ISSN 2278 – 0211 (Online)

Investigation of Performance Analysis and Emission Characteristics of Biodiesel

D. Sivakumar
PG Student, Department Of Mechanical Engineering, Nandha Engineering College, Erode, India
M. K. Murthi
Assistant professor, Department Of Mechanical Engineering, Nandha Engineering College, Erode, India

Abstract:
The emission characteristics of carbon dioxide, carbon monoxide, nitric oxide hydrocarbons and improve engine performance was found to be higher than pure diesel. Biodiesel is to choose a diesel that is safer, produces less harmful combustion emissions are easily. B20 is the most common biodiesel blend in the world. B20 is popular because it represents a balance of cost, emissions, materials compatibility, reduced engine wear through the increased lubricity and ability to act as a solvent. However, biodiesel has a higher Cloud Point (CP), Pour Point (PP), and Cold Filter Plugging Point (CFPP) than diesel oil. The increase in these cold flow properties is related to the gelling of biodiesel at higher temperatures than diesel fuel oil. The use of biodiesel blends, thus, pose potential operational problems in cold external environment. Biodiesel degrades due to oxidation, contact with water, and activity. The oxidation of biodiesel can produce various acids or polymers which, if in high enough concentration, can cause fuel system corrosion and deposits which in turn can lead to filter clogging and fuel system malfunctions. In addition, advanced direct injection engines may lose significant power when poor quality biodiesel blends are used. An effective performance diesel fuel additive can help guard against such problems. This work includes analysis with B20 blends of the some oils and use of additives in biodiesel.

Keywords*: Mono Alkyl Ester, Transesterification, Biodiesel, Emission characteristics and Engine performance.*

1. Introduction

As a result alternative fuels have received much attention due to its ability to replace fossil fuels. Moreover, the environmental issues concerned with the exhaust gas emission by the usage of fossil fuels also encourage the usage of alternative fuels such as biodiesel. In this context, there has been growing interest on alternative fuels like vegetable oils to provide a suitable diesel oil substitute for internal combustion engines. The main drawback of vegetable oils is associated with their high viscosity, 15–20 times greater than the standard diesel fuel. Researchers have suggested different techniques for reducing the viscosity of the vegetable oils. The different techniques are blending with diesel fuel, micro-emulsification with methanol or ethanol, thermal cracking, and conversion into biodiesels through the transesterification process. Among these transesterification process is most widely used. The advantages of biodiesels are that they are renewable, can be produced locally, cheap, higher lubricity, higher cetane number, and minimal sculpture content and less pollutant for environment compared to diesel fuel. On the other hand, their disadvantages include the higher viscosity and pour point, and lower calorific value and volatility. Moreover, their oxidation stability is lower, they are hygroscopic, and as solvents may cause corrosion in various engine components. For all the above reasons, it is generally accepted that blends of diesel fuel, with up to 20% bio-diesels, can be used in existing diesel engines. The mixing quality of biodiesel spray with air can be generally improved by selecting the best injection parameters and better design of the combustion chamber.

2. Literature Survey

Saswat Rath et al. [2012] investigated that many vegetable oils has been analyzed in compression ignition engine. The vegetable oils are very high viscosity and density. The methyl ester of the oil to overcome these many problems. Their use in the form of methyl esters in non modified engines has given encouraging results. Karanja oil is an experimental investigation to evaluate the performance, emission and combustion characteristics of a diesel engine using different blends of methyl ester of Karanja with mineral diesel. Karanja methyl ester was blended with diesel in proportions of 5%, 10%, 15%, 20%, 30%, 40%, 50% and 100% by mass and studied under various load conditions in diesel engines. The performance parameters are very close to that of mineral diesel. The brake thermal efficiency and mechanical efficiency were better than mineral diesel for specific blending ratios under certain loads. The emission characteristics investigated to carbon dioxide, carbon monoxide, nitric oxide and hydrocarbons were found to be higher than pure diesel.

Gaurav Dwivedi et al. [2012] evaluated to focus on the work done in the area of production of biodiesel from Pongamia biodiesel. The characterization of properties of various blends of Pongamia biodiesel. The higher viscosity is problem with biodiesel comparing than diesel. The higher content of viscosity leads to formation of gums in the biodiesel, which will affect its performance and also includes the impact analysis of Pongamia oil and its biodiesel on engine performance and exhaust emission. The results obtained are compared with the Jatropha curcas biodiesel. The research has indicated that up to B20, there is no need of any modification. The test result of using biodiesel reduction in particulate emission, CO emissions accompanying with power loss, the increase in fuel consumption and the increase in NOx emission on conventional diesel engine with no or fewer modification. The result, it can be observed when biodiesel will replace diesel as a source of fuel in near future.

Stalin et al.[2012] investigated from Karanja oil was produced by an alkali catalyzed transesterification process. The Performance of IC engine using pongamia biodiesel blending with diesel and various blending ratios has been evaluated. The engine performance studies were conducted with a prong brake-diesel engine set up. The experimentally investigate Parameters like parameters speed of engine, fuel consumption and torque also measured in different loads of pure diesel and various combinations of dual fuel. Brake power, brake specific fuel consumption and brake thermal efficiency were calculated by using testing of engines. The test results also indicate that the dual fuel combination of B40 can be used in the diesel engines without making any engine modifications.

Hossain Mohammad Imran et al. [2010] investigated about the process involved transesterification of Karanja oil with methanol in the presence of a catalyst (NaOH), to yield biodiesel as the main product and glycerin as by-product. In review this paper off, free fatty acid (FFA) of Karanja oil was determined and it was found less than 5%. As the result of one step transesterification was carried out. Pongamia Oil to methanol molar ratio (6:1 to 12:1) and the variation (0.5% to 1.6% with of oil) of Catalyst (NaOH) concentration was found. Base-catalyzed transesterification converted Karanja oil into biodiesel and glycerol using 1.5% NaOH as alkaline catalyst at 60-650C. This paper study revealed the maximum yield of biodiesel up to 85% with methanol to oil ratio 1:9 and for 1.5 her reaction at 650C.The Co-ignition of biodiesel with commercial diesel was also evaluated and it was found that diesel engine runs smoothly in the ratio of commercial diesel to biodiesel was 7:3.

Nagarhalli et al. [2009] investigated to study about this paper to analyze the emission and performance characteristics of a single cylinder 3.67 kW, compression ignition engine fuelled with mineral diesel and diesel-biodiesel blends at an injection pressure of 200 bar. To evaluate, performance parameters were break thermal efficiency, break specific energy consumption (BSEC) brake specific fuel consumption and the emissions also measured. The carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbon (HC), and oxides of nitrogen (NO_x) also measured. The test results indicate that the CO emissions were slightly higher, HC emissions decreased from 12.8 % for B20 and 2.85 % for B40, NO_x emissions decreased up to 39 % for B20 and 28 % for B40. The efficiency decreased slightly for blends in comparison with diesel. The BSEC was slightly more for B20 and B40. Till now the investigation can be concluded that biodiesel and it can be used as an alternative to diesel in a compression ignition engine without making any engine modifications. Hence a blend of 40% biodiesel and 60% diesel (B40) is recommended.. The results are in line with that reported in literature by different researchers using various biodiesel fuels and their blends.

Rathod et al. [2010] analyzed vegetable oils, due to their agricultural origin, are able to reduce net CO_2 emissions to the atmosphere. The review studying in this paper to conclude that directed towards improving the performance of C.I. The engine uses oil (Methyl ester Kusum oil) as a fuel. The engine performance was studied at constant speed, with the engine operated at various loading conditions to perform of parameters considering about comparing with brake specific fuel consumption, thermal efficiency, brake power, exhaust gas temperature, smoke density part load and peak load performance of the engine. The increase in thermal efficiency, when it is powered by Kusum oil, and its blends at various loads by engine performance. The result of power developed, and exhaust gas temperature, increases with the increase and specific fuel consumption is higher than diesel fuel.

Shirish Sonawane et al. [2000] discussed about the process for the production of the ethyl ester from Karanja oil to use as a biodiesel fuel. The studying this paper, first the transesterification of Karanja oil using methanol. NaOH is used as catalyst to yield methyl ester of Karanja oil as a product biodiesel and glycerol as a by-product. Experiments have been performed to determine the optimum conditions for the preparation of Easter. The temperature, catalyst, methanol used to select the parameters. The engine performance of biodiesel was checked with petroleum diesel and increase in the catalyst concentration there is an increase in the biodiesel output. The optimum value at the concentration of 0.6 g and increase in the catalyst concentration the biodiesel output was found to decrease.

Venkateswara Rao et al. [2008] investigated the methyl esters of vegetable oils, known as biodiesel are increasingly low environmental impact and potential as a green alternative fuel for diesel engine. The methyl ester of Pongamia (PME), Jatropha (JME) and Neem (NME) are derived through transesterification process. Experimental investigations have been investigated to examine the properties, performance and emissions of different blends (B10, B20, and B40) of PME, JME and NME in compared to diesel. Results also indicated to B20 have closer performance to diesel and B100 had lower brake thermal efficiency mainly due to its high viscosity compared to diesel. The diesel blends showed reasonable efficiencies, lower smoke, CO and HC. Pongamia methyl esters have better performance compared to Jatropha and Neem methyl esters.

Anand Kumar Pandey et al. [2008] discussed about global warming due to engine emission and rapid depletion of petroleum reserves, to find using vegetable oil. The Karanja oil methyl ester biodiesel used in a CIDI engine. To carry about the engine performance along with lower exhaust emission as compared to diesel fuel, but with slightly higher NOx emission and low wear characteristics. A Military 160hp, Turbo charged with intercooled, 06 cylinders CIDI engine was operated using Esterifies Karanja oil, biodiesel and

diesel fuel respectively. Metal debris concentration analysis was done by atomic absorption spectroscopy. Wear of metals was found to be about 35% lower for bio-diesel operated engine. The additional lubricating property of biodiesel fuel due to higher viscosity as compared to diesel fuel resulted in lower wear of moving parts and improved the engine durability with a bio-diesel fuel.
Ş. Altun et al. [2009] investigated an experimental study of exhaust emissions of a diesel engine is carried out using biodiesel-diesel-ethanol (indicated as BDE). The results compared with both petroleum diesel fuel and biodiesel-diesel blend known as B20.Biodiesel also used in comparing waste cooking oils. Experiments were conducted on a 4-cylinder engine, and DI diesel engine at speed characteristics of full load condition. An increase in brake specific fuel consumption (BSFC) for blended fuels were observed and compared with diesel fuel. A reduction in carbon monoxide (CO) was found for blended fuels while emissions of nitrogen oxides (NOx) were slightly higher for B20, and lower for BDE compared with diesel fuel.
Seventeen Sivalakshmi et al. [2009] analyzed vegetable oils have an energy content compared to diesel fuel. The effect of neem oil and its methyl ester on a direct injected four strokes, single cylinder diesel engine combustion, performance and emission also investigated in this paper. The results show that at full load, peak cylinder pressure is higher for neem oil methyl ester; peak heat release rate during the premixed combustion phase is lower for neem oil and neem oil methyl ester. Ignition delay is lower for neem oil and neem oil methyl ester when compared with diesel at full load. The combustion duration is higher for neat neem oil and neem oil methyl ester compared to diesel at all loads engine performances. The brake thermal efficiency is slightly lower for neem oil at all engine loads, but in the case of non oil methyl ester slightly higher at full load. It has been observed that there is a reduction in NOx emission of neem oil and its methyl ester along with an increase in CO, HC, and smoke emissions.
S. Ramkumar et al. [2010] evaluated the depletion of fossil liquid fuels, research in alternate engine fuel. The conventional route of 'bio-diesel' production is not economically as well as Eco friendly. The by product like 'glycerine' does not have any market value and hence disposal also leads lots of issues. So this paper aims at finding out the feasibility of using pongamia pinnata oil to CI engines directly by catalytic cracking instead of going for transesterificaiton and also TGA & DSC studies have been carried out with this oil showing encouraging results.
Gaurav Dwivedi et al . [2005] investigated pongamia pinnata trees are normally planted along the highways, roads, canals to stop soil erosion. If the seeds fallen along road side are collected, and oil is extracted at village level explores, few million tons of oil will be available for Lighting the Lamps in rural area. It is the best substitute for Kerosene. Since these are spread over a large area, collection of seeds for Biodiesel manufacture is not viable. (A compact plantation can support a Biodiesel plant. The seedlings of Pongamia can survive in 1.5 meters deep water submergence / inundation for five to six months duration at a stretch. There are nearly 30,000 square km of water reservoirs in India. This tree can be cultivated in our water storage reservoirs up to 1.5 meters depth and reap additional economic value from unused reservoir lands. The estimated annual production of oil from its seeds is about 50,000 t. The oil has not yet found any significant commercial application. But due to increase in awareness and growth in research in this area the Pongamia it can be developed as the alternative source of fuel by replacing diesel.
M. K. H. Leung et al. [2009] - Desulphurization of diesel-like fuel (DLF) produced from waste lubrication oil, and the effects of desulphurized fuel on engine performance and emissions were investigated experimentally. Firstly, the DLF was produced by using a fuel production system and applying the pyrolitic distillation method. After Producing the DLF, oxidative desulphurization (ODS) method was applied at a temperature of 50 degrees in Order to decrease the amount of sulphur in the DLF. The sugar level of the DLF decreased from 3500 to 420 p.m. after the application of ODS method. It was observed that the temperature had an important effect on the decrement of sulphur content of the DLF. Secondly, characteristic tests such as density, kinematic Viscosity, heating value and flash point, sulphur content and distillation tests for the desulphurized fuel Named as low sulphur diesel-like fuel (LSDLF) are performed.
P.K. Devan et al. [2008] -Methyl ester of paradise oil and eucalyptus oil were chosen and used as fuel in the form of blends. Various proportions of paradise oil and eucalyptus oil are prepared on a volume basis and used as fuels in a single cylinder, four-stroke DI diesel engine, to study the performance and emission characteristics of these fuels. In the present investigation a methyl ester derived from paradise oil is considered as an ignition improver. The Experiment shows a 49% reduction in smoke, 34.5% reduction in HC emissions and a 37% reduction in CO emissions for the Me50–Eu50 blend with a 2.7% increase in NOx emission at full load.
Gerhard Knothe et al. [2009] - Biodiesel is produced by transesterifying the oil or fat with an alcohol such as methanol under mild conditions in the presence of a base catalyst. Another kind of product that can be obtained from lipid feed stocks is a fuel whose composition is simulated that of petroleum-derived diesel fuel. This kind of fuel, probably best termed ''renewable diesel'', is produced from the fat or oil by a hydrodeoxygenation reaction at elevated temperature and pressure in the presence of a catalyst. This article discusses general and comparative fashion aspects such as fuel production and energy balance, fuel properties, environmental effects including exhaust emissions and co-products.
Bobade S.N et al. [2012] - Biodiesel (fatty acid methyl ester) which is derived from triglycerides by transesterification, has attracted considerable attention during the past decade as a renewable, biodegradable and nontoxic fuel. Several processes of biodiesel fuel production have been developed, among which transesterification using alkali as a catalyst gives high level of conversion of triglycerides to their corresponding methyl ester in a short duration. Pongamia pinata has been found to be one of the most suitable species due to its various favorable attributes like its hardy nature, high oil recovery and quality of oil, etc. As the acid value of this oil is high, so that we have to reduce it by the process of esterification followed by transesterification. The methyl ester produced by this way gives the best result.
Mohite K.C et al. [2010] - In the present investigation, experimental work has been carried out to analyze the emission and performance characteristics of a single cylinder diesel engine 3.67 kW, compression ignition engine fuelled with mineral diesel and

diesel-biodiesel blends at an injection pressure of 200 bar. The performance parameters evaluated were break thermal efficiency, break specific energy consumption (BSEC) and the emissions measured were carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbon (HC), and oxides of nitrogen (NO_x). The Experiment of experimental investigation with biodiesel blends were compared with that of baseline diesel. The Experiment indicates that the CO emissions were slightly higher, HC emissions decreased from 12.8 % for B20 and 2.85 % for B40, NO_x emissions decreased up to 39 % for B20 and 28 % for B40. The efficiency decreased slightly for blends in comparison with diesel. The BSEC was slightly more for B20 and B40. From the investigation, it can be concluded that biodiesel can be used as an alternative to diesel in a compression ignition engine without any engine modifications.

Prasad B.V.V.S.U et al. [2011] - Detailed three-dimensional CFD simulations involving flow and combustion chemistry are used to study the effect of swirl induced by re-entrant piston bowl geometries on pollutant emissions from a single-cylinder diesel engine. The baseline engine configuration consists of a hemispherical piston bowl and an injector with finite sac volume. The first iteration involved using a torridly, slightly re-entrant bowl geometry, and a sac-less injector. Pollutant emission measurements indicated a reduction in emissions with this modification. Simulations on both configurations were then conducted to understand the effect of the changes. The simulation Experiment indicates that the selected piston bowl geometry could actually be reducing the in-cylinder swirl and turbulence and the emission reduction may be entirely due to the introduction of the sac-less injector. In-cylinder, air motion was then studied in a number of combustion chamber geometries, and a geometry which produced the highest in-cylinder swirl and Turbulence Kinetic Energy (TKE) around the compression top dead center (TDC) was identified.

3. Conclusion

BSFC and TFC values are lower when biodiesel blends are used. Also, brake thermal efficiency and indicated thermal efficiency increases when diesel is replaced by B20 biodiesel blends. Moreover, there is a slight reduction in CO and CO_2 emissions. NOx emissions are reduced by more than 25% and HC emissions are lowered by 20% using biodiesel blends. Using ethanol as additive further improves the engine performance. There is a reduction of 16% to 20% in BSFC is using additives and almost 10% reduction in TFC when BE-2 is used. Also, BT efficiency and IT efficiency are found to improve using additives. At full load condition, BE-2 has a 30% higher BT efficiency when compared to pure diesel. Ethanol reduced the emission of CO_2 by 12% when compared to diesel. There is not much change in CO emissions when biodiesel blends are used instead of diesel. But using ethanol as additive shows a slight reduction in CO emissions at full load condition. Ethanol increases the NOx and HC emissions, but it is still less than pure diesel.

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