# Experimental investigation on diesel engine using smart biodiesel

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**ABSTRACT:** Fuels derived from the renewable biological resources for the use in diesel engine are known as biodiesel. Biodiesel produced from non-edible and edible feed stocks such as Mahua, Palm, Jatropha, Soya etc. are reported to be feasible choices for developing countries like India. In this investigation the blends of varying proportions of smart biodiesel are prepared, analyzed and compared with the performance of diesel fuel and studied using single cylinder diesel engine at varying loads. Raw oils of two or more biodiesel are esterified (butyl esters) before blending with each other. The esterified oils of biodiesel blends satisfies the important fuel properties and it lead to an improvement in engine performance and emission characteristics without any design modifications in the engine. The brake thermal efficiency, SFC, Exhaust gas temperature, Smoke density, CO, CO2 and HC were analyzed.

**KEYWORDS:** Properties of smart biodiesel, Optimum production, Saving conventional Fuel, Improvement of performance on diesel engine, Emission.



## I. INTRODUCTION

For the past few decades, a lot of effort has been made to reduce the dependency on petroleum fuels for power generation and transportation all over the world. Among the proposed alternative fuels, biodiesel have received much attention in recent years for diesel engines and could be one remedy in many countries to reduce their oil imports. Biodiesel have many advantages over regular diesel as renewable and domestically produced energy resources. Moreover, they are recognized as environmentally friendly alternative fuels because previous studies have shown that there is a substantial reduction of CO, unburned hydrocarbons and particulate matter emission, when they are used in conventional diesel engines. Biodiesel is an alkyl (e.g. methyl, ethyl) ester of fatty acids made from a wide range of vegetable oils, animal fat and used cooking oil via the transesterification process. Moreover, biodiesel has been used not only as an alternative for fossil diesel. Bio diesel is considered to be a candidate alternative to diesel in order to decrease the use of conventional diesel. It is expected that the use of ethanol as a gasoline-blending component can reduce the amount of petroleum-fuel imports by up to 10–15%. Moreover, the use of Biodiesel can also increase farmer's incomes, because it can be produced domestically from many kinds of agricultural products such as sugar cane, molasses or cassava root. This success of Diesel–Biodiesel blending has led to interest in the use of oxygenated compounds as emissions reducing additives in diesel fuel. Moreover, the use of Biodiesel, particularly biomass-derived biodiesel, can result in significant savings in carbon dioxide emissions. This approach offers a ''no regrets'' policy that reduces potential future risks associated with climate change, and it has the added benefit of economic development. Generally, Biodiesel can be blended with diesel with no engine modifications required. These can result in fuel instability due to phase separation. Prevention of this separation can be accomplished in two ways: by adding an emulsifier, which acts to suspend small droplets of biodiesel within the diesel fuel, or by adding a co-solvent, which acts as a bridging agent through molecular compatibility and bonding to produce a homogenous blend. Additionally, the cetane number of the blend is low, making it difficult to burn by the compression ignition technology employed in diesel engines. As a result, a number of studies have been carried out to improve the solubility of ethanol in diesel, as well as to improve the cetane number of the blends. There are several studies concerning biodiesel production and utilization.

It has given a major boost for producing biodiesel from raw materials available in India, especially palm oil. Taking into account the environmental considerations, the more attractive system is the production and usage of fuel containing biodiesel and ethanol, which can both be produced in India. The objective of this research, therefore, was focused on studying the use of biodiesel (palm oil methyl esters) as an additive in stabilizing Biodiesel in diesel blends. The phase stability of biodiesel–diesel at different temperatures and different component concentrations was investigated, along with some basic fuel properties such as cetane index, density, heat of combustion, flash point, pour point, and emissions; these properties were compared with those of diesel fuel.

## II. LITERATURE SURVEY

**Kazi Mostafijur Rahman et al. (2010)** carried out As a result vehicles and engines are increasing. But energy sources used in these engines are limited and decreasing gradually. This situation leads to seek an alternative fuel for diesel engine. Biodiesel is an alternative fuel for diesel engine. The esters of vegetables oil animal fats are known as Biodiesel. This paper investigates the prospect of making of biodiesel from jatropha oil. Result As per this research papers conclude biodiesel is a viable substitute for petroleum-based diesel fuel. Its advantages are improved lubricity, higher cetane number, cleaner emissions (except for NOx), reduced global warming, and enhanced rural development. Jatropha oil has potential as an alternative energy source.

**Somnuek Jaroonjitsathian et al. (2011)** have been researched the biodiesel combustion, performance and emission, the various sources of biodiesel and engine technologies makes it more and more complicated to conclude that how biodiesel combustion react to the engine response especially for transient application. Some of biodiesel user always claims that the presence of biodiesel component in diesel fuel influence on poor engine drive-ability even only 5% v/v. While, there is a few publications comment on the low sensitivity of diesel fuel ignition delay when running with advance common-rail DI engine.

**P. Venkateswara Rao et al. (2012)** It was stated that An experimental investigation was carried out to evaluate the effect of Triacetin (T) as an additive with biodiesel on direct injection diesel engine for performance and combustion characteristics. Normally in the Usage of diesel fuel and neat biodiesel, knocking can be detected to some extent. By adding Triacetin [$C_9H_{14}O_6$] additive to biodiesel, this problem can be alleviated to some extent and the tail pipe emissions are reduced. Comparative study was conducted using petro-diesel, biodiesel and additive blends of biodiesel on the engine. Coconut oil methyl ester (COME) was used with additive at various percentages by volume for all load ranges neat diesel in respect of engine efficiency and exhaust emissions. Among the all blend fuels tried, 10% Triacetin combination with bio-diesel shows encouraging results. As per result in this research paper Triacetin is soluble in biodiesel, mineral oils and aromatic compounds. Because this additive is an oxygenated compound and also is anti knocking agent in the case of gasoline engines, a trial was made to investigate the suitability to biodiesel additive.

**Kasireddy Sravani et al. (2016)** It was stated that The main reason for the investigation of usage of alternate fuels in internal combustion engines was due to rapid increase in urbanization, usage of automobiles leads to the depletion of petroleum products, increase in emission of exhaust gases has increased. The emissions coming from engines cause severe harm to environment. So to overcome this problem government had lay down strict regulations to the engine manufacturers and consumers to follow emission norms. In this regard, alternate fuels came into existence after various investigations of many researchers.

**S.M.A. Ibrahim et al. (2012)** which was published on Jatropha biodiesel fuel blends are mixed by volumetric percentage of 20, 40, 70 and 100% with diesel fuel and burned in a diesel engine to study engine performance and emission. These tests were performed on a four stroke, single cylinder, water cooled diesel engine at different loads and rated speed of 1500 rpm. This research reveals that there is an increase in specific fuel consumption, exhaust temperature and air-fuel ratio in diesel- biodiesel blends (B20, B40, B70 and B100) than diesel fuel. The results show a decrease in thermal efficiency and volumetric efficiency for diesel-biodiesel than diesel fuel. The research exhibits a decrease in CO2, CO and HC for diesel- biodiesel blend than diesel fuel. NOx and O2 emissions increased with the use of biodiesel blends as compared to neat diesel fuel.

**L.Karikalan et al. (2013)** which was produced vegetable oil. Vegetable oil is one of several alternative fuels designed to extend the efficacy of petroleum, the flexibility and cleanliness of diesel engines. In this paper comparative experiments were carried out to measure the carbon monoxide, hydrocarbons, carbon dioxide and oxides of nitrogen emission level on Diesel engine with SCR technique using diesel fuel and Biodiesel blends of Jatropha, Pongamia and Neem (J20D80, P20D80 and N20D80) and the emission characteristics were analyzed. The results from the experiments prove that vegetable oil and its blends are potentially good substitute fuels for diesel engine in the near future when petroleum deposits become scarcer. The smart technologies deliver benefits to multiple interests, including an improved economy, and a positive impact on the environment and governmental policies. Continuous availability of the vegetable oils needs to be certain before embarking on the major use of it in I.C. engines. Domestically produced vegetable oil will

help to reduce costly petroleum imports and the development of the vegetable oil based bio-diesel industry would strengthen the rural agricultural economy of agricultural based countries like India. As per result show a variety of emission control technologies exist for controlling NOx, CO, NMHC, and PM emissions from stationary IC engines and have been in use for 10 years. Oxidation catalysts provide significant reductions in CO and HC and SCR can be used to reduce greater than 90 percent of NOx emissions from the diesel engines.

**H. M. DHARMADHIKARI et al. (2011)** it was stated that In the present investigation experimental work has been carried out to analyze the performance and emissions characteristics of a single cylinder compression ignition DI engine fuelled with the blends of mineral diesel and biodiesel at the different injection pressures. The optimal value of the injection pressure was observed as 200 bars in the range of 180 to 220 bars. The performance parameters evaluated were brake thermal efficiency, break specific fuel consumption and the emissions measured were carbon monoxide (CO), carbon dioxide (CO2), hydrocarbon (HC), and oxides of nitrogen (NOx). The results of experimental investigation with biodiesel blends with diesel are compared with that of diesel.

**Gaurav Dwivedi et al. (2011)** Pongamia Pinnata trees are normally planted along the highways, roads, canals to stop soil erosion. Billions of trees exist all over India. If the seeds fallen along road side are collected, and oil is extracted at village level expellers, few million tons of oil will be available for Lighting the Lamps in rural area.reported that in complete or partial filling up of transfer port by air/cooled exhaust gases which scavenges the burnt products and avoids the loss of fresh A/F (Air-fuel ratio) mixture during scavenging. Hence it results in improvement of specific fuel consumption and reduction of hydro carbon emissions.

**Table 1: Selected fuel properties for petro diesel & pongamia oil methyl ester.**

| Property | Pongamia oil methyl ester | Petroleum diesel |
|---|---|---|
| Viscosity (cp) (30°C) 52.6 | 5.51 | 3.60 |
| Specific gravity (15°C /4°C) | 0.917 | 0.841 |
| Solidifying Point (°C) | 2 | 0.14 |
| Cetane Value | 51 | 47.8 |
| Flash Point (°C) | 110 | 80 |
| Carbon Residue (%) | 0.64 | 0.05 |
| Distillation (°C) | 284 – 295 | 350 |
| Sulfur (%) | 0.13 - 0.16 | 1.0 |
| Acid Value | 1.0 - 38.2 | - |
| Saponification Value | 188 – 198 | - |
| Iodine Value | 90.8 - 112.5 | - |
| Refractive Index (30°C) | 1.47 | - |

**Bobade S.N et al. (2012)** It was based on preparation of 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. This process has therefore been widely utilized for biodiesel fuel production in number of countries.

**Table-2**
**Comparison of karanja biodiesel (KOME) with Diesel fuel**

| Properties | Unit | Karanja methyl ester | Diesel |
|---|---|---|---|
| Density | gm/cc | 0.860 | 0.840 |
| Kinematic Viscosity @ 40°C | Cst | 4.78 | 2.98 |
| Acid value | mgKOH/gm | 0.42 | 0.35 |
| Free glycerin | wt% | 0.015 | ------ |
| Cloud point | °C | 6 | -16 |
| Flash point | °C | 144 | 74 |
| Cetane number | | 41.7 | 49.0 |
| Calorific value | Kcal/KG | 3700 | 4285 |
| Iodine value | | 91 | ------ |
| Saponification value | | 187 | ------ |
| Moisture | % | 0.02 | 0.02 |
| Carbon residue | % | 0.005 | 0.01 |
| Ash content | wt % | 0.005 | 0.02 |

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**Dinesh Dabhi K et al. (2013)** In this research paper on Fuel crisis and environmental concerns have led to look for alternative fuel of bio origin successes such as vegetable oils, which can be produced from forests, vegetable. The effect of neem bio-diesel and its blending with pre- mineral diesel on different types of diesel engine combustion, performance and emission compared with this papers .The result shows that blending of bio-diesel of 20x shows better break thermal efficiency lower specific fuel combustion and less exhaust gas temperature while found less carbon monoxide, nitrogen oxide and hydrocarbons emission.

**TABLE 3: PROPERTIES OF NEEM OILS AND ITS ESTER**

| Properties | Diesel | Neem oil | Neem biodiesel |
|---|---|---|---|
| Density(kgm$^{-3}$) | 830 | 912–965 | 820–940 |
| Viscosity(cSt) | 4.7 | 20.5–48.5 | 3.2–10.7 |
| Flashpoint( C) | 60 | 214 | 120 |
| Cetane number | 45 | 31–51 | 48–53 |
| Calorific value(MJkg-1) | 42 | 32–40 | 39.6–40.2 |
| Sulphur (ppm) | 0.042 | 1990 | 473.8 |
| Iodine value | ---- | 65-80 | ---- |
| Titre( C) | ---- | 35-36 | ---- |
| Fire point( C) | 65 | 222 | 128 |
| Pour point( C) | -16 | 10 | 2 |
| Cloud point( C) | -12 | 19 | 9 |
| Total glycerine (%) | ---- | ---- | 0.26 |
| Free glycerine (%) | ---- | ---- | 0.02 |
| Oxidation stability (h),110 C | 3-6 min | 12.4 | 7.1 |
| Coldfilter plugging point( C) | ---- | 11 | ---- |
| Carbon residue(%mass) | 0.17 | ---- | 0.105 |
| Water content (%) | 0.02 | 0.098 | 0.036 |

**Pratap S Kulkarni et al (2013),** According to this research paper the Mahua trees are indigenous to India, grow even in draught prone areas and are found abundantly over several parts of India. If the seeds fallen are collected, and oil is extracted at village level expellers, few million tons of oil will be available for lighting lamps in rural area. In some countries, Mahua oil is considered edible as it is used only for preparing ghee, but in our country it has been considered as non-edible oil.

**Table 4 Properties of Raw Mahua**

| Properties | Diesel | Raw Mahua |
|---|---|---|
| Density (kg/m³) at40°C | 828 | 904 |
| Specific gravity at 40°C | 0.828 | 0.904 |
| K.V.(cSt) at 40°C | 4.4 | 38.86 |
| Calorific Value (KJ/kg) | 43910 | 37735 |
| Flash point (°C) | 45 | 220 |
| Fire Point (°C) | 63 | 234 |

**Auwal Aliyu et al. (2003)** This work focuses on the production of biodiesel from waste soybean oil via NaOH catalyzed transesterification reaction. Many properties of the waste soybean oil and the produced biodiesel have been measured. The density, kinematic viscosity, cloud point and flash point of the waste soybean oil were found to be higher than those of the produced biodiesel. The measured cetane number of the produced biodiesel is greater than that of the waste soybean oil; hence, transesterification process improves the combustibility of the waste soybean oil.



**Table 5: Properties of the waste soybean oil and the produced biodiesel**

| Property | Waste soybean oil | Biodiesel |
|---|---|---|
| Free fatty acid, % | 0.3 | |
| Density at $20^0$C, g/cm$^3$ | 0.893 | 0.860 |
| Kinematic viscosity at $20^0$C, mm$^2$/s | 32.6 | 4.1 |
| Cloud point, $^0$C | 8 | 2 |
| Flash point, $^0$c | 286 | 178 |
| Cetane number | 38.0 | 46.0 |
| Color | Dark brown | Golden yellow |

**R.K.Singh et al. (2009)** there has been greater awareness on biodiesel in developing countries in the recent times and significant activities have picked up for its production especially with a view to boost the rural economy. In the present investigation jatropha curcas linn. Seed oil (non-edible) and its methyl ester have been chosen to find out their suitability for use as petro-diesel. Experimental investigation has been done to find out the different properties of jatropha oil.

**Table 6 Properties of jatropha biodiesel**

| Property | Unit | Jatropha oil | Jatropha oil methyl ester | Diesel | ASTM D 6751-02 | DIN EN 14214 |
|---|---|---|---|---|---|---|
| Density at 15°C | kg/m$^3$ | 918 | 880 | 850 | 875–900 | 860–900 |
| Viscosity at 40°C | mm$^2$/s | 35.4 | 4.84 | 2.60 | 1.9–6.0 | 3.5–5.0 |
| Flash point | °C | 186 | 162 | 70 | >130 | >120 |
| Pour point | °C | -6 | -6 | -20 | — | — |
| Water content | % | 5 | Nil | 0.02 | <0.03 | <0.05 |
| Ash content | % | 0.7 | Nil | 0.01 | <0.02 | <0.02 |
| Carbon residue | % | 0.3 | 0.025 | 0.17 | – | <0.3 |
| Sulphur content | % | 0.02 | Nil | — | 0.05 | — |
| Acid value | mg KOH/g | 11.0 | 0.24 | 0.35 | <0.8 | <0.50 |
| Iodine value | — | 101 | 104 | – | – | – |
| Saponification value | — | 194 | 190 | – | — | — |
| Calorific value | MJ/kg | 33 | 37.2 | 42 | — | — |
| Cetane number | — | 23 | 51.6 | 46 | — | — |



## III. CONCLUSION

The present review paper gives the analysis of different biodiesel properties and blend two edible oil and two non edible oil into make biodiesel then after blend with this biodiesel to make smart biodiesel. It is found that properties wise blending 4 biodiesel and its smart biodiesel properties. So it is conclude from the above literatures, different type biodiesel in exhaust system directly affects the performance and the emission characteristics of the internal combustion engine. For improvement in the performance of an engine, it is necessary to control the temperature in automotive exhaust system. So it is economical and environment Friendly, which is the reason of selects bio-fuel as a fuel.

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