Experimental Study of CI Engine Fueled through Algae Biofuel Blend and Optimisation of Engine Operating Parameters

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Abstract The quantity of crude oil is continuously declining, which forces researchers to create new sustainable alternative fuels, particularly biofuels. The project's main aim is to optimize the diesel engine operation on biodiesel concerning performance and emission and to find optimum engine parameters using the hybrid AHP- Topis method. In direct-injection (DI) diesel engines, algae methyl esters are used as biodiesel. The general best biodiesel mixture AME20 (80% diesel and 20% algae methyl esters) is used. The engine injection pressure was varied from 200 bar to 240 bar in 20-bar increments. The outcomes demonstrated that AME20 injection pressure adjustment enhanced emissions and diesel engine performance. Algal oil is obtained from the microalga Scenedesmus obliquus. A 20% biodiesel blend was created.

The fatty acid composition of S. obliquus affects its fuel properties. Blend20 is similar to diesel oil in terms of its chemical and physical characteristics. A study was done on the performance metrics and exhaust emissions of a diesel engine burning diesel fuel and biodiesel blends. The biodiesel blend showed improved thermal efficiency, reduced exhaust gas temperature, and decreased specific fuel consumption. B20 produced fewer gas emissions than biodiesel. In this paper, compression ratio (CR) and injection parameters such as injection time (IT) and injection pressure (IP) are used to determine the performance and emissions of DI diesel engines using biodiesel (0%, 50%, and 100%). Experiments were performed using CR 18, Its (19, 20, and 27), and IP (200, 220, and 240 bar) (200, 220, and 240 bar).

Index Terms Emissions, AHP, Algae, Biofuel-blend, transesterification

I.INTRODUCTION

The internal combustion engine known as the diesel engine (compression ignition) ignites the fuel that is fed to the combust chamber as a consequence of the increased temperature of the air in the cylinder brought on by adiabatic compression. As the temperature inside the cylinder rises, the atomized diesel fuel that was pumped into the combustion chamber spontaneously ignites. In contrast, spark plugs are utilized in spark-injection engines to ignite the air-fuel mixture. Glow plugs are another alternative for use in diesel engines. Diesel engines have the highest thermal efficiency due to their high expansion ratios and internal lean combustion where heat can be removed by the excess air. A low-heat diesel engine can have a thermal efficiency of 50% or more. Results are presented using a hybrid AHP-Topis approach and experimental design is done using the Taguchi method. Results are presented using a hybrid AHP-Topis approach and experimental design is done using the Taguchi method.

1.1 BACKGROUND

Diesel oil engines are referred to as CI (compression-ignition) engines all over the world. The injection of fuel into extremely compressed air starts the combustion process. In 1892, Rudolf Diesel wrote that the only way to ignite the gasoline that would be injected at the end of the compression stroke was to compress the air until a temperature high enough to do so. He attempted to inject coal dust into an air-compressed cylinder in his initial experiment, which was only partially successful. Subsequently, he built a diesel engine. For the CI engine demonstration, he used peanut oil. "The use of vegetable oil for engine fuels may appear modest today," he said in the quotation. But these oils might eventually become as significant as petroleum and coal tar products are now, according to Rudolf Diesel in 1912.

1.2 TRANSESTERIFICATION

Glycerin is generated from fat or vegetable oil by a process known as "transesterification" that produces biodiesel. A basic collection of organic equilibrium exchange reactions dubbed transesterification arises when the alkoxy group of one ester is exchanged for that of another. Citations Vegetable Oil-Based Polymers. In the case of methyl acetate with ethyl alcohol, which in combination makes ethyl acetate as well as methyl alcohol, transesterification pertains to the reaction with an ester of one alcohol or a second alcohol to produce an ester of a second alcohol and alcohol from the original ester. Transesterification is basically the chemical process of taking a complex fatty acid and triglyceride molecule, neutralizing the free fatty acids, eliminating the glycerin, and generating an alcohol ester. To accomplish this, produce sodium methoxide by combining methanol with sodium hydroxide. Vegetable oil then gets mixed with this liquid. The blend then develops as a whole. Methyl esters, termed biodiesel, are left on top whilst glycerin is left merely at the bottom. These methyl esters are refined and processed, and glycerin may be utilized to manufacture soap.

1.2.1 BIOFUEL PRODUCED VIA TRANSESTERIFICATION OF ALGAE OIL:

Algal oil is typically transesterified using ethanol and sodium ethanoate as the catalyst. Ethanol and salt can be combined to create sodium ethanoate. Thus, ethanol is reacted with the algal oil to create biodiesel and glycerol using sodium ethanoate as the catalyst. Thus, glycerol, sodium ethanoate, and biodiesel are the reaction's final byproducts. Following is how this final combination is divided: Saltwater and ether were incorporated into the mixture and appropriately blended. The complete mixture would have separated into two layers after such a period, with such a layer of ether or biodiesel merely at the bottom. The stratum has been separated. In a vaporizer operating under a strong vacuum, ether and biodiesel are separately separated. The biodiesel will not evaporate as the ether does so first. Algae-derived biodiesel is now usable.

1.3 ABOUT ALGAE

Algae are small, suspended organisms with chlorophyll that are mostly aquatic in nature. They move very slowly and are vulnerable to winds, currents, and tides. The filamentous and phytoplankton populations of algae are the two primary populations. These two specific phytoplankton kinds multiply quickly to produce algal blooms. In watery settings, the majority of algae species are solitary cells, although some are arranged in straightforward, often filamentous colonies. Algae have been classified into about 20,000 different species. Algae also engage in photosynthesis, as all plants do, but they are particularly good at turning CO_2 and other nutrients into organic molecules. By positioning algae farms next to power plants, the ability of algae to fix carbon dioxide can also be an intriguing means of eliminating emissions from power plants. These algae ponds may receive flue gases from these power units. As a result, it will contribute to reducing emissions into the environment and halting climate change by producing more microalgal biomass, which will produce more biodiesel. Recent studies have demonstrated that oil-producing algae are superior to oleaginous terrestrial plants like rapeseed or soybeans because they are unicellular and can access water, carbon dioxide, and minerals more effectively when grown in a liquid environment. This explains why algae may produce 30 times more oil per acre than terrestrial plants. Algae produce around 90,000 t/ha of oil annually, which is significantly more than seed crops like maize (172 t/ha), soy (450 t/ha), canola (1200 t/ha), palm (6000 t/ha), and jatropha (1892 t/ha). Algae also have the critical benefit of having a very quick doubling period, which can be as quick as 3–4 hours during exponential development. Algae are incredibly effective for producing biodiesel since they can double their weight three to five times each day in perfect conditions. Lipids and fatty acids are found in algae as sources of energy, metabolites, storage products, and membrane components. They will cease reproducing and stop developing under adverse environmental or stressful circumstances, transferring the majority of their energy into lipids as store products for survival. Some strains can gain more than 80% of their weight in lipids under these circumstances. It's not uncommon for algal cells to have 20–50% oil. Neutral lipid accumulation primarily takes the form of a trial. The microalgae Scenedesmus obliquus can be utilized to make high-quality biodiesel, which can then be used in conventional diesel engines in an environmentally safe and effective manner.

1.3.1 BIOFUEL FROM ALGAE

Due to its environmental responsibility, non-poisonous qualities, biodegradability, and lower net co2 cycle as associated with ordinary diesel fuels, biofuel has attracted a lot of attention in recent years. n-Hexane and diethyl ether were employed as solutions to extract the oil from the algae species in the first phase, and a transesterification process was applied to transform the recovered oil into biodiesel in the second stage. The size of an algal biomass and contact duration had an effect on the percent yield of the extracted oil, as did the solvent-to-oil ratio. With a solute ratio of 3.5, algal biomass with a size of 0.4 mm, and a contact duration of 24 hours, the greatest amount of biomass that could be extracted was 0.09 fraction. The quantity of biodiesel created during the transesterification technique was studied for the impacts of the mole fraction, temperature, reaction duration, and catalyst (Sodium Hydroxide) (Sodium Hydroxide) (Sodium Hydroxide). During 25 min. of preparation time at 60 ° with a catalyst quantity of 0.5% weight of oil as well as an oil-to-methanol ratio of 8, over 95% conversion of the oil extracted into biodiesel was accomplished.

1.3.2 IMPACT OF BIOFUEL ON PERFORMANCE, EMISSIONS, AND COMBUSTING BEHAVIOR

Whether an engine utilizing biodiesel would operate differently from an engine using regular gasoline-based diesel is one of the main worries for every potential biodiesel user. Numerous researchers and experts have assessed the performance, emissions, and combustion behavior of internal combustion engines using algal biofuel to determine the acceptability and viability y as an alternative fuel. The results of earlier research are shown below: The physical and chemical characteristics of diesel fuel with 30% (vol) algal oil methyl esters were examined (B30AME). They noticed that the methyl esters made from algal oil and their combination with diesel fuel satisfied the standards for acceptable fuel quality. However, the engine operating efficiency and fuel consumption were impacted by the AME's somewhat reduced calorific value (by around 6%). Additionally, they noticed that while using B30AME instead of diesel fuel, thermal efficiency was 2.5–3% higher, exhaust gas smokiness was reduced by 10–75%, and HC emissions were reduced by 5–25%. Variable load studies on common rail direct injection diesel engines utilizing various mixes of microalgae methyl ester biodiesel in diesel were conducted in 2015. (B10. B20 and B50). Engine performance, combustion, and exhaust pollutants were compared between the biodiesel mixes and regular diesel fuel. It was discovered that the engine ran smoothly and without any major issues while using biodiesel mixes. The BSFC rose, the BTE decreased by up to 4% at higher loads, and a 7% decrease in mean effective pressure was observed as a result of the lower calorific value of microalgae oil methyl ester blends. Additionally, all microalgae biodiesel blends exhibit an increase in NOx emissions while significantly lowering UHC emissions.

Algal oil (raw and diesel mixes) was experimentally explored for usage in indirect injection diesel engines. They produced algal oil using Ankistrodesmus brauniiand Nannachloropsis, and they grew primary algae on modified bold 3N media. Algal oil was extracted from microalgae using an open pond system and ultrasonic/Soxhlet techniques. By transesterifying the algal oil using 3.5 grams of sodium hydroxide and 20% by volume of methanol, they were able to generate fatty acid methyl ester from the algal oil. The influences of engine speed, loads, activation time, output torque, burning noise, greater pressure increase, and maximum temperature release were studied in this study employing a Ricardo E6 IDI engine. Finally, it has been shown that the qualities of algal oil methyl ester are equivalent to those of diesel fuel, and its utilization has been advantageous in enabling the smooth operation of diesel engines. Regrettably, its utilization increased combustion noise and greatly diminished engine output torque.

These performance characteristics of computerized single-cylinder, four-stroke engines were put through a series of tests. The engine was manually started and given time to warm up while operating under load. The test was run under a variety of loads, from no load to the maximum load. The engine was worked for 15 min after each load to enable it to settle in under the new conditions. The engine was initially tested with diesel fuel at the given parameters: SOI 23 deg bTDC, IOP 200 bar, CR: 18, and nozzle hole ϴ = 0.3 mm. Additionally, the engine was running with 100% algal biodiesel at optimal settings. The optimal settings for algal growth were found to be SOI: 19 deg bTDC, IOP

200 bar, CR18, and injector nozzle hole geometry: 4-hole nozzle, O 0.3 mm. In 50% increments, the engine was loaded from empty to fully loaded. At this loading, measurements were made of the fuel and air consumption, different emissions, peak in-cylinder pressure, and exhaust gas temperature.

Parameter	Specifications
CR & Speed	18:1 @ 1500 rpm
SOI	19 bTDC, 23 TDC & 23 8TDC (Diesel & 20% Algae)
IOP	200 bar, 220 bar & 240 bar
Fuel studied	Algae Biofuel BD20
Load Zero to full load	(0 to 12.6 kg) in steps of 50%

1.4 FUELS CURRENTLY EMPLOYED

Diesel is one of the fuels utilized in one method of operation. Algae and the fuel it is mixed with. Blending biodiesel and diesel was done using their respective percentages of volume for net unit volume. The mixes that were investigated were chosen in a fairly reasonable manner. 20% of biodiesel (BD) While the figure represents the percentage of diesel fuel that is biodiesel by volume. Table 2, which compares the qualities of diesel, algae biodiesel, and algae blends visually, provides information on these fuels.

Property	Units	Fabricated biodiesel
Density	kg/m^3	0.841
Kinematic viscosity	mun^2 /s	2.92
Flash point	°C	73
Fire point	°C	80
Calorific Value	kJ/kg	42640

II.METHODOLOGY, DIFFERENTTOOLS, AND MEASUREMENT EQUIPMENT USED

A.PRESSURE SETTING EQUIPMENTS

The different nozzle hole injector pressures were set using the injector pressure setting tool. It was also used to research the spray properties of different biodiesel and diesel sprayed in a chamber made of opaque glass. The range of the pressure setting was 0 to 300 bars. It features a manual injection pump that is pumped using a lever. The device used to set the pressure and examine the injector's spray behavior at 1 ATM has a port where the injector may be connected. Additionally, several nozzle hole injectors were researched. It offers a circumference of each nozzle tip of 4H of = 0.3 mm. Bosch developed and produced the pumps, while Kirloskar Oil ITD produced the injectors.

B.LOADING AND MEASURING SPEED

The engine may be operated fully or partially thanks to a direct connection to an eddy current dynamometer. The control panel was interfaced with the engine and dynamometer. It lists the dynamometer's properties. The engine speed was measured using a digital RPM indicator and a photo sensor. To display the pulse conversion and engine speed, the voltage pulses from the sensor are transferred to a digital rpm meter with an accuracy of I rev/min.

C.MEASUREMENT AND FUEL SUPPLY

The M.S. framed stand's fuel tank served as the source of gasoline. Three solenoid valves provided gasoline to the fuel pump. One connection supplied the burette, one of the other two connections fed the tank, and the remaining connections was linked to the fuel pump filter. By shutting the gasoline tank line valve to limit fuel from the fuel tank and only enabling fuel consumption from monitoring the burette, the engine's fuel consumption was measured. The volumetric fuel supply rate was calculated using a burette as well as a stopwatch.

D.*PRESSURE MEASUREMENT*

A water-cooled piezoelectric transducer was used to measure the pressure within the cylinder. On the cylinder head's surface, the pressure increased. Piezotronics are made by PCB. This was accomplished using a transducer with a sensitivity of 0.145 mV/kPa. the piezoelectric. The charge output from the transducer is proportional to the pressure within the cylinder. A charge amplifier received the charge output and amplified it to parity electric pressure. Piezoelectric transducers are only capable of transmitting pressure variations; hence the signal must be referenced to determine the real pressure. At some point, knowledge of the average pressure cycle is required for this pressure recorded by the pressure transducer in the cylinder when the piston is in motion has been corrected in the current work using the suction BDC. The average intake manifold pressure was supposed to be equal to the cylinder pressure at the suction BDC. A pressure manometer was used to determine the average manifold pressure.

E. EMISSION MEASUREMENTS FOR HC, CO, CO2, AND NOX:

Shown NOx emissions, the exhaust emissions were measured using a DELTA 1600 S non-dispersive infrared (NDIR) exhaust gas analyzer. By blasting infrared radiation through the test sample and onto an optical block, it is possible to determine the emission levels of incomplete combustion hydrocarbons (CO, HC n-Hexane equivalent: C_6H_{14}, CO_2) (CO, HC n-Hexane equivalent: C_6H_{14}, CO_2) (CO, HC n-Hexane equivalent: C_6H_{14}, CO_2). To account for the sample gas in the measurement, the sample cell temperature is regulated. Differentials in temperature and pressure are given. Four optical bandpass filters, one for each target gas, are used to pass the infrared gas through (one filter is the reference filter). Four piezoelectric detectors gather the light that has passed through four filters and use that information to create a voltage that is proportionate to the light's intensity. The detector's output is sent to a digital or analog converter (ADC). The ADC is sampled by the CPU, which then sends the required data through it. Hexane equivalents in parts per million (ppm) were used to assess hydrocarbons, and percentages of carbon monoxide emissions were computed. Electrochemical (fuel cell) sensors are used to monitor the levels of oxygen and NOx gas. An electrical response from a fuel cell sensor is equal to the A concentration of the sample gas. The sensors were metal-air battery types with self-powering, diffusion-limited anodes, electrolytes, and air cathodes.

III.RESULTS AND DISCUSSIONS

The findings are broken down into four subsections with detailed explanations: the effect of changing ignition timing on engine performance, the investigation of the effects of changing nozzle hole and injection opening pressure, and finally the effect of different CSOME biodiesel and its blends on engine performance-emission characteristics.

A. VARIATIONS IN INJECTION TIMING'S IMPACT ON AN ENGINE'S EMISSIONS AND PERFORMANCE CHARACTERISTICS:

In a diesel engine, the injection time is a key design factor. Because of differences in delay time, its optimal value varies depending on the fuel type. The impact of injection time on the thermal efficiency of brakes, specific fuel consumption (bsfc) fuel economy, and HC, CO, CO, and NOx emission characteristics have been researched in this field.

B.BRAKE THERMAL EFFICIENCY (BTE)

We only take into account full load situations since it has been demonstrated in practice that the diesel engine operates most efficiently under these conditions. The tendency is also consistent across all load values. BTE was at its highest (22.95%) during full load operation with a static injection timing of 23 bTDC, a compression ratio of 18, an injection pressure of 200 bar, and diesel fuel. The performance of the BTE with diesel was closer to the manufacturer's ratings. Additionally, it was made sure that diesel operating settings were more in line with the manufacturer's recommendations. Variable injection time (19° to 27 in steps of 4") affects BTE with 20% algae biofuel. By increasing the injection time, it was found that BTE was 22.98% at 19 b1DC as opposed to 20.45% at 27 bTDC. The crank angle changed by 4° increments. Retarded injection time was seen to cause a 2.53 percent increase in BTE. The combustion phase may move away from TDC as a result of the biodiesel's delayed injection timing (195TDC), which resulted in a shorter delay time. Abo, better combustion may result in a faster rate of heat release. As a result, the delayed injection may demonstrate enhanced pre-mixed and quick consumption that led to an increase in thermal efficiency. Due to its greater viscosity and density, biodiesel may require delayed injection. This causes more fuel to potentially collect in pre-mixed combustion at 27°bTDC, lengthening the delay duration. As a result, heterogeneous mixtures change the combustion process to avoid TDC Thus, at all injection times under consideration, biodiesel had lower BTE than diesel due to its higher viscosity, density, and lower heating value.

The efficiency with which the engine converts the chemical energy of the fuel into meaningful work is measured by the brake thermal efficiency. When dividing the engine's braking force by the system's input energy, this figure is determined. The variance in BD20 blend brake thermal efficiency under all loads. According to the results of the experiment, BTE rises as the load rises for both diesel and biodiesel mixes. It was brought on by an increase in power produced by mixes during maximum load. It has been noted that the blend BD20's brake thermal efficiency is greater for compression ratios of 18 at full load, reaching a maximum of 24.02% at 240 bars and a low of 20.45% at 200 bars. Peak pressure and combustion temperature increase to cause an improvement in thermal efficiency.

C.BRAKE-SPECIFIC FUEL CONSUMPTION (BSFC):

The fuel economy of any motive force that consumes fuel as well as delivers rotational, or shaft, power is determined by the BSFC fuel utilization. It is extensively used to analyze the effectiveness of engines having a shaft output. It is the fuel use rates divided by the amount of electricity generated. For such a reason, it may also be viewed to be fuel use that is power-specific. The fuel efficiency of different engines may be simply compared according to BSFC. At various speeds and loads, every engine will have a distinct BSFC value. For instance, when the intake air is throttled and the engine is operating close to its peak torque, the reciprocating engine is at its most efficient state. However, the efficiency that is frequently quoted for a certain engine is not its greatest efficiency but rather a statistical average of fuel economy. By illustration, a gasoline engine's cycled averaged BSFC rating is 322 g/kWh, which amounts to a 25% efficiency. Due to different operating conditions, the engine's actual efficiency may be greater or lower than its average efficiency. One of the most acceptable BSFCs for a commercial gasoline engine is roughly 225 g/(kWh), which is comparable to a 36% thermodynamic efficiency. Effect of injection time and load on BSFC. With all varieties of biodiesel, this tendency has been noticed. The cause might be ascribed to biodiesel's lower calorific value and increased volatility (flash point). At 27 degrees bTDC injection time, greater BSFC (0.48 kg/kWh) was seen with algae biodiesel, nevertheless. This could be brought on by a longer delay time with injection progress. Additionally, the lowest BSFC of 031 kg/kWh was noted during full load operation at 19 bTDC injection time. The injection that was retarded demonstrated lower fuel usage than the injection that was advanced under all loads. Because the air and fuel are properly mixed, a shorter delay time enhances combustion quality.

IV.EMISSIONS

A. NOx EMISSIONS

At the highest combustion temperature, nitrogen oxidation (NOx) increases dramatically. Changes in injection timing's impact on NOx emission Retarded injection often causes a significant reduction in NOx output. A reduction in delay duration was seen when injection timing was delayed. This could be caused by compressed air's increased peak pressure and temperature during the delayed injection. Due to this delay, the duration of the combustion phase may be shortened. The result was a reduced exhaust gas temperature (EGT) during retarded injection. Therefore, NOx generation was reduced. Because of the greater delay, NOx emission increased with increasing injection timing. Longer delay times cause NOx emissions to increase, which raises combustion's peak pressure and temperature. The figure indicates that NOx emissions rose as the load increased. Since it has been demonstrated practices that a diesel engine operates most efficiently at full load, only full-load circumstances are taken into account. The experiment's outcomes are as follows:

NOx emission, 520 ppm, was discovered at 20% Algae Biodiesel at the lowest operating pressure of 200 bars. With advanced injection timing of 276TDC Algae biodiesel at maximum load with 1OP 240 bar, the highest NOx emission of 924 ppm was discovered. The findings show that the timing and pressure of the injection are at their best, resulting in the least amount of NOx emissions.

B.HC EMISSIONS

Changing injection time results in HC and CO emissions. Lean mixture during in the delay time and an under of the fuel exiting the injector nozzles at a lower velocity were the two reasons that led to HC emission in CI engines. All injection timings showed an overall tendency of higher HC as well as CO emissions as compared with diesel fuel. This could be explained by biodiesel's poor spray characteristics and slow heat release rate, which lead to lower combustion efficiency.

At full load and 19-degree, 23-degree, and 27-degree bTDC operations, the HC emission values with biofuel were 111, 116, and 128 ppm, respectively, at 240 bars. At 19degree bTDC, the HC emission was found to be greater and lower, respectively. This may have happened as a consequence of a prolonged delay owing to the advanced injection schedule. Due to reduced cylinder pressure and temperature of compressed air, this (increased delay period) not only causes inappropriate fuel-air mixing but also results in less fuel atomization, leaving more HC unburned.

C.CO AND CO2 EMISIONS

We are aware that partial combustion of the form before the mixture is indicated by CO release, a dangerous by-product. In many cultures, poisoning with carbon monoxide is the most prevalent type of deadly air poisoning.

Colorless, odorless, and tasteless carbon monoxide is extremely poisonous. As it combines with carboxyhemoglobin, hemoglobin is formed, which is inefficient in providing oxygen to the body tissue. Mobile vehicles produced 52% of the carbon monoxide emissions in the US in 2011. For all injection time operations, the quantity of CO emission was reduced at lower loads and rose at higher loads. In comparison to comparable operations using biodiesel at 240 bar, part load applications using algae biofuel showed decreased CO emission of 0.0844% vol.

However, at full load with biodiesel at advanced injection time at 200 pressures, greater CO 0.633% vol. was noted.

More CO2 is emitted when a load is applied, which is a sign that the fuel has been completely burned in the combustion chamber. It also has to do with the temperature of the exhaust gas. For complete load operation, the CO2 emission of the BD20 and diesel mix is 5.96% at IT 19 bTDC at 220 bar IP and 10.73% at IT 27 6TDC at 240 bar IP, respectively. When employing algae bio-diesel blends, less carbon monoxide (CO2) is produced than when using diesel at all loads. This may be because fuel was burned too late, causing only a partial oxidation of CO2. The build-up of CO2 in the atmosphere causes ozone depletion and global warming, among other environmental issues. The plant can reduce the CO2 emissions from biofuel burning while maintaining a consistent carbon dioxide level and temperature.

V.CONCLUSION

The need of the hour is for an efficient, cost-efficient, and environmentally benign replacement for traditional diesel fuel. To develop alternate fuels for Cl engines, extensive research has been done. However, scientists advise that vegetable oils and their esters make appealing substitutes. The validation of Cl for long-term usage in engines, durable availability, low volatility, high viscosity, and high density in comparison to diesel fuel are some of the significant difficulties, nevertheless. Furthermore, a CI engine with this option has no significant emissions to worry about. The following results are obtained from extensive studies on engines employing algal biodiesel.

A.ENHANCEMENT BY USING HYBRID AHP AND TOPSIS:

Conclusion At a delayed injection timing of 196TDC, the BD20-powered C1 engine exhibits good performance and emission characteristics. At 50% load, the injection pressure of 200 bar and timing of 196TDC result in the best performance. BTE 20.44%, BSFC 0.42 kg/kWh, HC 242 ppm, CO 0.102%vol CO 3.32% vol, and NOx 349 ppm are additional values for optimal performance. This is explained by the biodiesel's brief ignition delay at 19 bTDC delayed injection time. BTE was discovered to be 2244% as opposed to 19.31% at 27 6TDC while operating at half load. Additionally, at slower injection timings, reduced ignition delay led to lower HC, CO, and NO emissions were found to be lower with delayed injection timing due to a shorter ignition delay and full combustion. The ideal injection parameters for algal biofuel are 19 bTDC retarded injection time and 200 bar injection pressure. Diesel engines may undergo durability tests lasting 1000 hours, and the wear of the engine's moving parts can be examined. It is possible to try a fresh engine design rather than changing an existing engine. Future research on biodiesel and biodiesel-diesel hybrids may be done to decrease viscosity and NOx production as well as to enhance the spray properties of non-edible vegetable oils. This is done by taking into account comprehensive combustion optimization.

B.BIO FUEL SPECIFICATION

The characteristics of algal biodiesel were discovered to be comparable to those of biodiesel as specified in ASTM standard D6751-06). Additionally, it was discovered that the kinematic viscosity of 2.92(mm/s) was somewhat higher but within the permitted range of 2-6. (mm). Algae are therefore widely available in underdeveloped countries, and if they are treated to suit fuel requirements in large-scale manufacturing, there is a chance to lower their overall cost. In the event of a shortage or high density of diesel fuel, it will then become a renewable source of energy.

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NOMENCLATURE

1. CI Compressed Ignition
2. SI Spark Ignition
3. SOI Start of Injection
4. IOP Injection Opening Timing (bar)
5. CR Compression Ratio
6. H Nozzle Holes of injector geometry
7. CA Crank Angle (deg)
8. BTE Brake Thermal Efficiency (%)
9. BSFC Brake Specific Fuel Consumption (kg/kWh)
10. EGT Exhaust Gas Temperature (OC)
11. bTDC Before Top Dead Centre (deg.)
12. LHR Low Heat Rejection
13. HC Hydrocarbon (ppm)
14. CO Carbon Monoxide (% Vol)
15. NOX Nitric oxide (ppm)
16. PM Particulate Matter (HSU)
17. BD Biodiesel
18. BD 10 Biodiesel 10% with Diesel 90% by Vol.
19. BD 20 Biodiesel 20% with Diesel 40% by Vol.
20. BD 40Biodiesel 40% with Diesel 60% by Vol
21. BD 80 Biodiesel 80% with Diesel 20% by Vol.
22. BD 100 Biodiesel 100% by Vol. Mass of total suction
23. m-total suction Mass of total suction