# PERFORMANCE AND EMISSION TEST ON SINGLE CYLINDER FOUR STROKE DIESEL ENGINE USING COTTONSEED AND PALM OIL BLENDED WITH DIESEL

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## ABSTRACT

Present energy situation of the world is unsustainable due to unequal geographical distribution of natural wealth as well as environmental, geopolitical and economical concerns. Even increasing drift of energy consumption due to growth of population, transportation and luxurious life style has motivated researchers to carry out research on bio fuels as a sustainable alternative fuel for diesel engine.

Cottonseed and palm biodiesel was produced by transesterification process and further physical and chemical properties were analysed. An experimental investigation is conducted and evaluated the use of cotton seed and palm oil at blend ratios are B10 (10% Bio-diesel + 90% petroleum diesel), B20 (20% Bio-diesel + 80% petroleum diesel) and B30 (30% Bio-diesel + 70% Petroleum diesel) is done. After successful comparison of the above experiment I will approach the best one for domestic and also industrial use.

## *I. INTRODUCTION*

Biodiesel refers to alternative fuel for the diesel. It is a renewable clean burning fuel that is produce from vegetable oil or animal fat (methyl, ethyl and propyl) and recycled grease for use in diesel engines. Biodiesel used in air craft, vehicles, railway, fuel in generators.

Biodiesel produced by the transesterification, thermal cracking and base-catalyzed transesterification etc.., Transesterification used to make vegetable oil in 1853 by Patrick Duffy. Rudolf Diesel's prime model was peanut (Groundnut) oil use to run the engine successfully in Augsburg, Germany on 1893.

Energy produces in a variety of renewable forms, wood, biomass, wind, sunlight. It also produces in the non-renewable form of fossil fuels- oil and coal and their use is a major source of pollution of land, sea and above all the air we breathe. Partial of fossil fuels has been set as a worldwide to reduce green house effect and energy dependence as well as to improve agricultural economy. Emission from transportation engines are considered to greatly contribute to greenhouse gases (carbon dioxide) release. Bio-diesels (methyl or ethyl esters) are recently considered as most promising ones add by nature oxygen emitted carbon dioxide reduction. Because Octane number of fossil fuel is high.

**[1]** stated and determined that the methyl ester of cottonseed oil was prepared and blended with diesel in four different compositions varying from 5% to 20% in steps of 5%. Highest break thermal efficiency and lowest specific fuel consumption were observed different composition of bio-diesel. The 20% bio-diesel blend at a compression ratio of 17 had maximum nitric oxide emission as 205 ppm, while it was 155 ppm for diesel. The reason for increase in bsfc for all loads was due to calorific value of bio-diesel blends being lower than pure diesel. Also bio-diesel blends have large negative heat release rate due to cooling effect of the liquid fuel injected into the cylinder at all compression ratios. **[2]** Determined and evaluate the use of sunflower and cottonseed oil methyl esters at blend ratios of 10/90 and 20/80. Tested in a fully instrumented, six cylinder, turbocharged and after-cooled, direct injection (DI), mini bus diesel engine at the author laboratory. The tests are conducted using each of the above fuel blends, with the engine working at two speeds and three loads. Fuel consumption, exhaust smokiness and exhaust regulated gas emissions such as nitrogen oxides, carbon monoxide and total unburned hydrocarbons are measured. Theoretical aspects of diesel engine combustion with the differing physical and chemical properties of these blends, aid the correct interpretation of the observed engine behavior. **[3]** Biodiesel is known as the mono-alkyl-esters of long chain fatty acids derived from renewable feed stocks, such as, vegetable oils or animal fats, for use in compression ignition engines. Different parameters for the optimization of biodiesel production were investigated in the first phase of this study, while in the next phase of the study performance test of a diesel engine with neat diesel fuel and biodiesel mixtures were carried out. Biodiesel was made by the well known transesterification process. Cottonseed oil (CSO) was selected for biodiesel production. Cottonseed is non-edible oil, thus food versus fuel conflict will not arise if this is used for biodiesel production. The transesterification results showed that with the variation of catalyst, methanol or ethanol, variation of biodiesel production was realized. However, the optimum conditions for biodiesel production are suggested in this paper. A maximum of 77% biodiesel was produced with 20% methanol in presence of 0.5% sodium hydroxide. The engine experimental results showed that exhaust emissions including carbon monoxide (CO) particulate matter (PM) and smoke emissions were reduced for all biodiesel mixtures. However, a slight increase in oxides of nitrogen (NOx) emission was experienced for biodiesel mixtures. **[4]** The alkyl monoesters of fatty acids derived from vegetable oils or animal fats, known as biodiesel, are attracting considerable interest as an alternative fuel for diesel engines. Biodiesel–fueled engines produce less carbon monoxide, unburned hydrocarbons, and particulate emissions than diesel–fueled engines. However, biodiesel has different chemical and physical properties than diesel fuel, including a larger bulk modulus and a higher cetane number. Some of these properties can be affected by oxidation of the fuel during storage. These changes can affect the timing of the combustion process and potentially cause increases in emissions of oxides of nitrogen. A John Deere diesel engine was fueled with two different biodiesel fuels, one of which had been deliberately oxidized, and with their 20% blends with No. 2 diesel fuel. The engine was operated at three different timings and two loads at a single engine speed of 1400 rpm. The engine performance of the biodiesel was similar to that of No. 2 diesel fuel with nearly the same thermal efficiency. The range of injection timings studied produced changes of 50% and 34% in the CO and HC emissions, respectively. A reduction in NOx emissions of 35% to 43% was observed for a 3_ retarded injection timing compared with a 3_ advanced injection timing. A common linear relationship was found between the start of injection and the NOx emissions for all the fuels studied. When compared at the same start of combustion, the neat biodiesel produced lower NOx emissions than the No. 2 diesel fuel. **[5]** Biodiesel production is a modern and technological area for researchers due to constant increase in the prices of petroleum diesel and environmental advantages. The most detrimental properties of vegetable oils are its high viscosity and low volatility, and these cause several problems during their long duration usage in compression ignition (CI) engines. The most common method to make vegetable oil suitable for use in CI engines is to convert it into biodiesel, i.e. vegetable oil esters using process of transesterification. In the present work, experimental investigations of the performance and emissions of the diesel engine was conducted for different proportions of blends of cotton seed oil methyl ester biodiesel (CSOME) with ordinary diesel at different engine loads. **[6]** In this article, the status of fat and oil derived diesel fuels with respect to fuel properties engine performance an end emission is reviewed. The fuels considered re primarily the methyl esters of fatty acids derived from a variety of vegetable oils and animal fats, and referred to as biodiesel. The major obstacle to wide spreads e of biodiesel is the high cost relative to petroleum. Economics of biodiesel production are discussed and it is conclude that the price of the feed stock to raw oil is the major factor determining bio diesel price. Biodiesel is completely miscible with petroleum diesel fuel, and is generally tested as a blend. The use of Biodiesel in neat or blended form has no effect on the energy based engine fuel economy. The lubricity of these fuels is superior to conventional diesel, and this properties imparted do blends at levels above 20vol%. Emissions of PM can be reduced dramatically through use of biodiesel in engines that are not high lube oil emitters. Emissions of NOx increase significantly for both neat and blended fuels in both two- and four-stroke engines. The increase may blower in newer, lower NOx emitting four-stroke bus, traditional at are needed to confirm this conclusion. A discussion of available at a on un regulated air at toxins is presented, and it is concluded that definitive studies have yet to be performed in this area.**[7]** Rapid expansion in world production of palm oil over the last three decades has attracted the attention of the oils and fats industry. Oil palm gives the highest yield of oil per unit of any crop. Palm oil is the major oil produced, with annual world production in excess of 50 million tones. Throughout the world, 90% of palm oil is used for edible purposes (e.g., margarine, deep fat frying, shortening, ice creams, and cocoa butter substitutes in chocolate); the remaining 10% is used for soap and oleo chemical manufacturing (fatty acids, methyl esters, fatty nitrogenous derivatives, surfactants and detergents). Two distinct oils are produced by oil palms (palm kernel oil and palm oil), both of which are important in world trade. Palm oil contains 50% saturated fatty acids. The saturated fatty acid to unsaturated fatty acid ratio of palm oil is close to unity and it contains a high amount of the antioxidants, β-carotene, and vitamin E. Palm oil contains a high proportion of palmitic acid as well as considerable quantities of oleic and linoleic acids. **[8]** Stated that rapid increasing of industrialization and motorization has led arising of petroleum and energy demand. This pursue a new energy blends to cater the depletion of fossil fuel and the environmental degradation condition. Malaysia is blessed, which has suitable climate to plant alternative fuel (palm oil) and become one of the largest exporters to the world. Palm oil in its refined form as cooking oil has high energy content which can be adopted as an alternative to the petroleum based fuel. This paper evaluates the performance and emission characteristics of refined palm oil (RPO) as a fuel to the diesel engine. Moreover, by increasing the percentage of RPO in blends would lead a character of higher percentage in density and viscosity. Studied revealed that the small percentage of RPO composition promises a good thermal efficiency together with the emission released. **[9]** the growing economic risk of relying primarily on fossil fuels with limited reserves and increasing prices has increased the interest on alternative energy sources. Clean and renewable biofuels have been touted as the answer to the issue of diminishing fossil fuels. Malaysia, the largest producer of palm oil has committed to focus interest on biofuels, namely, palm biodiesel. Since palm oil has a high fossil energy balance, it is a key source of raw material for biodiesel production. This paper presents palm biodiesel as an alternative source of green renewable energy through a survey conducted from previously researched findings. The production of palm biodiesel is discussed by the transesterification reaction of triglycerides of refined palm oil to yield palm methyl ester (palm biodiesel) and glycerin as a by-product.**[10]** state in current day the biodiesel is so extensively studied, but even today the question of which blend of methyl ester-diesel is best suitable for current diesel engine is yet remains unanswered. Comparing to laboratory testing and Actual testing where transport vehicles are studied on street, the only operating parameters studied are load and speed which define engine efficiency and fuel utilization for a particular length. The observations made are lesser Carbon Monoxide emissions and Exhaust Gas temperatures reduced within increase of doping of ethanol content in Blends of Methyl Ester and its blends.

## *II. THE PROPERTIES COMPARISION OF COTTONSEED OIL AND PALM OIL*

Table 1. Standard properties of diesel and bio-diesels

| Properties | Cottonseed oil | Palm oil | Diesel |
|---|---|---|---|
| Specific Gravity | 0.912 | 0.875 | 0.835 |
| Calorific value (mJ/kg) | 39.6 | 37.25 | 42.5 |
| Flash point(°c) | 220 | 314 | 44 |
| Viscosity ($mm^2/s$) | 50 | 29 | 4 |
| Fire point (°c) | 253 | 341 | 85 |
| Cetane number | 48.1 | 52 | 47 |

## *III. METHODOLOGY*

### A. Selection of blended oil

In this experiment we are using the alternative fuel for diesel that means the some vegetable oils blending with diesel. The vegetable oils are cottonseed oil and palm oil used to blending with diesel due to its have low calorific value than the diesel.

### B. Blending composition of cottonseed oil and palm oil with diesel

- 10% Cottonseed oil blend with 90% Diesel.
- 20% Cottonseed oil blend with 80% Diesel.
- 30% Cottonseed oil blend with 70% Diesel.
- 10% Palm oil blend with 90% Diesel.
- 20% Palm oil blend with 80% Diesel.
- 30% Palm oil blend with 70% Diesel.

### C. Performance and emission test in c.i engine

Performance and emission test conduct C.I engine specifications are given below

Engine name : single cylinder high speed four stroke diesel engine

Engine type : vertical engine

Type of cooling : water

Speed : 1500rpm

Break power : 3.7kw

Bore diameter : 80mm

Stroke length : 110mm

Loading method : resistive loading

### D. Experimental set up

Figure.1 experimental set up

## *III. RESULT AND CONCLUSION*

| Fuel | Specific gravity | Kinematic Viscosity mm²/s | Calorific Value mJ/kg | Flash point |
|---|---|---|---|---|
| Palm oil | 0.875 | 27.84 | 34.00 | 205 |
| B10 | 0.832 | 2.69 | 39.28 | 76 |
| B20 | 0.848 | 3.39 | 38.28 | 79 |
| B30 | 0.851 | 3.92 | 36.26 | 80 |

Table 2 palm oil methyl ester properties.

| Fuel | Specific Gravity | Kinematic viscosity | Calorific Value Mj/kg | Flash point |
|---|---|---|---|---|
| Cotton Seed oil | 0.912 | 38.00 | 39.6 | 202 |
| B10 | 0.876 | 5.68 | 38.40 | 78 |
| B20 | 0.869 | 6.42 | 37.54 | 86 |
| B30 | 0.864 | 7.76 | 37.12 | 89 |

Similar reduction in specific gravity was observed. However, the calorific value of biodiesel was found to be 39.6MJ/Kg which is less than the calorific value of diesel (42.21 MJ/Kg) and greater than the palm oil (34 MJ/Kg).

In the present investigation, transesterification helps to improve the physical and chemical properties of cottonseed and palm oil into biodiesel. With the addition of diesel into biodiesel at various blending proportions, SFC slightly increases and BTE slightly decreases when compared with neat diesel.

The NOx emissions were lower from 8.61% to 61% for biodiesel and its blends comparing to neat diesel at all types of loads.

When comparing with diesel, B20 were lower emission and efficiency is almost equal to diesel.

This type of biodiesel helps to reduce emission, protect the environment from ODP and GWP and keep the environment clean and safe.

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