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Performance Research and Low Heat Rejection (LHR) Diesel Engine Emission Characteristics with Alternative Fuels

Altaf Hasan Tarique*

Assistant Professor, Department of Mechanical & Chemical Engineering, Galgotias University, Greater Noida, Uttar Pradesh, India

Abstract – The rapid depletion of traditional sources of energy alongside the demand and major contributors of air pollutant sources, also plays a key role in oil-based fuels. Fossil fuels are already being met by the major contributors to Indian energy market. It is therefore high time renewable energy fuels for engines are obtained from indigenous sources. This complex situation in the fields of oil, supply and demand has been driven by the tremendous rise in world population, the enhanced technological progress and living standards in industrial countries. As India is a farmland, vegetable oils (both edible and non-edible oils) from different oils are generated in a broad range. The emphasis of the present work is on non-edible oils as fuels for motors, since the edible oils are far too demanded and too costly. By transesterification all tidy oils must be extracted and transformed into the respective methyl esters. In providing thermal isolation of heat engine components, thermal barrier coating is increasingly necessary. Heat insulation decreases the transmission of in-cylinder heat from the engine combustion chamber and thus reduces the structural temperatures of components. Bio-diesel also has the ability to offer its diesel partners a product that is appealing as a fuel, while remaining economically friendly, affordable and green. The efficiency and emission characteristics of an STD with Magnesium Stored Zirconia (MSZ) (LHR) motors are studied in this work. The study would examine the comparative effects. The fuel-related properties of the traditional diesel engine must be measured and evaluated. The impact on engine speed, fuel usage and thermal performance of the use of biodiesel fuel must be measured and evaluated using conventional diesel engine.

Keywords – Low Heat Rejection, Diesel Engine, LHR, Alternative Fuels;

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INTRODUCTION

Energy is a key input for both developed and emerging countries' economic growth and sustainable development. Non-renewable fossil fuels meet the world's electricity need for shipping. The dramatic increase in crude oil prices from 20 dollars a barrel in 2002 to nearly 100 dollars, even 140 dollars before it stabilized to some 80 dollars, also caused nations to take serious consideration in sustainable, non-polluting alternate energy sources. Oil prices are likely to continue to increase, given the decline in supply and increasing demand. In addition, the fears regarding climate change caused by human beings have further stimulated energy supplies as demonstrated by the temperatures and environmental emissions. One such source is plant biomass and biodiesel, from which vegetable oils are processed.

The world today has two crises: the scarcity of fossil fuels and the destruction of the atmosphere. Bio-fuels may provide a viable alternative to this global oil crisis.

The brake thermal performance with biodiesel as fuel increased slightly in LHR engines. Although other pollution parameters were regulated, NOx emissions for almost all biodiesel fuels were intentionally strong. Nitrogen oxides (NOx) are the main and most damaging contaminants in diesel engine emissions, in addition to CO (Krishnamurthy & Muralikrishna 2012). The explanations for this are the scarcity of oxygen in biodiesel and the high temperature during combustion on the LHR turbine.

Low Heat Rejection (LHR) Engines

Each engine generally has the settings suitable for conventional fuel for its producer (petroleum diesel or neat diesel). However, optimization can be carried out by varying these parameters in some test work with fuel change. In the injection timing, injection pressure and compression ratio, changes are generally made.

LHR motor is also known by other names including the low-heat loss motor, thermal, adiabatic motor, etc. LHR motor is a very common motor. Different LHR engine types are,

- Ceramic coated motor
- Isolated air gap piston motor
- Isolated air gap piston and sealed air gap liner motor
- Air gap isolated piston and air gap isolated liner motor and ceramic cylindrical head motor.

Alternative Fuels

Alternative fuels may be described as fuels that are able to be utilized without significant structural changes in the current engines. It may be used in its pure shape or mixed with petrol. At an exhibition of peanut oil, the maker of the diesel engine showed his innovation. He showed the researchers the way to use vegetable oil for the engine. The exponential rise in cars around the planet and the faster decline in fossil fuel are the world's challenges in the future of the current cars. In addition, emissions from fossil fuel burning are the main cause of global warming, and several nations have enacted laws to monitor those environmental pollutions. For the past two decades, there have been few substitute fuels that have been evaluated in the diesel machine. Though hydrogen is still being explored, the production of it is restricted by its properties, including higher flame speeds, fast combustion rate. Therefore, hydrogen research as an alternate fuel is on a long road to completion. The most current investigations are into emulsified liquid, the fuel water content (diesel emulsion and biodiesel emulsion). An emulsified fuel has the big benefit of reducing smoke and NOx by not changing the thermal effectiveness of the brake.

Vegetable Oil as an Alternative Fuel

The availability of fossil fuels and cars on the road did not generate much interest in alternative fuel during the early stages since the price was not very strong, as was now the case. Jatropha oil, pongamia oil, mahua, neem oil, nerium oil, eucalyptus oil, etc. were the few vegetable oils examined. India, a developing world, has shown an interest in vegetable oils that do not eat, since edible oils are preferred for cooking purposes. However, the viscosity of vegetable oil was 10 times that of petrol, which appears to be less spray than diesel. It led to combustion chamber deposits as well. Long-term application of vegetable oils led to piston rings coking and a reduction in engine life. The polymerization of vegetable oil into the engine oil occurred and blocked the engine, causing further motor loss. Furthermore, the cold start efficiency was bad. Because of this study the viscosity was reduced. The research on the transesterification of vegetable oils later on was established as an appropriate method for reducing the viscosity of vegetable oil and biodiesel production.

Biodiesel as an Alternative Fuel

Biodiesel is made by means of a chemical method known as transesterification from vegetable oils or animal fat. Biodiesel is the perfect substitute for diesel fuel and a purified and recycled fuel (Singh & Singh 2010). Biodiesel is a refined diesel fuel produced from biological sources. The WCO defines it as 'the mixture of long-chain (C16-18) monoalkyl esters of fatty acids from vegetable oil or animal fat, a household, fuel-based renewable diesel engine that complies with the requirements of ASTM D6751' (in German) (Refeat et al 2008). The method of transesterification is usually used for biodiesel extraction from vegetable oil. 9 is used as the catalysis of the reactions along with methanol or ethanol, NaOH (Sodium hydroxide) or KOH (Potassium hydroxide). Transesterification includes removing glycerine and substituting it with an anhydrous alcohol that is generally a methanol from fatty acids by catalyst such as sodio or potassium hydroxide (Refeat et al 2008). Jatropha, pongamia, mahua, nerium etc. were the few biodiesel fuels studied. It is green and biodegradable and environmentally sustainable. The danger to health from petroleum gasoline is therefore reduced. There have been lower PAH rate (Polycyclic aromatic hydrocarbons).

LITERATURE REVIEW

Need for Alternate Fuels

The current studies aim to satisfy potential vehicle fuel requirements as petroleum fuel quickly depletes and thus protects the atmosphere against deterioration. Oil fuel from small supplies is collected. Just certain countries of the world are available for these stocks, and petroleum product is required to be imported from them. It is also mandatory for an alternate fuel to be produced from the wealth of one nation. Prior research has taken place on some vegetable oils as fuel.

Vegetable oil as an alternative fuel for diesel engines

Misra et. al. (2011) Experimental research has been undertaken to ensure that unmodified vegetable oils, their mixtures or biodiesel and their mixtures in diesel mineral as substitute fuels in diesel engines can be used. They used Jatropha vegetable oil as diesel fuel and noticed that the efficiency of Jatropha oil and Jatropha biodiesel combinations in compression ignition engineers is quite similar to the performance of diesel fuel.

Balat et. al. (2010) The studies of Vega-oil and bio-diesel found that more than 350 olive-tree crops were deemed possible alternatives for diesel engines and edible oils, including only sunflower, safflower, soybean, prey and peanut-oil. Jatropha, karanja, tobacco seed, rice bran, Mahua, neem and rubber seed oils have been used for non-edible vegetable oils, such as biodiesel feedstock.

Biodiesel as Fuel for IC Engines

Senthur et. al. (2014) Has performed an experimental study in one single pump, direct diesel injection with Eucalyptus oil as fuel. They concluded that the brake-specific fuel usage has been marginally decreased relative to traditional fuel with rising biodiesel and thermal performance (diesel). They have also confirmed that unburned hydrocarbon (HC) and carbon monoxide have been reduced considerably. Another discovery by the researchers was the increased oxides of nitrogen (NOx) pollution.

Ashwani et. al. (2011) The use of seeds that can be reliable sustainable feedstock for the development of biofuels was confirmed. In addition, most seeds containing non-edible trees have recover possible wastelands and do not clash with food cropping in small-scale growing areas. It is also essential to look for special feedstocks that are not edible and suitable for production of biodiesel.

Low Heat Rejection (LHR) Engines

Ratnareddy et. al. (2013) Conducted an experimental analysis to assess Mohr Oil's performance in crude form and bio-diesel form at different operating conditions in medium grade low-heat rejection diesel engines with an air gap isolated piston supreme crown and air gap insulated liner with supreme insert and varying pressure injection (nickel alloy) They concluded that, in comparison with a traditional engine with pure gasoline, the output of both versions of the engine increased with advanced injection times and an increased injection pressure with crude vegetable oil and biodiesel. The best injection time for the coated motor was 31o bTDC while the LHR with biodiesel was 30o bTDC. Peak brake thermal performance improved by 12.5%, the smoke levels decreased by 38% and the NOx levels increased by 35% at optimal injection timing relative to a pure diesel in traditional engines at 27 degrees bTDC with biodiesel activity on an LHR vehicle.

EXPERIMENTAL SETUP

This chapter presents the specifics of the experimental set-up. The engine details, parts, devices and controls in the test engine are identified.

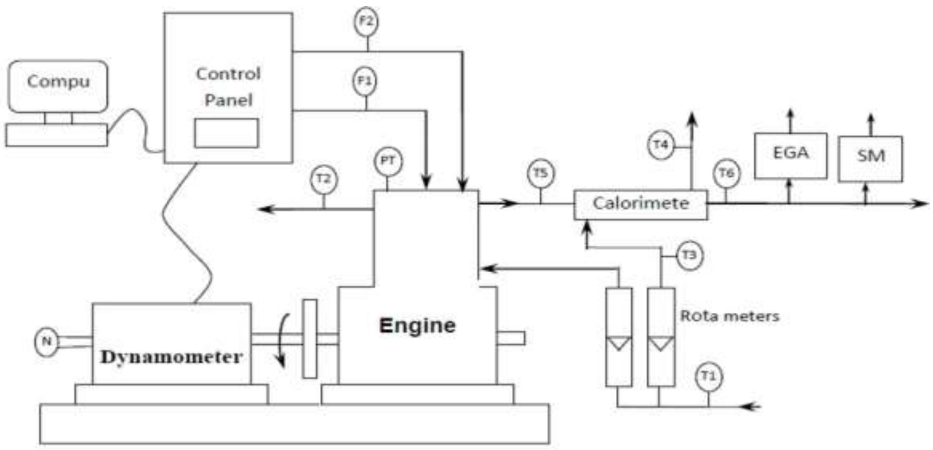

Figure 1: Line diagram of Experimental set up

Experimental Set up

The Kirloskar engine is one of the main engines used in agricultural pumping sets, agricultural machinery and industrial medium scale applications. The set-up includes a single four-stroke cylinder, naturally sucked water-cooled Diesel motor and a power supply unit. This dynamometer is used to load the generator. This dynamometer. The motor is interfaced with engine software for combustion parameter calculation. The required instruments are given for the pressure chamber combustion and the calculation of a crank angle. A pressure transducer is attached on the engine cylinder head for measuring of the cylinder pressure and a crank angle encoder is used for measuring the angle and direction of the TDC. A Data Acquisition Card with a Pentium 4 personal computer is supplied with the pressure and crank angle signals. In combination with the optical rpm indication that is an integral part of the eddy current rpm, the engine speed is sensed and indicated by an inductive sensor. The flux of liquid fuel is determined by electronic transmitter on a volumetric basis. Airflow, temperatures and load calculation interfaces are also included. The airflow is determined by a hole meter and chromelalumel thermocouples record exhaust gas temperatures. The setup is made up of an air-lock, fuel tank, manometer, fuel unit, air and fuel measurement transmitter, method indicator and engine indicator. It is composed of a standalone box. Cold water and calorimeter water flow analysis rotameter are given. The sensor transmitters will perform the computerized diesel injection pressure calculation. Here are the different elements of the test setup. The line diagram displays Fig.1 and the experimental photograph shows Fig. 2.

The experimental configuration instruments are

1) The engine

2) Dynamometer

3) Exhaust gas analyzer

The Engine

A single cylinder, 4-stroke vertically, water-cooled, computerized direct injection engine from Kirloskar makes CI Engine. The engine chosen for exploration This engine can cope with higher stresses and is also widely used in agriculture and industry. This engine is thus chosen for experimentation. The current C.I. Engine and its connection are seen in Fig.3.

Dynamometer

The motor has an electrodynamometer DC for its performance measurements. Prior to use, the dynamometer is statistically adjusted. It functions both as a control system and as an absorption unit. The dynamometer is reversible. Changing the field current controls, the load. The principle of Eddy-Current Dynamometer is based on Eddy Current (the right-hand legislation of Fleming). The construction of a flange-current dynamometer is equipped with the notched disk (rotor) driven by a primary mover (e.g. engine) and with a space outside magnetic poles (statators). In a circumferential direction, the coil which stimulates the magnet pole is wound. A magnetic flux loop is created by means of stators and a rotor as the current passes into a thrilling bob. Density difference is generated by rotation of the rotor and then eddy current is passed to the stator. By means of this eddy current the electromagnetic force is exerted contrary to the rotating path.

Exhaust Gas Analyzer

Figure 2: Five Gas Emission Analyzer

The 5 Gas pollution analyzer MULTI GAS ANALYZER MN-05 uses emissions such as carbon monoxide, carbon dioxide, un-burner hydrocarbons, nitrogen oxide and unused oxygen. In this cord the first end is linked with the inlet and at the end of the exhaust gas outlet the other end is connected. In order to work effectively, a continuous charge of the analyzer is essential. The current Exhaust Gas Analyzer picture is shown in Fig.4. The system of measurement is founded on the infrarouge theory of absorption of light, defined as infrarouge non-dispersive absorption. Light source infrarot broadband radiation travels into a chamber that is supplied with coal, methane or carbon dioxide in general. This gas receives radiation of a known wavelength which is an indicator of the gas concentration. At the end of the hall, a small optical filter is available for measurement with a pyroelectric detector to eliminate all other Wave Lengths.

EXPERIMENTAL PROCEDURE

This work keeps the engine at 1500 rpm and has a set injection pressure of 180 bar throughout the trial. The regular (STD) uncoated motor is increasingly tested at nine separate loads. The new dynamometer of eddy is used for this purpose. Multi-gas analyzer MN -05 records emissions. In order to achieve the steady state, the engine is set to idle for a minimum of 15min before each experiment.

The piston of the STD engine is then reconnected and switched on and off via the MSZ piston.

Figure 3: Experimental setup of computerized CI Engine

Figure 4: Uncoated and Coated piston Crowns

The same operation would then be performed. The LHR (modified engine) is contrasted with the baseline (STD) engine with diesel, PSME and ATME fuel for efficiency and emission characteristics. GUI program records performance characteristics Apex technologies engines also

Ltd. Engines. Fuel intake, cylinder strain, exhaust gas temperatures, and CO, carbon dioxide, CO2 and NOx levels are measured at nine separate loads at any single range of test readings.

INVESTIGATION INTO PERFORMANCE AND EMISSIONS CHARACTERISTICS

Compared with brake energy at nine separate loads, Break Specific Fuel Consumption (BSFC) and EGT (Exhaust Gas Temperature) are thermal brake efficiencies (BTHE). This are shown using graphs.

Brake Thermal Efficiency

The Brake Thermal Efficiency Difference as shown in Fig 5. BTE for coated motor driven by ATME is improved in comparison with standard motor. The increased combustion results from higher oxygen content and stronger ignition efficiency of the ATME's biodiesel molecule. biodiesel the As a result of the effective combustion induced by proper Atomization and good mixture forming at higher loads, the BTE rises when the load for a fuel is increased.

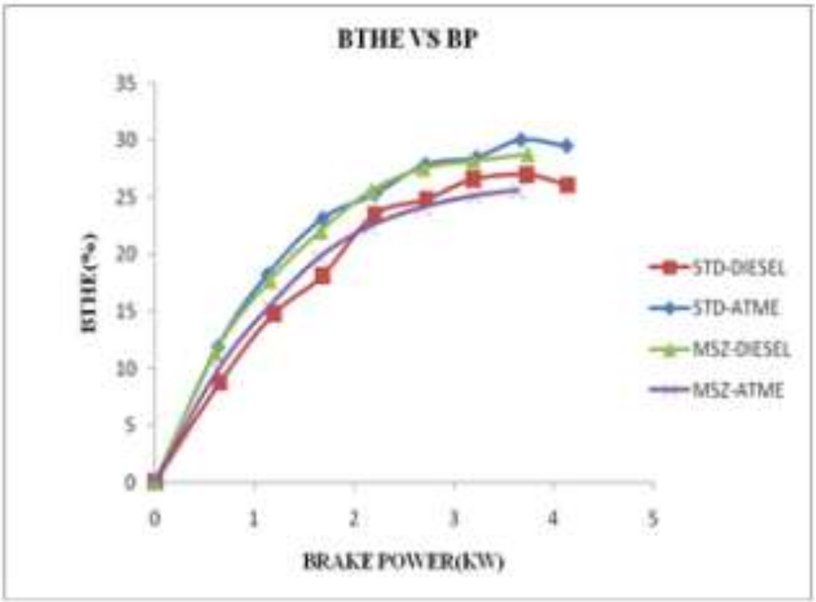

Figure 5: Brake Thermal Power Variation

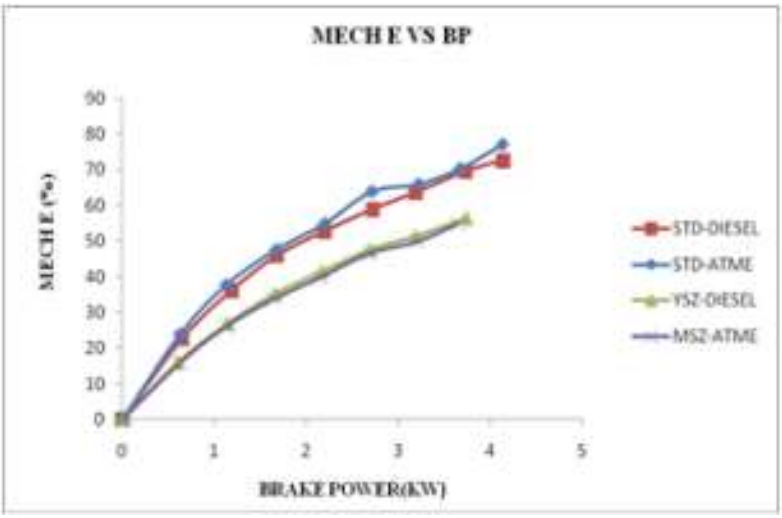

Figure 6: Variation of Brake Power mechanical efficiency

Mechanical efficiency

Figure 6 illustrates changes to Brake Power's mechanical performance. In case of a standard vehicle, diesel mechanical performance is much higher than biodiesel. The effect of thermal barrier coating, which improves mechanical performance, can be seen here. The fuel burning in the LHR engine is attributed to the rise in combustion chamber temperature.

Carbon Dioxide

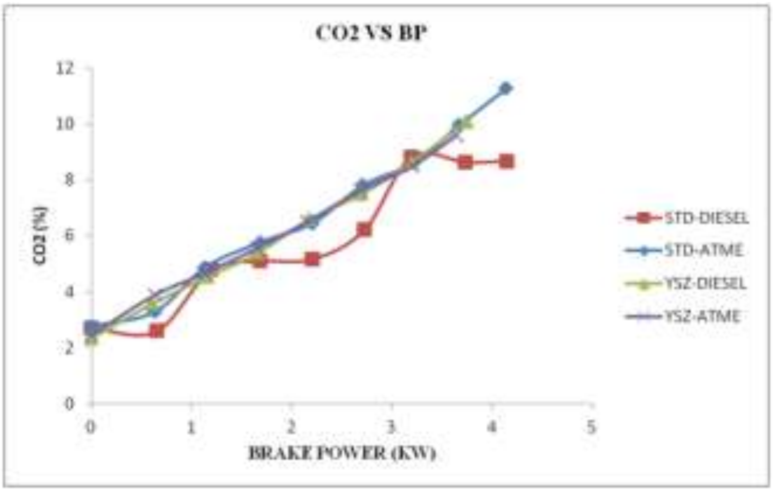

Figure 7: Brake power variety of carbon dioxide

Figure 7 indicates BP's CO2 variance. The emission of CO2 is commensurate with fuel usage. The MSZ-ATME is obviously less CO2 than the standard motor. The reduced carbon content of bio-diesels can also be due to this. The CO2 decrease in LHR-ATME is approximately 4 percent in comparison with the baseline engine.

Carbon Monoxide

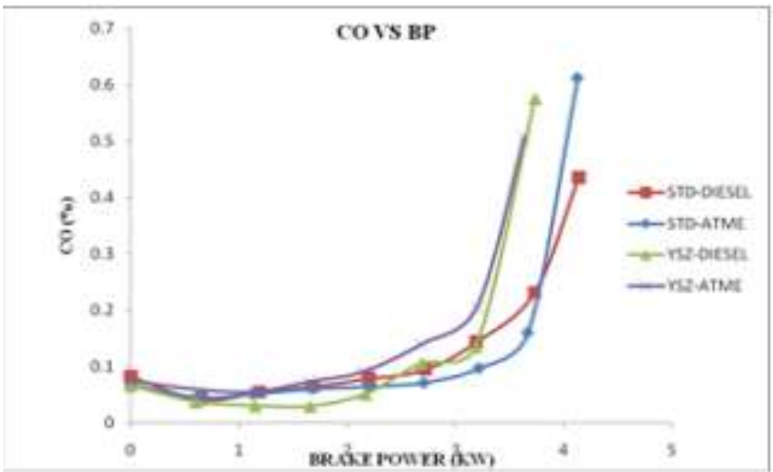

Figure 8: Variable Brake Power Carbon Monoxide

Figure 8 shows the variation in CO and BP and the capacity for LHR engines is substantiated. The carbon monoxide emissions from the D1 engine primarily rely on the physical and chemical characteristics of the petrol. Better combustion contributes to lower exhaust CO levels. It's well understood. The tendency rises as air-fuel ratios decline by load increases. The CO concentration of LHR-ATME is considerably below that of the basic generator. The reason for this lies in the total combustion of LHR and high oxygen content of biodiesels in the isolated climate. ATME also has a large number of cetane, which decreases the risk of forming a high fuel area that reduces the amount of CO injected. The lower carbon-hydrogen ratio for bio-diesel may also be attributed.

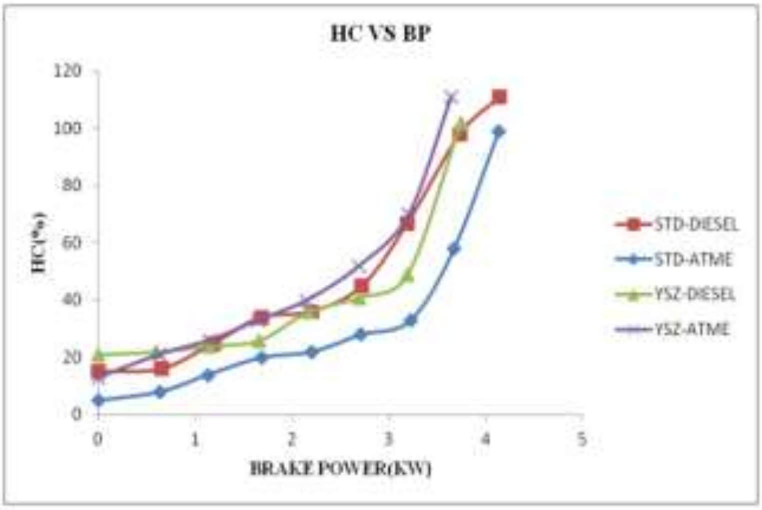

Figure 9: Variation of Brake Power unburned hydrocarbons

Hydrocarbons

Figure 9 indicates BP's HC variance. SI engines typically produce more emissions of HC and CO, whereas CI engines do not. Due to elevated combustion temperatures and stresses in the LHR-ATME turbine, HC emissions are minimized. The creation of a rich blend of air-fuel plays an essential role in this phenomenon. This may be caused by high cetane in bio-diesels.

CONCLUSIONS

The traditional diesel engine is transformed into the Thin Ceramic LHR engine. In this work. The cumulative impact on efficiency and pollution characteristics of a coated biodiesel-powered engine is examined. As a result, the processing of biodiesel from animal fats is a modern alternative which can be used effectively in diesel engines. Advanced ceramic coatings of high-performance opened up new markets. Ceramic coatings have the capacity to increase the thermal efficiency of engine parts, longer durability and greater reliability. This study tacitly indicates that excess oxygen content in biodiesel plays a major role in the efficiency of engines and that biodiesel is a possible fuel for the substitution of diesel fuel in whole or in part. The oxygen content in biodiesel improves combustion and the temperature of the combustion chamber increases, leading to higher emissions of NOx, especially at high engine loads. Eco-friendly machine features.

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Corresponding Author

Altaf Hasan Tarique*

Assistant Professor, Department of Mechanical & Chemical Engineering, Galgotias University, Greater Noida, Uttar Pradesh, India