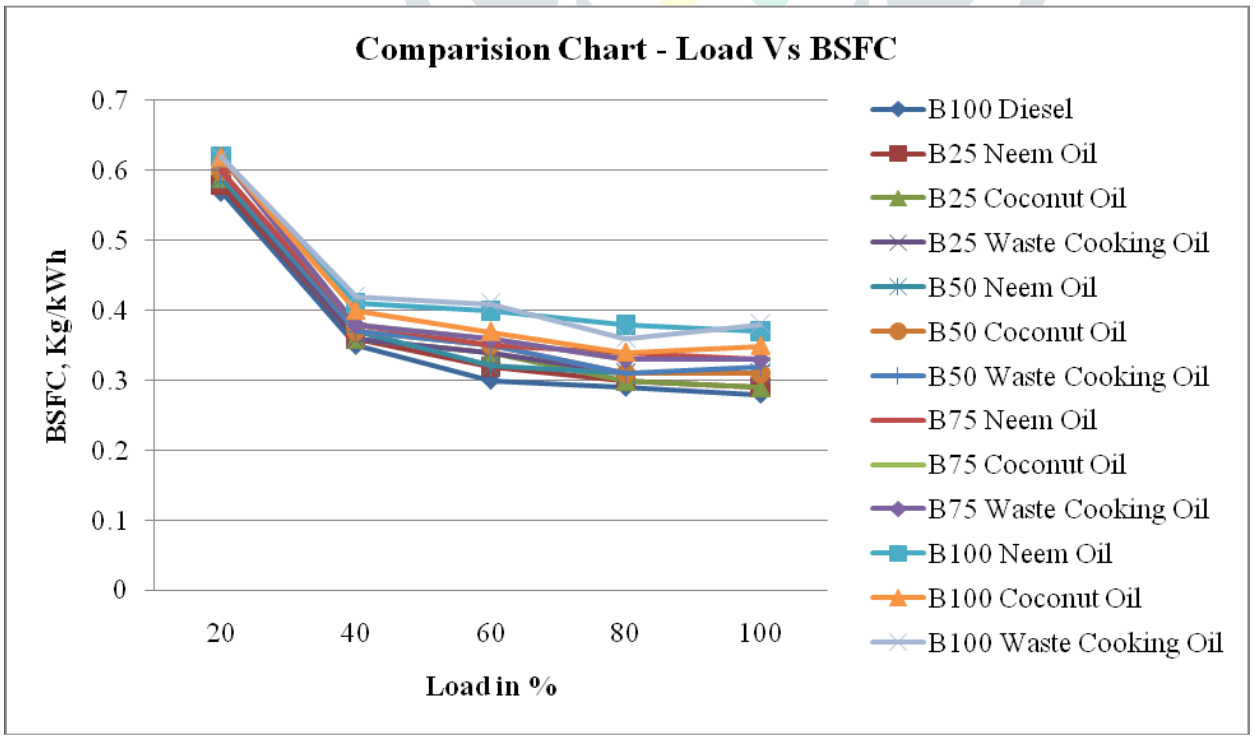

FIG. 5 COMPARISON OF THE BSFC OF WASTE COOKING OIL, DIESEL, NEEM , COCONUT OIL AND THEIR BLENDS.

2 . BTE:

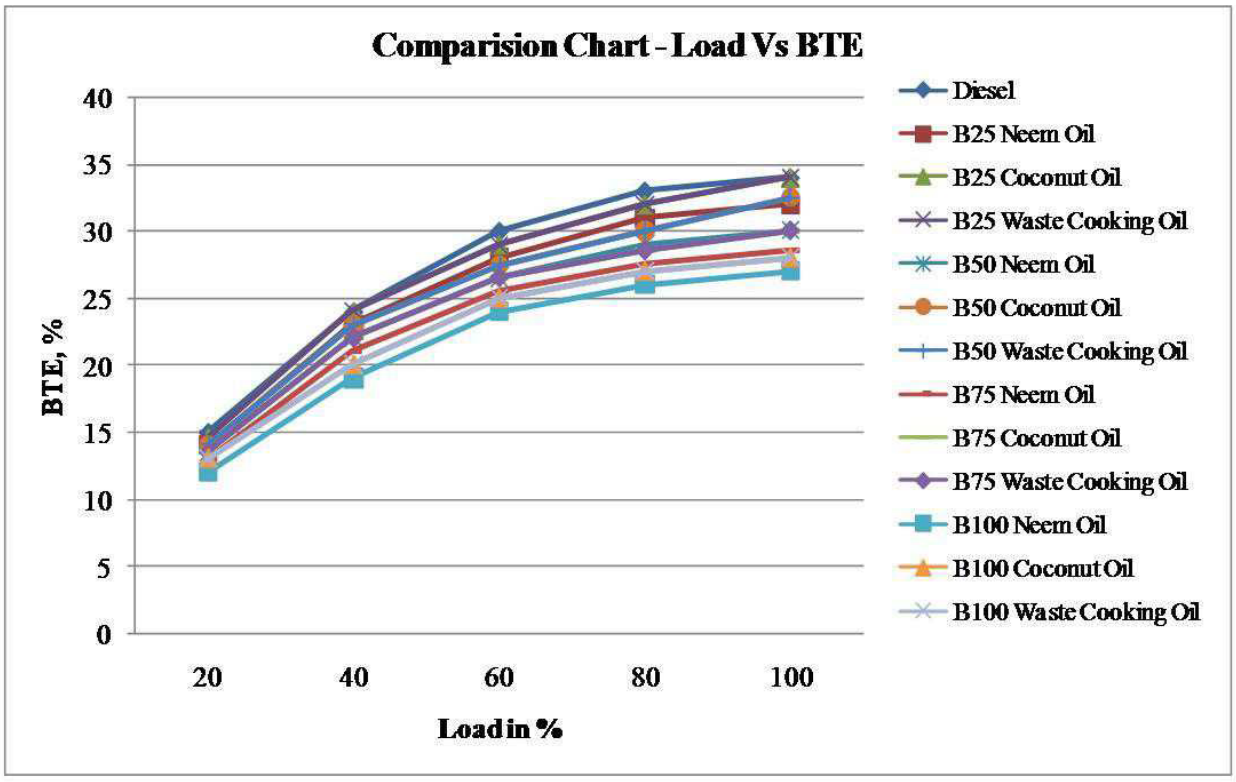

FIG.6 COMPARISON OF THE BTE OF WASTE COOKING OIL, DIESELOIL, NEEM OIL AND COCONUT OIL & THEIR BLENDS.

3. CO (CARBON MONO OXIDE) EMISSIONS

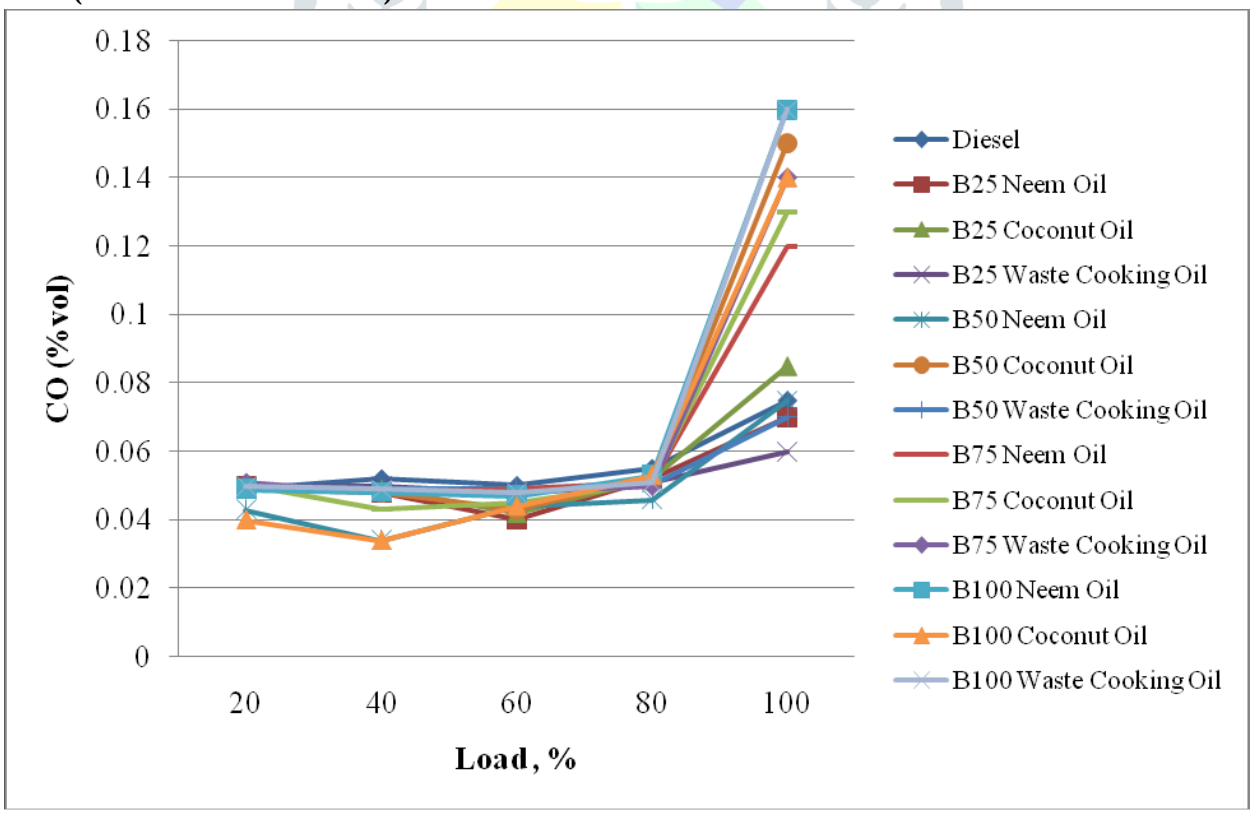

FIG 7 CO EMISSION COMPARISON OF DIESEL, NEEM, and COCONUT WASTE COOKING OIL BIODIESEL & THEIR MIXES.

4 .HC EMISSIONS

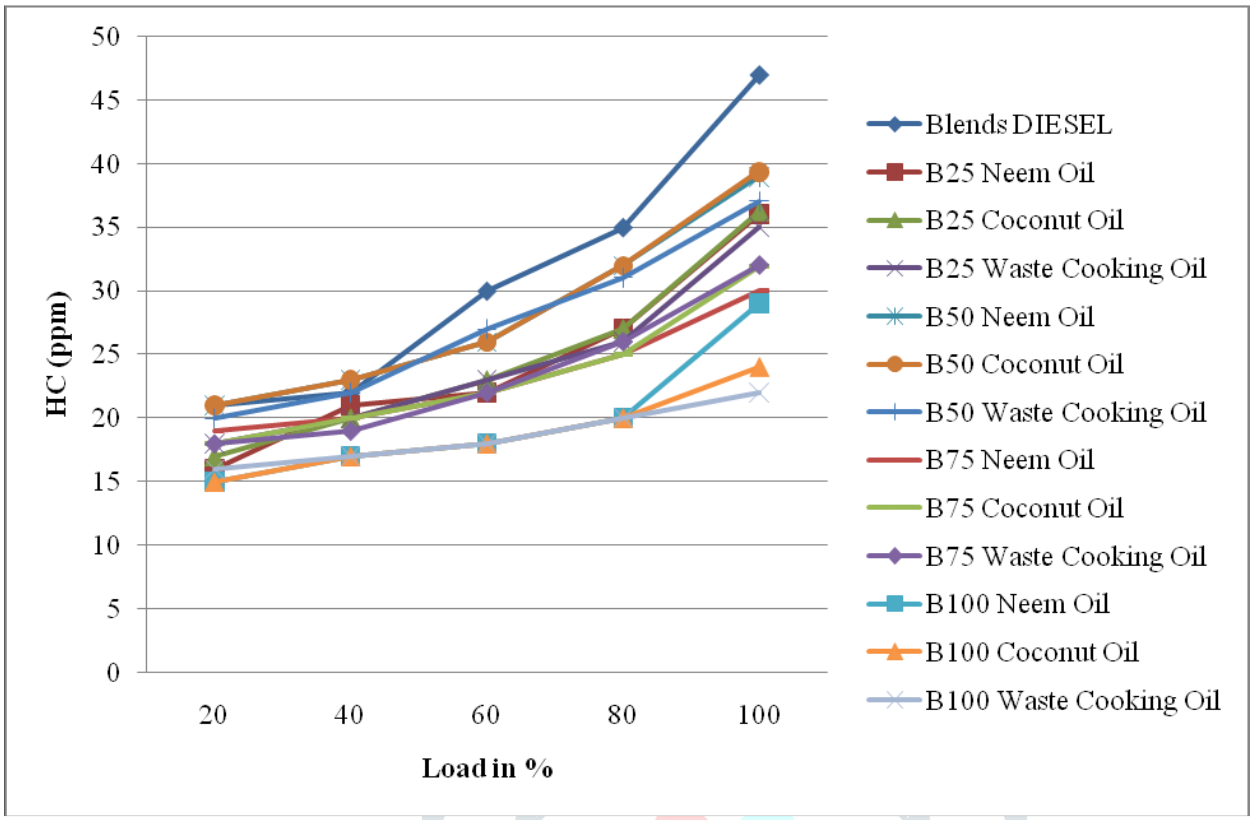

FIGURE 8 HYDRO CARBON EMISSION COMPARISONS OF DIESEL, NEEM, COCONUT, WASTE COOKING OIL BIODIESEL & THEIR MIXES.

5. NOx EMISSIONS

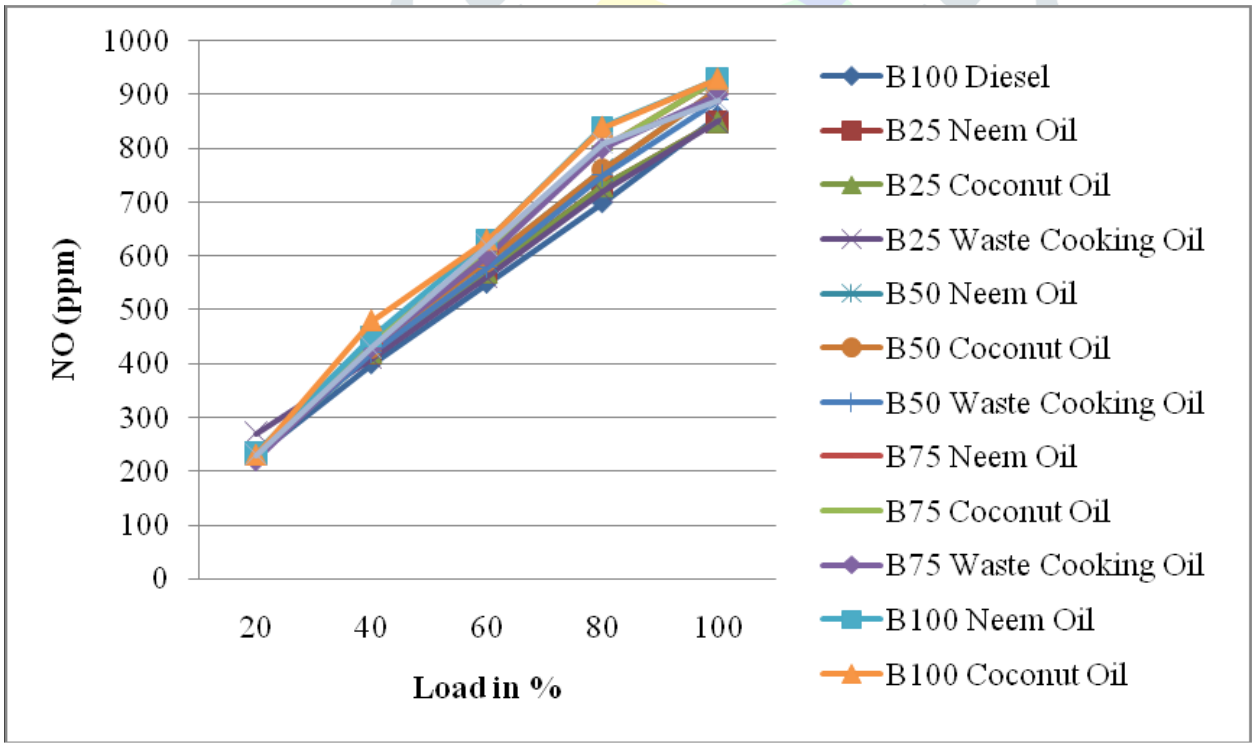

FIG.9 COMPARATIVE ANALYSIS OF NOx EMISSIONS FROM DIESEL, NEEM, COCONUT, & WASTE COOKING OIL BIODIESELS, AS WELL AS THEIR MIXES.

6. SMOKE DENSITY

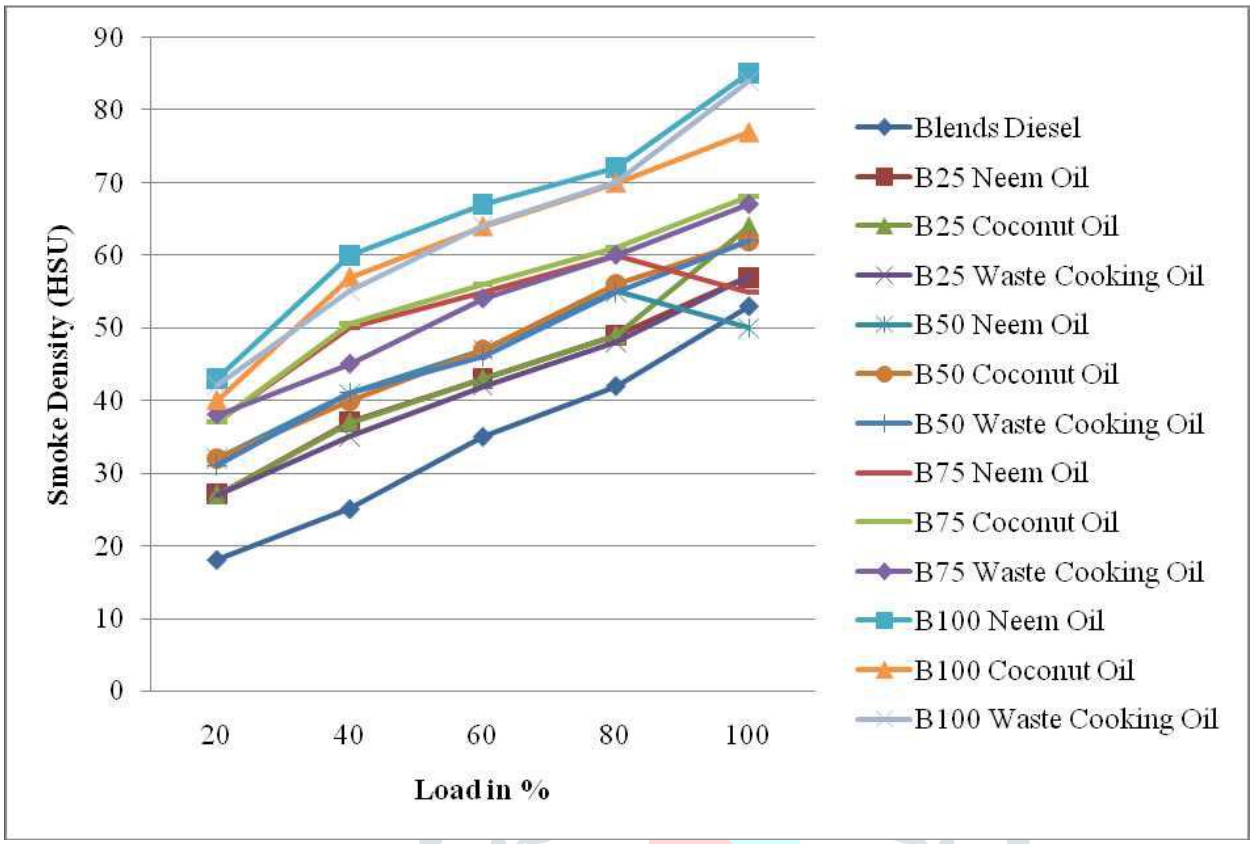

FIG10. CHANGE IN SMOKE DENSITY OF DIESEL, NEEM OIL, COCONUT OIL, WASTE VEGETABLE OIL BIODIESEL PLUS BLENDS AT VARIED LOADS

VIII.CONCLUSION OF MY STUDY

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. Following conclusions are drawn from present study:

- 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.
- All forms of biodiesel & biodiesel blends have lower hydrocarbon emissions than diesel fuel. The coconut bio fuel had the highest HC emission of these three biodiesels at a B50 mix, at 39.4 ppm. Coconut oil & waste cooking oil made the best bio fuel combination in this category.
- Neem oil biodiesel, value of 85 HSU had the highest smoke emission, followed by waste cooking oil biodiesel value of 83.5 HSU & coconut oil biodiesel value of 77 HSU. In this experiment, coconut oil was shown to have the minimum values of smoke density of 77 HSU when compared to waste cooking oil & neem oil as a fuel.

IX. FUTURE SCOPE OF WORK

Following suggestions should be considered for future research in biodiesel production:

1. Research on bio fuel engine durability testing & driver's test should be conducted to determine the cause of wear mechanisms.

2. Future improvements to the biodiesel manufacturing process are required to boost biodiesel characteristics.

3. 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.

4. The suggestion was made that future investigations will use computational models or computer simulations for appreciatively verifying experimental data.

5. Development of additives that boost biodiesel consumption is required for energy recovery & emissions, particularly NO emissions.

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