International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 7, November-December 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Experimental Investigation on the Influence of Palm Oil Biodiesel in a Diesel Engine

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ABSTRACT

The majority of petroleum products are utilised in automobiles, and an alarming problem of outflow is the thickening of vehicles in urban areas. An alternate fuel option is biodiesel. A renewable and generally domestic source, such as fresh or used vegetable oil or animal fats, are trans-esterified with an alcohol (methanol or ethanol) in the presence of a catalyst to create biodiesel. It has been demonstrated that using biodiesel lowers engine emissions of SO_x, CO, and particulate matter (PM). It has been shown that biodiesel lowers the emission of CO, CO_2, and hydrocarbons. Among all current raw materials, palm oil contains a high concentration of palmitic and oleic acids, which are generally acknowledged as the best sources for biodiesel synthesis. In this Present work, Experiments were carried out in this thesis on a compresses injection internal combustion engine and a naturally aspirated diesel engine to investigate the performance characteristics and production of biodiesel and its mixes derived from Palm Biodiesel. Experiments with only 10% and 20% blending with diesel fuels were carried out. Results revealed that at 1500 rpm constant engine speed, the brakes thermal efficiency of B10 and B20 is comparable to or lower than diesel fuel. The thermal efficiency of B20 brakes was found to be more equivalent to diesel. More blending are necessary for a thorough knowledge of brake thermal efficiency. Also, the fuel consumption of B10 and B20 has risen in comparison to diesel. It was discovered that at the same braking load, the engine used more fuel (B10 & B 20) than standard diesel fuel.

How to cite this paper: Prof. V. K. Nema | Deepak Kumar Sahu "Experimental Investigation on the Influence of Palm Oil Biodiesel in a Diesel Engine" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-7, December 2022, pp.485-493, URL: www.ijtsrd.com/papers/ijtsrd52359.pdf

IJTSRD52359

KEYWORDS: *ICE, Palm Oil, Diesel/biodiesel, Fuel properties, Combustion efficiency, Emission control*

I. INTRODUCTION

Economic progress in India has lifted millions of people out of poverty and contributed to the modernisation of society. However, economic ambition does not come cheap. India has become more reliant on energy imports, posing a threat to energy security. Pollution from industry, transportation, and traditional cook stoves reduces air quality while increasing greenhouse gas emissions and contributing to climate change [1, 2].

India began producing biofuels about a decade ago in order to lessen its reliance on imported oil and so enhance energy security, and it is currently one of the leading producers of Jatropha oil. In 2001, the government launched a 5% ethanol blending (E5) pilot programme, and in 2003, it established the National Mission on Biodiesel, with the goal of reaching 20% biodiesel blends by 2011-2012. (Government of India, 2002, 2003) [5, 6, and 7]. India's biofuel initiatives, like those of many other countries throughout the world, have suffered difficulties, owing mostly to supply constraints and global worries about food security. In 2009, India's National Regulatory on Biofuels set a non-mandatory aim of a 20% mix for both biodiesel and ethanol by 2017, as well as a broad plan for the biofuels programme and policy measures to support it [8, 9].

Bio-fuel is most usually characterised as a renewable energy source derived from biological materials or biomass, such as sugar cane, corn, or vegetable oils. Bio-strategic fuel's objective is to augment or perhaps replace fossil fuels.

India is rich in biomass, and the bulk of the Indian people has traditionally used biofuels inefficiently, resulting in a couple of severe societal concerns, mainly the health implications of air pollution. Appropriate technology for making biofuels available to the public, as well as their successful use, would have a substantial influence on India's socioeconomic situation [10, 11, and 12].

Technologies for producing biofuels include the following:

1. Energy plantation
2. Accumulation and/or reclamation of wastes
3. Conversion of biomass to bio-fuels
   A. Using mechanical process
   i. Extraction (Eg. bio-diesel)
   ii. Compression (Eg. Pelletization)

   B. Using chemical process
   i. Liquefaction (Eg. Conversion of cellulosic biomass to oil)
   ii. pressurized water reactor in a hydrothermal medium
   a) hydrolysis
   b) fractionation
   c) gasification and
   d) reaction

   C. Using bacteria (Eg. Bio gasification through biomethanisation)
   D. Using algae for Conversion of micro-algal biomass to biofuels
   i. Oil extraction from microalgae
   ii. Microalgae wastewater treatment
   a) Hydrothermal gasification
   b) super-critical water as reaction medium
   c) ultrasonic treatment

Bio-fuels utilization technologies include the following:

1. Direct burning, combustion or gasification for heating or power generation or both (cogeneration)
   a. Co-firing along with fossil fuel(s)
   b. Fluidized bed
   c. Transported bed
   d. Circulating fluid bed
   e. Ablative (vortex and rotating blade)
   f. Rotating cone
   g. Vacuum

2. Bio-gas for cooking or fuel cells for power generation or co-generation

3. Transport fuels

1.1. Production of Biodiesel Using Palm Oil

Palm oil is seen as an alternate and potential feedstock for diversifying global biodiesel production. Palm oil includes a variety of phytonutrients that may be isolated prior to the synthesis of biodiesel. These phytonutrients have a high market value and can thereby counterbalance the entire production cost of palm biodiesel. This benefit has not been anticipated for other edible oil crops. Palm biodiesel conversion methods, particularly the catalytic approach, have received much investigation to date.

The full usage of fuel from vegetable oils as an elective fuel is obliged by the accompanying contemplations:

- Vegetable oils can make just a negligible commitment to the fuel Supply around the world.

- Vegetable oil powers could just get a noteworthy portion of the fuel showcase under certain nearby conditions (e.g., in Malaysia, some EU nations, and the US).

- Fluctuations on the planet market cost of vegetable oil muddle the appraisal of the financial suitability and the accessibility of vegetable oil fuel contrasted and ordinary powers [7].

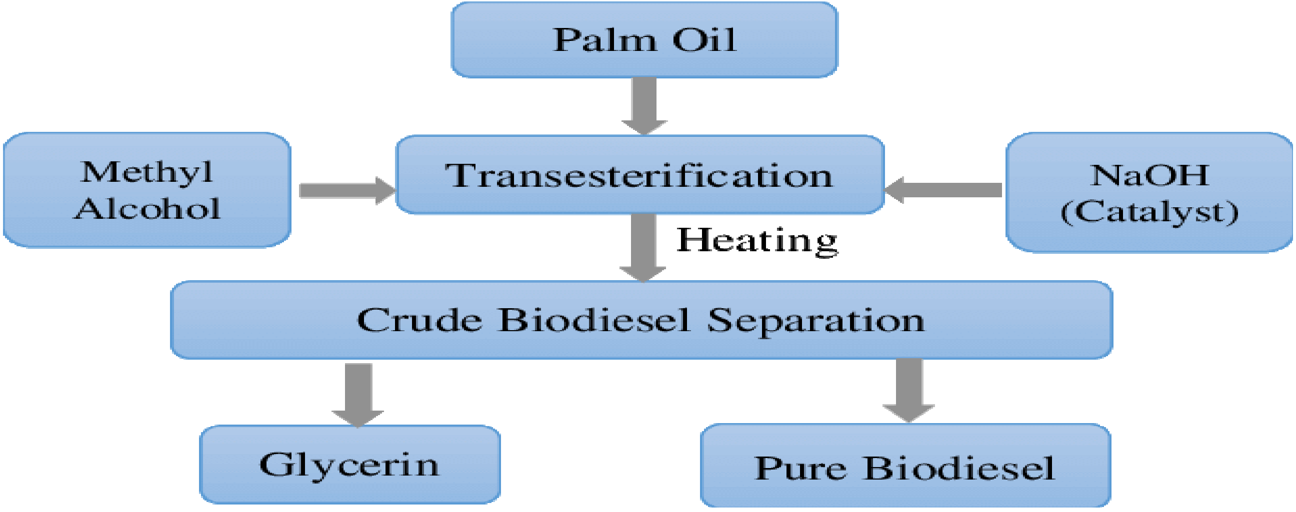

Figure 1 Steps of biodiesel manufacturing process from palm oil

II. METHODOLOGY

2.1. Biodiesel Production

The soluble base catalysed Trans esterification method using methanol and potassium hydroxide was used to produce palm and coconut biodiesel. The liquor interacted with the triglycerides to form the mono-alkyl ester or biodiesel and glycerol. The straightforward condition of this process is shown below.

Esters + Glycerol = Triglyceride + Alcohol

Rough coconut oil or unprocessed palm oil were mixed with methanol (25 v/v% of the oil) and potassium hydroxide (KOH)/NaOH (1 w/w% of the oil) in a coat reactor at 60 degrees Celsius with a rotating water shower. This mixture was mixed at 1200 rpm for 2 hours using an engine stirrer before being put into a detachment pipe. A partition time of 12 hours was assigned to isolate glycerine and methyl ester. The lower layer included glycerol and debasements, whereas the top layer contained vegetable oil's methyl ester. To eliminate entrained contaminants and glycerine, the methyl ester isolated from glycerol was rinsed with distilled water.

In this procedure, (50 v/v% of the oil) distilled water at 60 was sprayed over the ester and gently shaken. The water and impurities-containing opaque bottom layer was removed. The biodiesel was then put in a rotary evaporator to remove moisture. The biodiesel was then vacuum distilled at 65°C for 1 hour with a rotary evaporator to remove water and methanol. Finally, anhydrous sodium sulphate was used to absorb moisture, and the final product was recovered after filtering [12].

- Heating oil to a temperature of 60°C.
- Stirring and heating an alkaline or acidic catalyst into an alcohol-oil combination.
- Glycerol separation and ester washing with water

Figure 2. Chemical Components used.

Figure 3. Biodiesel Production from Palm oil.

Figure 4. Palm oil Biodiesel separation from funnel.

2.2. Experimental Setup

A four stroke, single chamber CI motor was utilized for the current investigation. The motor particulars are appeared in table 1. The presentation and discharge were assessed on variable burdens in diesel motor utilizing different mixes of diesel, biodiesel, as fuel. The trials were led at the consistent speed of 1500rpm at different burdens. The course of action for estimation, fuel stream, temperatures and burden gave. Four stroke single chambers CI motor test rig was appeared in figure 5.

Figure 5. Kirloskar diesel engine with dynamometer.

Table 1 Engine Specifications

TYPE	4 STROKE SINGLE CYLINDER ENGINE
RPM	1500
POWER	5 HP
FUEL	DIESEL
BORE	80 mm
STROKE	110 mm

AVL 444 digas analyzer was utilized for estimating the grouping of different contaminations in the motor fumes gas. The test was associated with the ventilation system of the motor to attract the exhaust to the analyzer.

Figure 6 Exhaust gas analyser.

2.3. Experimental Procedure

1. Examine the diesel in the fuel tank.
2. Fill the radiator with water.
3. Examine all motor components for proper operation.
4. Begin the motor in no heap state and then take readings in various load conditions.
5. The temperature will be calculated using a computerised display on the motor.
6. These procedures are carried out in various proportions for various fuels such as diesel/biodiesel.

Table 2: Observation table

S. No.	Time(in seconds)			
	Load (W in kg)	Diesel (100%)	Biodiesel(B10)	Biodiesel(B20)
1	0	46	42	43
2	1	34	32	35
3	2	29	27	29
4	3	25	25	25
5	4	22	22	23
6	5	19	19	19
7	6	18	17	17

III. RESULTS AND DISCUSSIONS

This chapter presents experiments that were carried out on a compresses injection internal combustion engine and a naturally aspirated diesel engine to investigate the performance characteristics and production of biodiesel and its mixes derived from Palm Biodiesel. Experiments with only 10% and 20% blending with diesel fuels were carried out. The experiments results are divided into two categories are following:

1. Comparison of diesel and its blends on performance parameters
2. Comparison of diesel and its blends on emission parameter.

3.1. Comparison of diesel and its blends on performance parameters

Result of Brake specific fuel consumption Brake thermal efficiency and Mass of fuel consumption for each load for three fuels (diesel, B10 and B20) are shown in figure 7, 8 & 9 respectively.

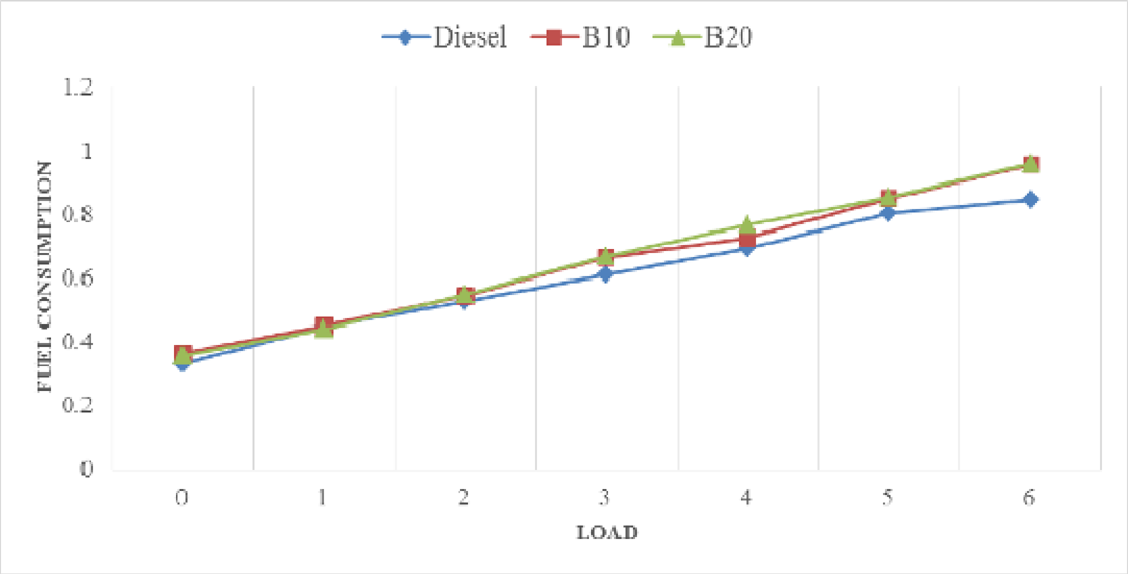

Figure 7 Variation of mass fuel consumption with load

Figure 7 depicts the change in fuel consumption for diesel B10 and B20 engines when different mixes are employed. As the load grew, the diesel engine burned more fuel than diesel fuel. The fuel consumption of B10 and B20 has risen in comparison to diesel. It was discovered that at the same braking load, the engine used more fuel (B10 & B 20) than standard diesel fuel.

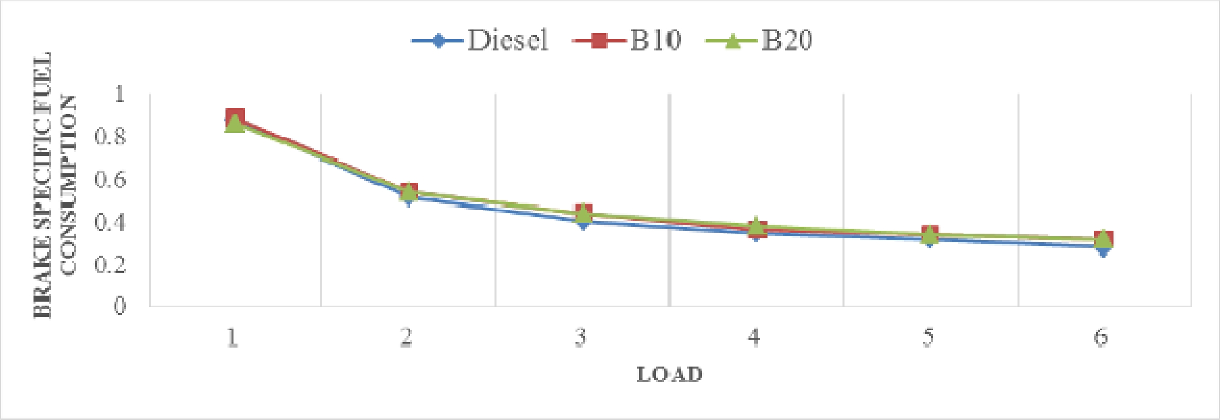

Figure 8 Variation of Brake specific fuel consumption with load

Figure 8 depicts how brake specific fuel consumption (BSFC) varies with load for diesel, B10, and B20 blends. When B10 and B20 mixes are used in diesel engines, the brake specific fuel consumption (BSFC) is greater than that of diesel. When compared to diesel fuel, the brake specific fuel consumption for B10 and B20 rises. As the engine braking load rose, the BSFC of the diesel engine was somewhat reduced. The brake specific fuel consumption is an important parameter for comparing engines and determining engine fuel efficiency.

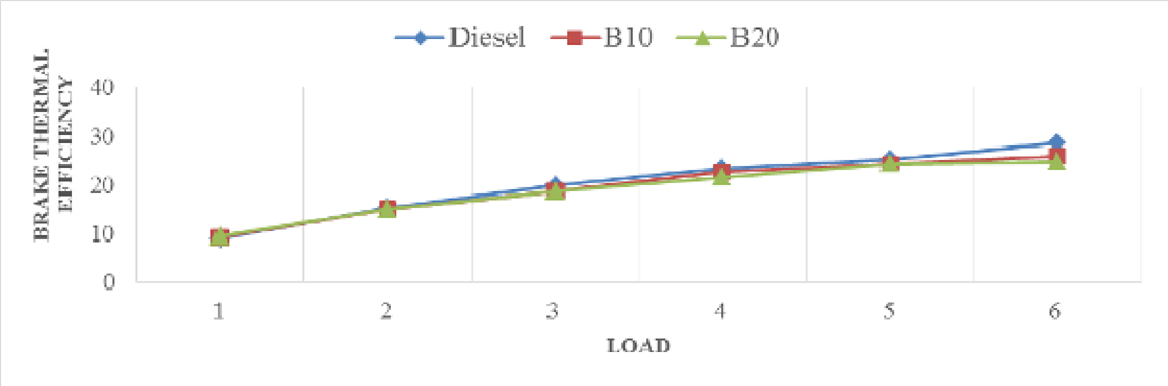

Figure 9 Variation of Brake thermal efficiency with load

Figure 9 depicts the variance in brake thermal efficiency (BTE) of a diesel engine running on diesel, B10, and B20 blends at different loads. As the mixes were raised, the brake thermal efficiency (BTE) of B10 and B20 declined. At 1500 rpm constant engine speed, the thermal efficiency of B10 and B20 brakes is comparable to or lower than diesel fuel. The thermal efficiency of B20 brakes was found to be more equivalent to diesel. More blending are necessary for a thorough knowledge of brake thermal efficiency.

3.2. Comparison of diesel and its blends on emission parameter

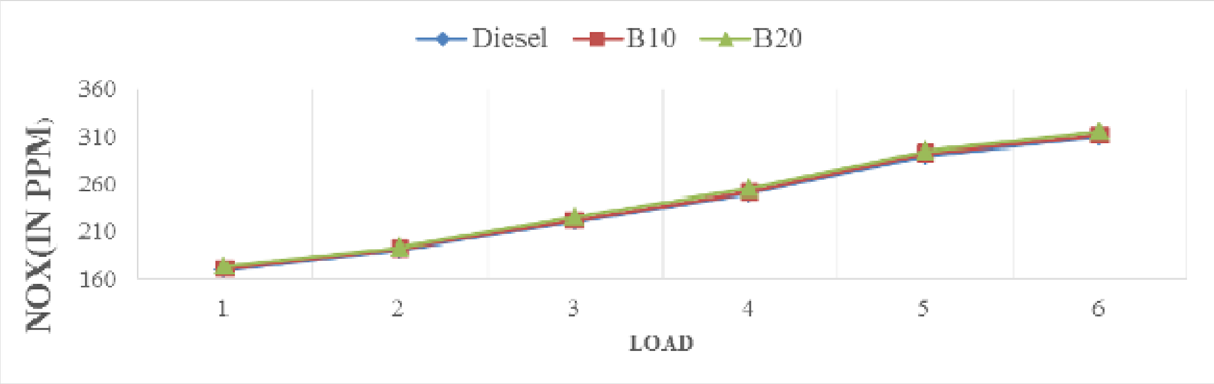

Figure 10 Variation of NOx with load for diesel, biodiesel (B10, and B20)

Figure 10 depicts the variance of NOx with respect to load at various biodiesel mixes. Experiments revealed that NOx pollution from all fuels improved with an increase in load. This is related to the increased amount of gas consumed. The NOx emissions of all biodiesel mixes were somewhat lower than diesel. Because biodiesel is an oxygenated fuel, this occurrence occurred as a result of the higher temperature in the combustion chamber. It provides more oxygen to inhaled air in the combustion chamber, resulting in full combustion and raising the temperature of the combustion chamber. At higher temperatures, nitrogen interacted with oxygen in the air, resulting in increased NOx generation.

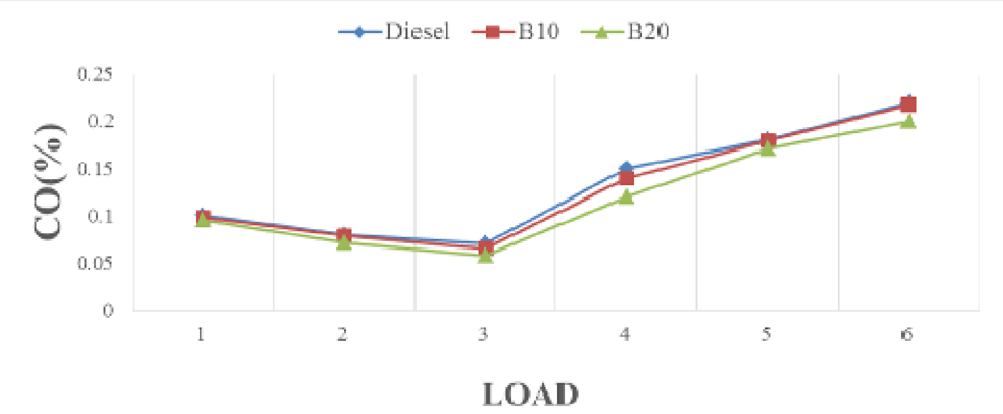

Figure 11 Variation of CO with load for diesel, biodiesel (B10, and B20)

It was discovered that pure diesel produced the most CO of all energises. Because there is insufficient oxygen to convert all carbon to carbon dioxide, a few powers are not completely used, and the carbon of fuel ends up as carbon monoxide. As the heat increases, the blending of the fuel increases, causing CO outflows to decline for a while, and at high loads, the fuel usage increases, causing the comparability proportion of fuel to increase, resulting in increased CO discharge at high loads. When compared to pure diesel, biodiesel and biodiesel blends performed better and communicated less CO. This is due to the presence of sufficient oxygen in the methyl esters. Figure 11 depicts the different types of CO emission in diesel and biodiesel mixtures with loads. Biodiesel emits approximately 27.12% less CO than diesel gasoline.

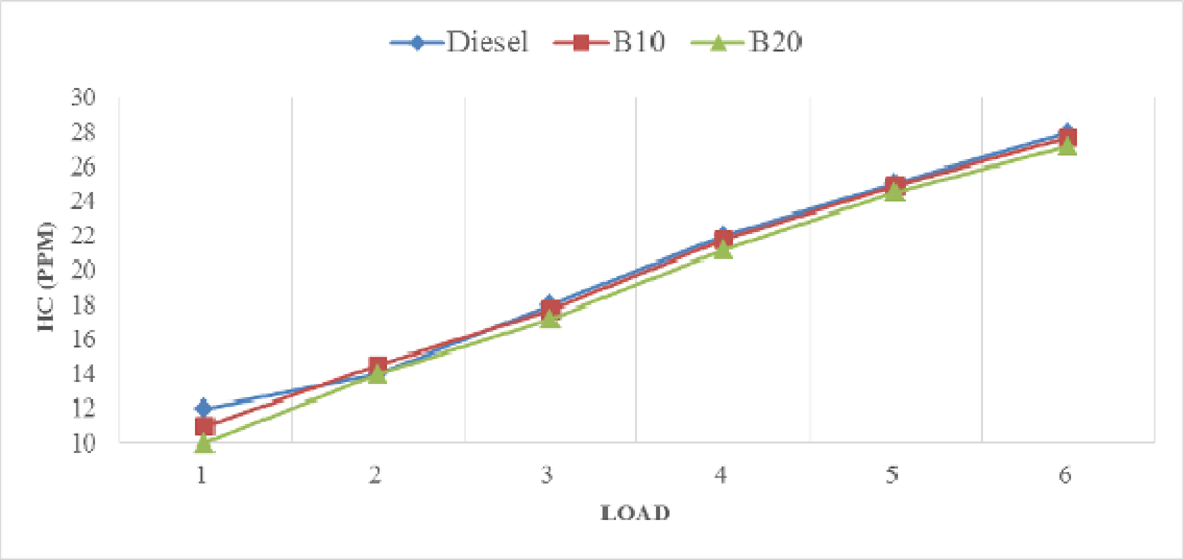

Figure 12 Variation of HC with load for diesel, biodiesel (B10, and B20)

It was discovered that hydrocarbon emission was most notable for diesel fuel and also the least in the B10. More hydrocarbon means that the atoms in the ignition chamber did not ignite properly. Figure 12 illustrates that biodiesel emits less HC than diesel due to a lower hydrocarbon percentage in biodiesel.

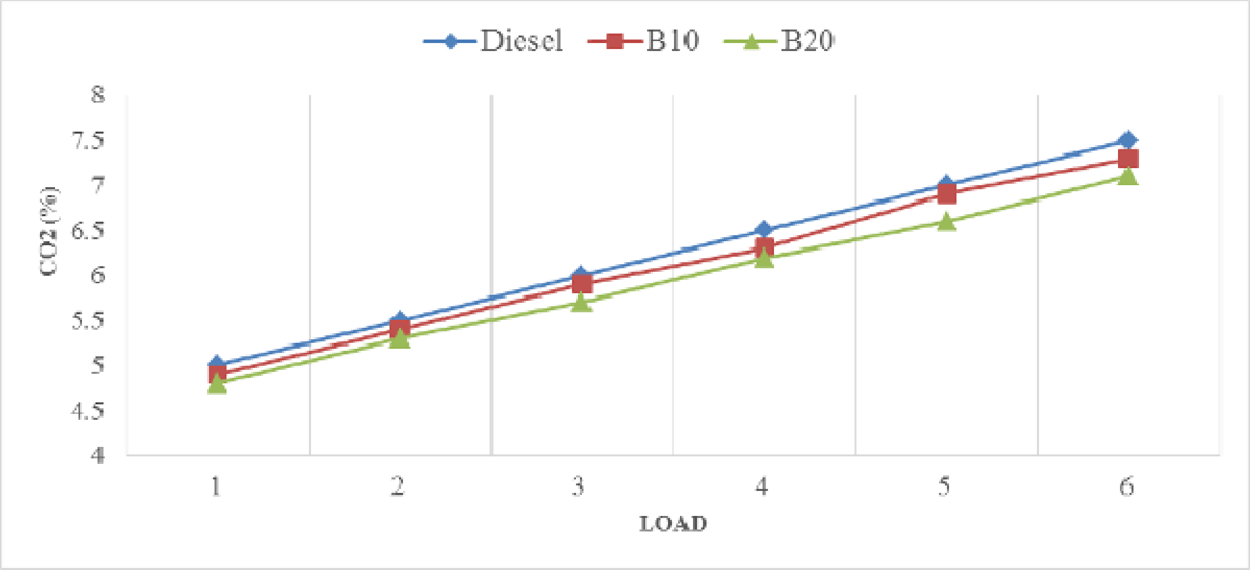

Figure 13. Variation of CO_2 with load for diesel, biodiesel (B10, and B20).

IV. CONCLUSIONS

The performance and emissions of a diesel engine powered by a novel fuel, palm oil, were assessed. The findings demonstrated that adding palm oil to diesel fuel can reduce pollutants while also improving engine performance.

- Change in fuel consumption for diesel B10 and B20 engines when different mixes are employed. As the load grew, the diesel engine burned more fuel than diesel fuel. The fuel consumption of B10 and B20 has risen in comparison to diesel. It was discovered that at the same braking load, the engine used more fuel (B10 & B 20) than standard diesel fuel.
- When B10 and B20 mixes are used in diesel engines, the brake specific fuel consumption (BSFC) is greater than that of diesel. When compared to diesel fuel, the brake specific fuel consumption for B10 and B20 rises. As the

engine braking load rose, the BSFC of the diesel engine was somewhat reduced.

- At 1500 rpm constant engine speed, the thermal efficiency of B10 and B20 brakes is comparable to or lower than diesel fuel. The thermal efficiency of B20 brakes was found to be more equivalent to diesel. More blending are necessary for a thorough knowledge of brake thermal efficiency.
- In comparison to diesel, biodiesel emits less CO. Furthermore, increasing biodiesel percentage in diesel-biodiesel blends resulted in a decrease in CO output.
- Pure diesel showed lower HC emission than unadulterated diesel. Diesel produced the least amount of CO2 since B10 reduced fuel use. The major disadvantage of using biodiesel as a fuel in CI engines is that it increases NOx emissions, which can be reduced by combining it with palm oil.

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