IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Performance Emission Characteristics Of Biodiesel From Pumpkin Seeds And Diethyl Ether Using Diesel Engine

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ABSTRACT - Numerous scientists look at developing a new fuel to solve the fossil fuel troubles. Wealthy nations have placed emphasis on alternative sources of electricity such as wind, hydro, fuel, oceanic, and renewable thermal by wealthy nations. According to the country's energy requirements, changes in land, environmental deterioration, and food security, these hydrocarbons are increasingly recognized as an easy solution in the Indian setting. It is the diesel engine in use today. The molecules have been integrated throughout the fuel. The biodiesel's output elements will be improved if the modifiers are used properly. Micro additions significantly improve fuel economy as ignition particles release gas to the fuel. In the present research, a single-cylinder, four-stroke diesel engine was performed to explore the impact of diethyl ether performance on the effectiveness and particulate characteristics of pumpkin seeds biodiesel.

INTRODUCTION - It is a considerable difference between the demand and availability of fossil fuel to the various energy-consuming industries as the fuel's supply reduces on a daily basis. Oil and fuels derived from plant and animal fats can close this market gap between supply and demand. The most hazardous emissions into the atmosphere come from vehicles with diesel engines. The scientific community studies several bio-based fuels, including biodiesel, biogas, animal fat-based oil, and vegetable oil. Every bio-based oils must transfer and process in a form that is suitable for the fuel and uses. Most of these resources are economically more affordable and less environmentally damaging than fossil diesel. Comparing biodiesel to other alternative fuels, it stands steady, produces amazing results, and leaves minimal footprints. B20, B40, B60, and other biodiesel-blend fuels can be created by blending increasing amounts of biodiesel with diesel fuel. The matching number reflects the biodiesel's proportion in the overall blend where "B" stands for biodiesel. Almost every major country in the world is currently dealing with two significant issues: environmental deterioration and the rapid depletion of fossil fuel reserves. Earth carbon sources are reduced as a result of the continued extraction and use of these fossil fuels. A quest for alternative fuels is therefore warranted in the current environment as it will lead to the overall development of sustainable energy resources, environmental improvement, and alternative energy eco system. Fuel cells, i.e., fuels derived from plant and animal fats, are substitute fuels that can be utilized to address the world's petroleum crises. Gasoline and diesel-powered vehicles are the main producers of hazardous emissions, which release greenhouse - gas emissions. Researchers and scientists looked at a variety of other resources, including methane, alcohols, vegetable oil biofuels, and biodiesel, to meet the rising need for liquid fuels. These various alternative resources have certain benefits and drawbacks; each situation must be thoroughly investigated to see whether they qualify as alternative fuels. Several fuels can be utilized in the engine as directed. Yet, compared to regular gasoline or diesel fuels, the majority of other fuels need to be modified to fit engine fuel qualities. The catalyst employed, reaction temperature, and reaction time all play a significant role in the characteristics of biodiesel. Biodiesel additives significantly enhance the general characteristics of biodiesel blends. Enhancing a fuel's characteristic always helps the fuel's combustion chemistry and air in the engine cylinder, which enhances the efficiency of the engine. The amount of hazardous gases released into the atmosphere is decreased by fully combusting the fuel in the cylinder. So many properties of biodiesel additives, such as volume, viscosity, energy content, fire point, specific heat, and cloud and pour point, are taken into consideration while choosing an additive. pumpkin seeds with diethyl ether blended oil biodiesel is employed as an alternative fuel in this study. Diethyle ether composites was chosen for this research project. Diethyle ether composites were present in concentrations of B20, B20 + 50 ppm, and B20 + 100 ppm. It is used as fuel in a diesel engine to assess how well it performs and how much pollution it produces under various load circumstances.

The implementation of a better transportation system boosts the economy of any nation since the energy used in transportation grows on average by 1.1% annually. Demand for and consumption of energy have increased as a result of industrialization. Crude oil was initially employed as a substitute to meet the energy demand, and starting in 1970, there was a global crude oil crisis. Researchers and scientists from all around the world have been working to find alternative fuels as a solution to this problem. Many researchers have claimed that the physical and chemical characteristics of biodiesel and conventional diesel are identical. also outlined the production and use of biodiesel as an engine fuel in the world today. Because biodiesel can be used in diesel engines without needing to be modified, its use has been on the expansion. **Datta et al.** After presenting a thorough analysis of biodiesel as a substitute fuel for compression ignition engines, the authors came to the conclusion that while utilizing biodiesel benefits the environment, it considerably degrades engine performance. Vegetable oil and animal fat are used to make biodiesel, which is non-toxic. Biodiesel has no sulphur and a high cetane number, which are benefits. The main drawback is that regular diesel fuel cannot be completely replaced. Researchers have found that biodiesel with low calorific value has high kinematic viscosity and density values. **Ogunkunle et al**. had already experimented with different biodiesel to diesel blend ratios to solve the low temperature burning issue and enhance engine performance. The ideal blend ratio is B20, which improves density, viscosity, calorific value, flash point, and improved engine performance. Its effects of bio-based additions on the characteristics of biodiesel have been reviewed by **Lawan et al.** The amount and type of phenolic compounds in the feedstock used for the decreased antioxidant effects as well as the freezing point of the fuel source used for the cold flow reducing impact determine the effectiveness of the bio-based chemicals. In their review of the benefits of using waste plastics as biodiesel additives**, Arjanggi et al.** also covered pertinent facts regarding polymer dissolution phenomena, the impact of fuel characteristics, and the general makeup of biodiesel. A thorough analysis of biodiesel as a substitute fuel for marine diesel engine applications was carried out by **Mohd Noor et al.** There are a number of challenges faced by marine applications, including fuel stability, increased production and feedstock costs, material compatibility, cold flow qualities, and a lack of marine-grade standards, which call for future technology advancements and effective solutions. According to research by **Gad et al.,** kerosene and HHO gas additives have an impact on a cotton ethyl ester blend's ability to improve the performance and emissions characteristics of a diesel engine. The findings demonstrate that the cold flow characteristics were improved by the use of kerosene additive. The addition of HHO improved the combustion properties. In order to increase the oxidation stability of hydrogenated biodiesel without sacrificing the cold flow qualities**, Adu-Mensah et al.** examined the developments in this area. They claim that a combination of catalysts can be employed to lessen partial hydrogenation and trans-FAME (fatty acid methyl esters). **Chandran** The FDM degeneration caused by exposure to oxidised biodiesel containing oxidised products such as aldehydes, ketones, and short-chain acids wasn't true for CRDE (heavy - duty diesel engine), but the dissolved oxygen and conductivity value of biodiesel has an adverse effect has reviewed the suitability of biodiesel with fuel system materials (FDM). **Jiaqiang et al.** A thorough evaluation of various technologies used in biodiesel-fueled engines was carried out When compared to other technologies such as diesel fuel additives, recirculation of exhaust gas (EGR), water injection (WI), emulsion technology (ET), injection strategy modification, dynamic technologies (ST), and engine cylinder geometry modification, they discovered that the Low Temperature Combustion (LTC) mode is more effective at reducing Nitrogen oxides and PM particulate. **Wang et al.** study of the particles in the air (PM) emission components of diesel engines using biodiesel or biodiesel blends has emphasised the importance of the parameters of biodiesel fuel, such as the length of the chain of fatty acids. the amount of unsaturation, and the oxygen concentration, on PM emission. **Akhabue et al.** calcium oxide corncobs and calcined chicken droppings were impregnated with sulfonate to create a new bio-based biofunctional catalyst (BBFC). The neem leaf oil has been processed with a bio-based catalyst and has a free fatty acid concentration of 4.426%. **Ramalingam et al.** studied the effects of a biodiesel blend made from moringa oleifera employing cutting-edge injection techniques on diesel engine parameters. They discovered that the engine emissions are significantly influenced by the fuel injection pressure (300 bar to 600 bar) and timings (15°CA to 25°CA bTDC). Compared to NOx emissions, the addition of moringa oleifera biodiesel mix has lowered CO and CO_2 emissions more significantly**. Suresh et al.** had already examined the findings of earlier studies that employed variable compression ratio (VCR) engines with fuel injection of biodiesel blend fuel and hypothesised that VCR engines with optimal compression pressure improve engine performance and lower dangerous hot exhaust. **Mirhashemi et al.** assessed the ability of several biodiesel blends to minimize NOX emissions, including fuels, propane, natural gas, biomass, and various alcohols. They have also stated that using different fuel mixes with biodiesel will minimize NOX emissions, but that suitable injection parameters and fuel blending proportions must be adjusted. **Erdiwansyah et al.** a study comparing the effects of alcohol on gasoline and biodiesel on diesel for engine performance, combustion, and emission parameters was published. highlighted the benefits and drawbacks of using biodiesel and alcohol as fuel for engines**. Yesilyurt** examined the operation, combustion, and exhaust emission properties of a diesel engine powered by a mixture of diesel fuel, biodiesel, and 1-heptanol (C7 alcohol), a newer higher alcohol. They found that, in comparison to diesel fuel, the oxygenated additive 1-heptanol increased CO_2, O_2, and NOX emissions while decreased CO and unburned HC emissions from diesel fuel and biodiesel/diesel fuel blends. **Shahir et al.** Analyzed the advantages and potential of employing a diesel-biodiesel-ethanol/bioethanol blend in the current diesel engine. They claimed that keeping the ethanol level below 5% generated superior outcomes. It remains difficult to reduce NOx emissions since more catalytic converters are required to do so**. Zaharin et al**. examined the impact of a biodiesel-alcohol blend on the efficiency and emissions of diesel engines. Because there is an increase in NOx output, the addition of alcohol blend reduces CO, HC, and PM emission.

The entire combustion is improved and the combustion temperature rises with increased oxygen content, increasing NOx and co emission. **Mujtaba et al.** examined the effects of oxygenated methyl esters and fuel additives with nanoparticles on the CI diesel engine characteristics of diesel-biodiesel blends. They discovered that adding alcohols plus B30 lowers CO and HC emissions while adding CNT nanoparticles plus B30 lowers NOx pollution. **Hasan et al.** studied the effect of biodiesel production on the economy and the environment as well as how biodiesel mixes affect IC engine performance, durability, and emission characteristics. They come to the conclusion that existing engines can accommodate a small volume of biodiesel blends without any adjustments. Few engine adjustments are necessary for long-term use and a greater percentage of diesel. **Hosseinzadeh Bandbafha et al.** reviewed the biodiesel life cycle assessment. **Godri Pollitt et al.** due to rising use of biodiesel fuel in IC engines, the public health hazards have been addressed. Researchers conducted some experimental research utilising animal models to evaluate the effects of biodiesel engine exhaust from soy- (B3-B100), rapeseed- (B20-30), corn- (B50, B100), and sewage- (B3-B100) derived biodiesel fuels on cardiovascular, pulmonary, and systemic outcomes. According to their findings, health policies should be developed in the future to address the following issues: the quality of biodiesel feedstock, standardised test procedures, and evaluation of gas pollutants caused. **Soudagar et al.** had outlined the disadvantages of using biodiesel, including the rise in nitrogen oxide emissions, its incompatibility with cold weather, and the need to repair engine equipment like gasoline filters, fuel tanks, and fuel lines at regular intervals owing to clogging. They have proposed that nanoparticles could be used as fuel additives to enhance the qualities of biodiesel. Metallic nanoparticle addition decreased the ignition delay time, increased calorific value, and accelerated oxidation rates, resulting in a complete and cleaner combustion. **Guo et al.** examined how the use of diesel, xylene, butanol, coconut oil, and toluene affected the chemical makeup and thermal oxidation of the diesel engine. Each of these fuels underwent separate testing in an IC diesel engine. They came to the conclusion that depending on the type of fuel, thermal oxidation and chemical structure differ. The soot produced by biodiesel is more reactive, causing more mass loss at lower temperatures.

Biodiesel manufacturing and testing have begin in a number of nations. There is a greater need for alternative fuel because traditional diesel fuel is more expensive, and thus biodiesel might be a better option. A wide range of equipment, including heavy trucks, marine engines, and industrial, use biodiesel fuel. This review paper's major goal is to provide an overview of the experimental research done on diesel-biodiesel blends for increasing performance and lowering emission levels. It is clear from the literature that a thorough comparison of the performance traits of conventional diesel fuel and biodiesel blend fuel was presented. Additionally, it was discovered that there aren't many review studies on the effects of additives in biodiesel. In order to support the impact of adding additives such methanol, ethanol, butanol, and propanol to reduce exhaust gases, this review offers a succinct description.

The qualities of biodiesel

The fuel characteristics, flash point, pour point, low octane number, density, kinematic viscosity, heating value, and calorific value are only a few of the factors that affect an engine's efficiency. As specified by several standards including ASTM, EN, and ISO, the physical and chemical properties of biodiesel blends must meet the cut-off points. Mixing at least two biofuels with diesel and other additives has gained popularity recently because it improves the qualities of the fuel. Certain physical and chemical characteristics of biodiesel mix fuels may affect engine performance and exhaust pollution levels.

Calorific value is considered to be the most important characteristics of any fuel because the engine's power output depends on it. On example, the calorific value of coconut oil is 38.50 MJ/kg, 40 MJ/kg for palm, and 39.80 MJ/kg for jatropha. When compared to normal diesel fuel, the calorific value of fuel blend is typically higher than that of biodiesel. When the amount of biofuel in a biodiesel blend is reduced, the calorific value of the fuel rises, improving engine performance. For instance, coal (32–36 MJ/kg) is more expensive than petroleum (46 MJ/kg), an oil (42 MJ/kg), etc.

The gasoline engine and exhaust emissions are directly impacted by the density of the biodiesel fuel. Higher viscosity due to higher density leads to actual ignition. Because the biodiesel-diesel mixtures are denser than regular diesel, the size of the fuel droplets is enhanced. The mass of fuel infusion is altered by the density value, which affects the quality of burning. and a high - viscosity value will increase combustion efficiency and the growth of the air-fuel ratio. High evaporation gases, in particular NOx particulate matter, are caused by the high density. The density of diesel engine varies depending on the source and implementation environment, as seen in Figure 1. The density of coconut biodiesel is lower (807.3 kg/m3) than that of soybean biodiesel (931 kg/m3).

Vegetable oil	Kinematics viscosity (mm^2/s)	Flash point (°C)	Density (kg/l)
Rapseed	37	246	0.911
Castor	227	230	0.961
Palm	36	164	0.880
Peanut	39.6	271	0.902
Soybean	32.6	254	0.914
Sunflower	33.9	174	0.916

Figure 1.

The IC engine's ignition is directly correlated with the fuel's viscosity. Fuel with a lower viscosity will wear out more quickly and leak more. At the time of infusion, gasoline with a higher viscosity forms larger droplets and emits more fumes and gases. When it's chilly outside, the fuel's viscosity rises and leads to combustion products. Because biodiesel fuel has a higher viscosity than regular diesel fuel, there is an increase in fuel efficiency. Biodiesel has a lower viscosity than diesel when blended with it. Sunflower oil biodiesel-diesel has a kinematic viscosity of 4.5 to 5.8 mm2/s, while palm oil biodiesel-diesel blend has a kinematic viscosity of 3.2 to 4.5 mm2/s. The kinematic viscosity values of different biodiesel fuels.

According on its cetane number under a specific circumstance, the quality of any fuel's ignition is identified. Compared to diesel fuel, the cetane number of the biodiesel fuel is greater. To make the engine run quietly and smoothly, to increase engine performance, and to reduce emissions, the cetane number must be increased. Higher cetane numbers are needed to reduce ignition delay. Higher emissions of hydrocarbons and particulate matter will result from a lower cetane number. The low octane number increases as the biodiesel blend with diesel grows because it determines the engine life. Biodiesel has a lower cetane number, between 46.8 and 49.8, than regular diesel, which has a range from 46 to 55. Palm biodiesel has a cetane number of 54.6, seed oil biodiesel is 37.9, peanut biofuel is 53.59, and jatropha biodiesel has a cetane number of 51.6.

A flash point is a crucial factor that has an impact on the use, storage, and transportation of oil. Higher flash points in fuel indicate that it is secure in both storage and transportation. The lowest temperature when a fuel will produce enough vapor to create a burning solution above the fuel surface is known as the fuel's flammability. The standard flash points for biodiesel in the EU and USA are 92°C and 120°C, accordingly. Because biodiesel's flash point is 50% higher than that of diesel, it can be stored and transported without risk.

The two most important fuel parameters to consider when evaluating performance at low temperatures are cloud and pour points. As a result of solidification, fuel may completely or partially obstruct fuel lines, and inadequate lubrication in fuel filters will result in engine damage. In comparison to diesel, biodiesel with a higher content of fatty acids retains a higher cloud and pour point. Diesel fuel performs far better than biodiesel in cold weather situations. Its high viscosity and cloud point make using biodiesel more challenging in cold weather conditions. For biodiesel and its blends, the cloud point and pour point are 16 and 15, while for soybean, they are 9 and 2, accordingly.

In determining if biodiesel is suitable for long-term engine use, it is a crucial factor. Iodine is added to the single bond of any fatty acid in a classed of 100 g to determine a fuel's iodine ratio. The maximum iodine content, 144 mg I/g, is found in Hevea brasiliensis, and the lowest iodine content, 40 mg I/g, is found in Simarouba glauca (paradise tree). There are two ASTM procedures for determining iodine value: D1959 and D1541. However, because stability tests like cetane number, viscosity, and cold flow characteristics depend on the position of the single bond that is open for oxidation, both methods are not appropriate for those tests. The iodine content of coconut biodiesel is roughly 19 while soy biodiesel has an iodine content ranging from 128 to 143.

In order to prevent an unsuitable change in the properties of the biodiesel, the copper contamination plays a crucial role in use and storage. Using a stripping chromo potentiometer, the amount of copper contained in ethanol, different biodiesels, and water bonding is measured (SCP). It is used to identify metal in fuel, particularly in oils, and to help eliminate any leftover organic waste that could cause system limitation issues. Utilizing a stripping voltammeter, it is possible to determine the availability of metal and portable power.

S. No	Biodiesel properties	Measured values	Units
1	Density at 20°C	950	kg/m^3
2	Kinematic viscosity 40°C	38.7	mm^2/s
3	Flash point (°C)	150	°C
4	Acid value	12.6	mgKOH/g
5	Saponification value mgKOH/g	180	mgKOH/g
6	Moisture content	0.019	(%)w/w
7	Ash content	0.04	(%)w/w
8	Iodine value	90.6	I_2g/100g
9	Free fatty acidic	5.28	%
10	Melting point	30.2	°C

Biodiesel's performance characteristics in IC engines Another crucial factor is engine performance, which includes factors like brake thermal efficiency, braking power, and brake-specific fuel consumption. This section presents a thorough analysis of the power, BSFC, and BTE performance parameters of a diesel engine running on biodiesel-diesel mixes.

Several researchers claim that the BTE for biodiesel-diesel blends is diethyl ether slightly lower or stays the same when compared to diesel fuel. **Raman et al.** According to reports, B20 blend was successfully used in diesel engines without modifying them, with adequate thermal efficiency. **Murillo et al.** observed that reduced brake thermal efficiency is caused by biodiesel's increased viscosity **John panner selvam et al**. According to research and reports, because of the lower heating value of beef tallow biodiesel, pure biodiesel made from it (B100) has a poorer thermal efficiency than diesel fuel with its blend (B5 to B78). **Rajaraman et al.** investigated the methyl ester of pumpkin seed oil's performance properties and its blend (B20 B000) in diesel engines under varied load circumstances. They found that while pumpkin blends are denser and have higher viscosity and lower heating values than diesel fuel, they had inferior brake thermal efficiency. **Bari et al.** noticed that the thermal efficiency of the brakes was lower for pumpkin seed oil diesel than for oil and natural. Due to pumpkin seed oil diesel's lower calorific content, its 10% greater fuel consumption has resulted in a 5% reduction in efficiency Because pumpkin seed oil diesel contains fuel-borne oxygen, it burned more efficiently than regular diesel. **Vijayakumar et al.** shown that the biodiesel fuel mixes with ether are extremely promising for enhancing the operation of diesel engines. They verified that the maximum efficiency was generated by 25% biodiesel made from fuel and alcohol. The efficiency would increase if the best ratio was chosen for adding the right ether addition to the biodiesel.

Brake specific fuel consumption

For utilised in CI engines, the amount of bio - diesel in the biodiesel-diesel blends increases with an increase in the blend's biodiesel content. For all biodiesel fuels, the BSFC value falls as engine load rises. **Pramanik** examined how well jatropha biodiesel performed in diesel mixes. They discovered enhanced performance, a decrease in BSFC when compared to vegetable oil, and a fall in jatropha viscosity as the cause. **Asokan et al.** According to an investigation and report, B20 performs nearly as well as diesel fuel. At heavy power, the brake-specific fuel consumption for blends B20 and B30 was comparable to that of regular diesel fuel. **Arumugam et al.** Without altering the engine, a diesel engine was studied using fuel that included only

100% pumpkin seed biodiesel. They claimed that when the engine operates at full load condition with 100% pumpkin seed biodiesel similar to diesel fuel, the brake power and rpm are 10 to 12% less. Fuel consumption for brakes specifically rose by 4% to 5%. **Srithar et al.** found that while brake power increases, BSFC decreases for all dual biodiesel blends. The BSFC is the perfect variable because it is based on the fuel's calorific value. Because to the ester's low energy content, there is a substantial energy demand. **Bari et al.** Due to pumpkin seed oil diesel's lower calorific value and 10% higher price compared to petro-diesel fuel, BSFC was somewhat greater. **Jafari et al.** has explored the use of two to three alternative fuels, employing triacetin as an oxygenated biodiesel additive and diesel and pumpkin seed biodiesel as base fuels. They have created a matrix of correlations between several parameters. Some of these are acceleration, braking force, injection pressure, thermal efficiency, air-fuel equivalency ratio, ignition delay, acceleration-specific fuel consumption, density, oxygen content, information on exhaust emissions, and particle morphology. Additionally, they discovered that fuel consumption rises as fuel oxygen concentration rises and that biodiesel and triacetin have lower heating values (LHV) than diesel, which results in higher BSFC.

Power

Many studies have found that using biodiesel-diesel mixes with biodiesel from various sources can result in a greater or lesser drop in engine power. **Murillo et al.** A four-stroke single-cylinder direct diesel injection engine's efficiency with a biodiesel blend at different percentages (10%, 30%, and 50%) was examined under various conditions, and it was determined that increasing the biodiesel blend reduces power output. **Allen Jeffrey** observed that for constant biodiesel percentage and compression ratio, effective power rises steadily and subsequently falls as load rises. When effective power falls to a certain level, efficiency rises, and for stable equivalency ratios and compression ratios, it starts to rise with an increase in biodiesel %. **Usta et al.** the usage of pumpkin seeds oil combination, hazelnut soap stock, and mixes in four-cylinder, indirect ignition diesel engines led to higher power being achieved. Diesel fuel loses some of its heating value when biodiesel is added to it. Greater oxygen mixes (10%), blends with higher viscosities, and blends with higher mass flow rates all have less internal leaks in the fuel pump. They discovered that power falls off as the amount of enriched biodiesel rises.

Biodiesel emissions from an internal combustion engine

NOx, Hydrocarbons (HC), Monoxide (CO), and Particulate Matter are the main emissions from CI engines. The engine characteristics, fuel quality, engine operating conditions, and engine design all affect the emission level. Using diesel-biodiesel blends reduces CO, NOx, HC, and particulate matter when compared to using pure diesel fuel. The comparison of each investigation's findings regarding the emission characteristics of diesel fuel alone against biodiesel fuel blends in various engines is described in table

Performance and Emission Result for various Test Condition

Engine	Fuel	Experiment Condition	Compared to Diesel fuel					
			Efficiency	BSFC	CO	HC	NO	Smoke
Single cylinder diesel engine	Pongamina Pinnata oil & mustard oil	Constant speed (300 rpm)	0.9% increase	H	L	H	H	H
	Rice bran oil	Constant speed (1,550 rpm)	2% increase	H	L	L	L	L
	Rice bran oil	Different load	S	H	H	H	-	-
	Pumpkin seed oil	Variable compression ratio (16:1,17:1, 18:1)	L	L	L	L	H	L
	Rapo seed oil	Constant speed (1,500 rpm) and constant injection of 20 bar	S	H	L	L	H	L
	Palm oil	Different speed (2,000, 2,500, 2,800) rpm	-	H	L	L	H	-
Single cylider direct injection engline	Safflones oil	Constant speed 1,500 rpm	H	S	S	-	S	-
diesel engine	Pongamia oil & waste cooking oil	At different loads (30%, 50%, 20%, 100%)	S	H	L	L	H	-
	Ether	Different load (20%, 40%, 60%, 80%, 100%)	Increase	L	S	L	L	H
	Palm oil	Different speed (1,000, 1,800, 2,000, 2,500, 3,000 rpm)	-	H	S	L	H	-
	Jatropha meringa palm	Different speed (100 to 400) rpm	-	H	L	H	H	-
Direct injection diesel engine	Juliflora oil	Different load (30, 50, 70, 100)	L	H	S	L	S	H
	Palm oil	Different speed (1,700, 1,800, 1,900, 2,100, 2,300, 2,500) rpm	L	H	L	L	H	-
Multi fuel direct injection	Palm oil	Direct injection pressure (190,140, 230) bar	-	L	H	-	L	-
Two cylinder 4 stroke diesel engine	Palm oil	S	H	L	S	L	-	
Four cylinder diesel engine	Diethyl ether	Constant speed 1,600 rpm	S	H	L	-	L	-

[i] Where; H- Higher, L- Lower, S-Similar

HC emission

When an internal combustion engines blend is used as fuel instead of straight diesel, the HC emissions are reduced. They discovered that the fuel mix D70B25E5 with 15-degree vane angles and the air swirl air D80B10E10 has the lowest HC emission. Due to the high oxygen concentration in butanol and safflower biodiesel, HC emissions are found to be slightly lower than those from diesel fuel. Additionally, biodiesel's greater cetane rating and butanol's superior mixing capabilities reduce the time between ignition and flame propagation, resulting in better combustion. Biodiesel blend B10 was shown to have lower HC emissions than base diesel, however B20 had the lowest level of HC emissions, which may be connected to a rapid ignition due to biodiesel's greater cetane number than diesel. A shorter ignition delay time results in a more thorough burning of the fuel and, as a result, emits less hydrocarbon exhalations. Increased HC emissions from the addition of n-butanol to gasoline mixes may be caused by a longer ignition delay brought on by higher alcohols' low cetane numbers. As a result of a longer ignition delay period, fuel is partially burned. Greatest HC emissions were measured for B20 nb20 fuel blend at 100% load, while the least value of HC exhalations were documented for B20 fuel blend at 20% engine load. The greatest value of HC emissions for pure diesel was 5.31 g/kWh at 20% load, while the lowest value was 5.01 g/kWh when the engine was operating at full capacity.

CO Emission

Analyzed to diesel fuel, employing a biodiesel-diesel blend results in lower CO emissions. studied using n-butanol supplied to the cylinder by valve injection under reactivity controlled combustion mode (RCCI) mode High CO emissions are a result of the highly premixed charge being evenly distributed throughout the cylinder, including the boundary layer region close to the cylinder liner and the crevice region where the fuel is difficult to totally oxidise. Relative to diesel fuel, it was observed that biodiesel emissions were emitting higher CO2 and NOx, but less carbon monoxide. When compared to B20 (20% biodiesel, 80% diesel fuel), they found that the overall HC emission increased while the CO emission decreased somewhat. discovered that, compared to engine running at maximum load, CO emission is higher during lower loads. This is mostly due to the presence of a fuel-rich mixture at full load. Composites of biodiesel emit less carbon dioxide than diesel engines do. stated that using ethanol results in CO emissions that are 8.6% lower than those from B7. B7E5 usage caused CO emissions to rise proportionately until the engine was running at 30 kW. CO emissions start to drop after 30 kW load, reaching a maximum reduction of 17.3% at 37.5 kW load. Between 10 and 20 kW of load, CO emissions for B7E10 increased, peaking at 21.3% at 10 kW of load. For engine loads between 22.5 and 37.5 kW, CO emissions decreased as engine load increased, eventually falling by 22.7%. All load ranges for B7E15 fuel exhibited a rise in particular CO emissions, with the exception of the 35 kW load, which showed a decrease of 9.8%. For this fuel, a 38.7% increase in CO emission was recorded at 5 kW.

NOX Emission

The majority of researchers concurred that the biodiesel-diesel combination emits more NOx than regular diesel fuel. indicated that a 45° D100 vane angle and swirling air will produce the highest NO output. An increase in NOx emission will result from the higher temperature and blended combustion at higher vane angles of 45°. The greater biodiesel percentage as an oxygenated fuel causes this emission at D70B25E5. observed that as the quantity of oil increases, NOx emission rises. According to the rise in combustion temperature causes NOx emissions to rise at lower loads. At maximum load, B100 emits more NOx than diesel, although other mixes are closer to diesel fuel. NOx emissions were lower for B5E20 than for B5 in the low- to medium-speed range, but they were greater at higher speeds. Additionally, between lower and medium speed ranges, the NOx production for B5E20 fueled engines is lowest at 0 h and full load performance. For all fuels, NOx generation rises with speed at low to medium speeds and reaches its maximum level at which point complete combustion occurs and the in-cylinder temperature reaches its maximum. In this investigation, the maximal peak temperature and NOx generation are located close to the maximum torque zone, which is where the combustion is complete. With B5E20, the highest NOx emissions were recorded among the investigated settings 500 hours into the durability cycle, which corresponds to the maximum torque speed. A longer ignition delay period caused by the inclusion of ethanol in the fuel composition is the cause of the rising trend in NOx generation for B5E20. When ethanol is added to base fuel, the cetane of the ethanol-blend biodiesel (B5E20) decreases, increasing the ignition delay time and increasing the amount of fuel/air mixture accumulated at the engine cylinder.

Particulate matter

According to using pure diesel fuel, using diesel-biodiesel mixes lowers particulate matter pollution. ssessed that a number of variables, including temperature, rotational velocity, fuel characteristics, engine load, including after systems, affect particulate matter emissions. Particulate matter, liquid, and solid mixes are complex pollutants found in exhaust gas emissions that lack a chemically well-defined component in terms of how they originate, what they are made of, and how they may be regulated. Adding 5% waste hydraulic fluid to the mixture decreased PN by 43% during a cold start, but raised PN by 13% during consistent. we discovered that the highest smoke particle matter for D55 was seen at loads of 20%, 40%, and 60%. Subsequent production particulate matter emissions from the D65 gasoline mixes were produced at 80% and 100% loading. Compared to basic diesel fuel, blends produced less smoke particulate matter. examined with 5 mixtures, including a mixture of orange and tea tree oils, individual eucalyptus oils, commercial biodiesel and diesel, and petrol blended with diesel. These fuel mixtures keep the oxygen level between 0% and 2.2%. The main particle diameter and fractal size of soot aggregates both decrease for oxygen-generated combustion. Diesel has an almost spherical form and complicated aggregate geometry. Additionally, compared to diesel, the fringes for oxygenated fuels are shorter, more curled, and have a disorganised shape. When opposed to diesel, oxygenated fuel has a longer fringe width. Researchers have thought about using butanol as the main fuel in a mixture with diesel (20% to 30%). They kept the needed oxygen content ratio between 0-4 to 32% and 6.48%, and they saw that the higher oxygen level in the fuel made the soot particles more reactive and produced smaller, more compacted nanoparticles. reported that a variety of blends of triacetin and biodiesel at different concentrations (B20, B50, B96, and B100) were employed as fuels. The fuel has an oxygen content that ranges from 0% to 14%. Using a Scanning Electron Microscope (SEM) at both low and high spatial resolutions, the particulate matter is examined. They discovered that, compared to diesel, increasing the oxygen level causes a reduction in the main particle diameter and gyrating radius. When compared with diesel, the fraction dimension grows as oxygen content rises. In fuels with oxygen contents up to 11.01%, which is the respiration concentration for pure biodiesel, the interior structure of combustion products appears to have a disorderly arrangement of graphene layers.

Combustion characteristics

Performance characteristics and emission are significantly influenced by the fuel's combustion characteristics, which represent a significant fuel differentiation. A few variables, including ignition delay, heat release, combustion length, cumulative heat release, and cylinder pressure, help to explain the combustion process. A review of combustion parameters in terms of heat release rate, ignition delay time, and cylinder pressure is provided in this section. We briefly cover the biodiesel-diesel blends that are used in Compression ignition.

Heat Release Rate

A substantially lower heat release was produced by the biodiesel-diesel mixture made of biodiesels from various sources than by diesel fuel. The peak emission rate of biodiesel was discovered to be higher than that of diesel fuel at slow speeds loads (20% of full engine load), whereas the opposite was true at increasing engine loads (95% of full engine load). examined the heat release rates of diesel and biodiesel blends when the engine is running at 25%, 50%, and 75% of its capacity. The maximal heat release rate increases as load goes from low to medium, while under high load, the opposite happens. At engine power load, closer to top dead centre, the largest heat release rate occurs. consequence of an increase in the oxygen component of the injected fuel at high engine speed, the maximal heat release rate and the percentage of fuel burned in the premixed phase of combustion both increased. In their investigation of the combustion properties, they looked into the heat release rate of the biodiesel-diesel blend made from jatropha methyl ester. They noticed that when the amount of seed oil transesterification biodiesel in the fuel increased, the value of the highest heat release rate decreased. Diesel has a longer fuel ignition delay than biodiesel-diesel combination, allowing additional fuel and air to mix correctly. In the end, this led to a higher rate of heat emission for diesel.

Ignition delay

The majority of researches discovered that diesel fuel and biodiesel blends have a shorter igniting delay than one another. under all loads, it was discovered that as the proportion of seed oil esters biodiesel in the blend increased, the ignition delay reduced. This is because seed oil methyl ester biodiesel contains oxygen, which increases its ignitability. It also breaks down the larger fatty acid compounds it contains into smaller components, which creates more volatile materials and speeds up ignition. showed that greater vehicle speeds and an emission and combustion characteristics delay can increase the nucleation of specific emissions The overall compactness of unburned carbon increases as oxygen content does. The concentration of fuel oxygen reduces the size and quantity of combustion products.

Conclusion - While according various operation settings, various engine tests, reference diesel fuel tests, and various measuring methodologies, the impacts on engine performance, emission, and characteristics were examined. The broad interpretations that can be made areThe increased oxygen supply in the biodiesel-diesel blend fuels reduces the ignition delay.The blended fuels fuel with additives has a higher flashpoint, higher density, and lower calorific value.Because of the high combustion rate and increased oxygen supply caused by the additives, fuel consumption has increased.Many researchers claimed that adding additives to biodiesel-diesel blends reduces CO, HC, and particulate matter emissions. A modest increase in the biodiesel blend might occasionally cause an increase in NOx emissions.The quantity of biodiesel and additives can be optimised to cause the least amount of modifications to the diesel engine while also improving oxidation stability. By using bio-based additives, you can extend the life of your engine's components and somewhat cut down on NOx emissions.

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