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Performance Evaluation and Emission Testing of Simarouba Seeds Oil Biodiesel Blends in CI Engine

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Abstract:- *Petroleum based fuels worldwide have not only resulted in the rapid depletion of conventional energy sources, but have also caused severe air pollution. The search for an alternate fuel has led to many findings due to which a wide variety of alternative fuels are available at our disposal now. The existing studies have revealed the use of vegetable oils for engines as an alternative for diesel fuel. However, there is a limitation in using straight vegetable oils in diesel engines due their high viscosity and low volatility. In the present work, Simarouba seed oil is converted into their respective methyl ester through transesterification process. Experiments are conducted using various blends of Biodiesel of Simarouba seed oil with diesel in a single cylinder, four stroke vertical and air cooled Comet diesel engine. The experimental results of this study showed that the Simarouba biodiesel Blends has similar characteristics to that of diesel. The brake thermal efficiency, BSFC, Volumetric efficiency and Emissions are observed to be lower in case of biodiesel blends than diesel. The tests for B00, B10, B20, B30, B40 & B50 are carried by varying load. Analysis showed that B20 blend give better results than other blends. From this study, it is concluded that optimized blend is B20 and could be used as a viable alternative fuel in single cylinder direct injection diesel engine without any modification.*

Key Words: Simarouba, transesterification, biodiesel blends

1. Introduction

We are living in twenty-first century and already have less storage of fuel, with its high cost in the market. Global warming is the biggest and the most devastating man made phenomenon and its consequences are far too dangerous. It all started when we live in the pre industrialized world. With the beginning of the eighteenth century the industrialization started, but then no one really knew what they are preparing for their children, and it was until late 70's of the last century we actually came to know about the effects and causes of the global warming.

Global warming is now a well-accepted phenomenon and we are almost helpless to stop it. Looking back in the history we can see the inevitable effects of industrial pollution which shatter the human life in pain. The fatal London smog and loss-Angeles smog are some important consequences of GW which takes thousands of lives. Let us explore the global warming in detail and the various ways to stop it. The main ingredient for this is greenhouse gases, which is almost essential by-product of any industry (even now). The greenhouse gases are responsible to cause the greenhouse effect which in the long run takes the shape of global warming. Most common greenhouse gases are carbon dioxide, water vapour, ozone, methane, nitrous oxide. The main sources of greenhouse gases are power plants and transport vehicles, both of which are now the integral part of our need. As the level of CO2 is increasing in the atmosphere so as the threat of Global Warming. Study says that situations could turn worst if the average temperature of the earth increased just by 4^0 C. On the other hand we almost used up the existing coal, petroleum and the other natural resources the earth has in it, without which we cannot imagine our existence.

This situation is forcing us to explore the new ways of getting energy. If we look around us we are actually living on the petroleum and its products. We really deeply on the earth natural resources to generate energy. Even when we switch on our study lamp we are indirectly puffing deadly CO2 in the atmosphere. But it is not going to be like this all the time, the supply of petroleum and coal are limited and will come to an end one day. So we have to find the possible solution to get some technology which will supply energy in both clean and inexhaustible way. One such solution is Bio Diesel. Bio Diesel has dual advantage when it comes to combat with the current situation. The current situation demands a type of fuel which is inexhaustible at the same time clean. If we take a look at the source of the Biodiesel we can see that it is almost a renewable energy source. There are many plants which can produce the Bio Diesel e.g. Jatropha, Karanja, Palm Oil, Cocklebur, Sea Mango, simarouba etc. The recent work on the Bio Diesel as fuel goes around the extraction and blending it with ethanol or diesel in right proportion to make it an ideal fuel. There are many works that has

been done in this area. Our work mainly concerning in the area of testing the performance of the diesel engine when running with a Bio Diesel.

2. About Simarouba

Simarouba is a species of flowering tree that is native to Florida, South America, and the Lesser Antilles. Common names include paradise-tree, dysentery-bark, and bitter wood. Its seeds produce an edible oil. The tree is well suited for warm, humid, tropical regions. Its cultivation depends on rainfall distribution, water holding capacity of the soil and sub-soil moisture. It is suited for temperature range of 10 to 40 °C. It can grow at elevations from sea level to 1,000 m. It grows (12 to 15 m) tall and has a span of (7.6 to 9.1 m). It bears yellow flowers and oval elongated purple color fleshy fruit.

The wood is generally insect resistant and is used in the preparation of quality furniture, toys, matches, as pulp (in paper making). It can be also used for industrial purposes in the manufacture of biofuel, soaps, detergents, lubricants, varnishes, cosmetics, and pharmaceuticals. Medically, although certain facets of research claim Simarouba is effective for treating certain diseases, Simarouba has insufficient evidence of curing diarrhea, malaria, fever and stomach upset. Simarouba is known in India as Lakshmi Taru.

Fig. Simarouba plant and seeds

3. Experimental Setup

Figure: Engine Setup

3.1 Engine Specifications

Sr. No.	Parameter	Specification
1	Manufacturer	Comet
2	Engine	1 cylinder, 4 stroke, CI
3	Bore Diameter	80 mm
4	Stroke length	110 mm
5	Brake drum diameter	300 mm
6	Dimensions of fuel tank	210 x 150 mm
7	Dia. of orifice meter	15 mm
8	Sp. fuel consumption	230 kJ/kW.hr
9	Rated Speed	1500 RPM
10	Rated power	3.7 KW

3.2 Objectives of Project

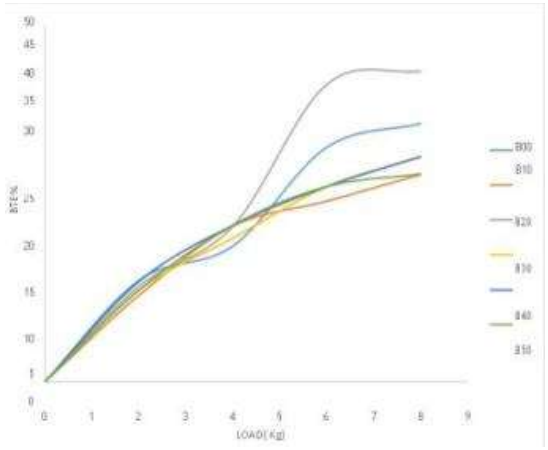
The main objective of this project was to study the use of Bio Diesel in CI engine experimentally. The purpose of the projectistoanalysetheeffectsondieselengineperformancewhen fuelled with the blends of biodiesel and diesel in various proportions on volume basis. The fuel blends to be investigated for performance analysis are 100% diesel (B00), blend of 10% biodiesel and 90% diesel (B10), blend of 20% biodiesel and 80% diesel (B20), blend of 30% biodiesel and 70% diesel (B30) blend of 40% biodiesel and 60% diesel (B40) and 50% biodiesel and 50% diesel (B50) and results are to be compared. The experimentation further extended to procure most desirable values for the relevant working parameters and their optimal combination based on the results. The performance parameters to be evaluated and compared are

- Brake specific fuel consumption.
- Brake thermal efficiency.
- Volumetric efficiency.
- Emission of CO, CO2, HC.

4. Results and Discussion

Performance characteristics of Simarouba seed biodiesel blends in diesel engine

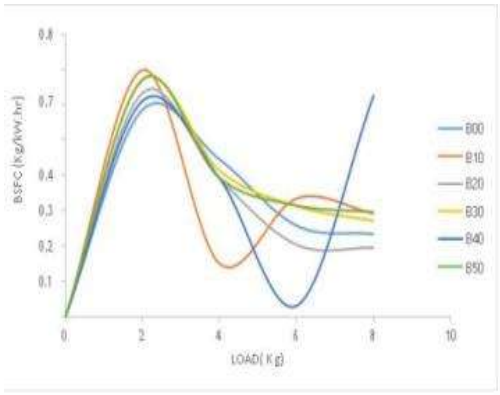
4.1 Brake Thermal Efficiency



Variation of brake thermal efficiency with load

The variation of brake thermal efficiency with load for diesel and blends of Simarouba seed biodiesel are shown in fig. As the load on the engine increases, brake thermal efficiency increases, because brake thermal efficiency is the function of brake power and brake power increases as the load on the engine increases. The maximum value of brake thermal efficiency for diesel is 36.21 %. The brake thermal efficiency of B20 blend is greater than that of diesel & other biodiesel blends, the brake thermal efficiency of B20 is 43.58% and it remains almost constant after the load of 6 kg. B30 & B40 have same brake thermal efficiency after applying load of 6 kg. At full load conditions, the brake thermal efficiency of B20 is more than all blends.

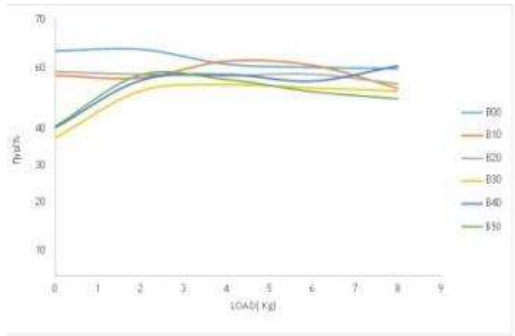
4.2 Brake Specific Fuel Consumption



Variation of brake specific fuel consumption with load

From the figure it is observed that from no load to 2kg load the BSFC of diesel and all the blends of biodiesel goes on increasing. Further increase in load beyond 2kg there is drop in value of BSFC. For B10 beyond 4kg load there is rise in the value of BSFC upto 6kg and again drop with further increase in load. For B40 we can see drop in the value of BSFC upto 6kg load & again it rises with further increase in load. B30 & B50 have almost same BSFC. The BSFC for B20 is less compare to other blends and diesel.

4.3 Volumetric Efficiency

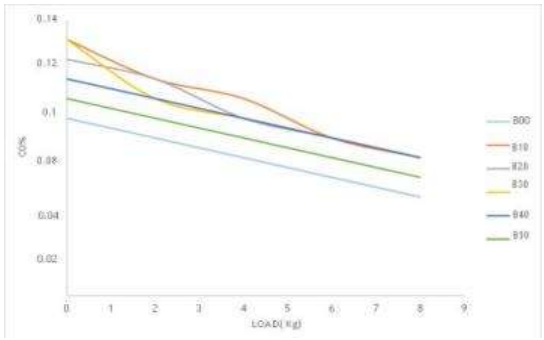


Variation of volumetric efficiency with load

The volumetric efficiency of diesel is maximum with the applied load as compared to other tested sample of Simarouba seed oil. The volumetric efficiency for B30, B40 & B50 increased from no load to 2kg load. On further increase of load the efficiency of B30 remains almost constant and that for further increase in load for B50 volumetric efficiency decreases. Blend B20 gives almost constant volumetric efficiency. B00 has higher volumetric efficiency compare to all Blends. B30 has low volumetric efficiency. Volumetric efficiency of B00 increases upto 2kg load & on further increase in load efficiency decreases.

4.4 Emission characteristics

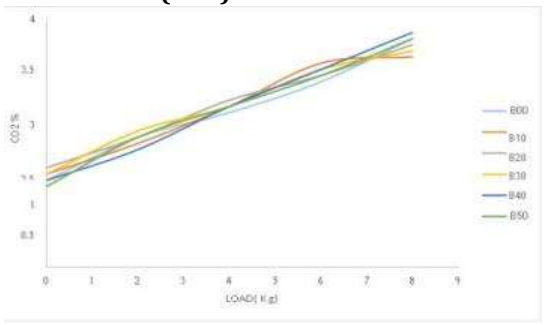
a. Carbon Monoxide (CO)



Variation of carbon monoxide with load

Fig. shows the variations of CO emission with respect to load on the engine. CO emission of all blends is higher than that of diesel. CO emission of biodiesel blends is in between 0.1 to 0.13 while on the other hand CO emission in diesel is in between 0.08 to 0.09. The CO emission of all the biodiesel blends and diesel decreases as the load increases. The blend B50 has lowest CO emission percentage compare to other biodiesel blends. The CO emission at full load for B10, B20, B30 & B40 is almost same.

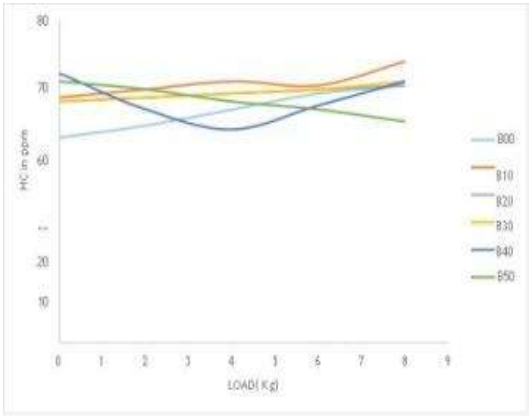
b. Carbon Dioxide (CO2)



Variation of carbon dioxide with load

The variation of carbon dioxide with load for diesel and blends of Simarouba seed biodiesel are shown in figure. CO_2 emission increases with increase in load for all blends & diesel. Blend B40 emits low CO_2 up to 4 kg load, further increase in load leads to increase CO_2 emission. The CO_2 emission of diesel lies in between B30 & B50 till 3.5kg load, further increase in load decreases the CO_2 emission for B00.

c. Hydrocarbons (HC)



Variation of hydrocarbons with load

Fig. shows the variation in the quantity of unburnt hydrocarbons with change in load. It is observed from the figure that for B50 biodiesel blends as the load increases the emission of HC decreases. While in case of B00 as load increased HC emission increased. B20 & B30 has moderate change in increase of HC. Unburnt hydrocarbon emission is the direct result of incomplete combustion. A reason for the reduction of HC emissions with biodiesel is the oxygen content in the biodiesel molecule, which leads to more complete and cleaner combustion.

5. Conclusion

Experimental investigations are carried out on a single cylinder diesel engine to examine the suitability of simarouba seed biodiesel as an alternative fuel. The performance, emission and combustion characteristics of blends are evaluated and compared with diesel and optimum blend is determined. From the above investigations, the following conclusions are drawn.

- The fuel properties of neat simarouba seed biodiesel and its blends, density, viscosity, flash point and fire point were found to be higher than that of diesel and calorific value is lower than that of diesel.

- A study of performance of the engine with the Simarouba seed biodiesel and its blends at higher temperature can be carried out. Higher temperature results in lower viscosity of the fuel; hence an improvement in the performance of the engine can be expected.

- HC emission of all blends is lower than that of diesel, HC emission of diesel and biodiesel blends at maximum load is in between 65ppm to 75ppm.

- The CO_2 emission of simarouba seed biodiesel for blend B40 is less up to 3.5 kg load in comparison with diesel, beyond 3.5 kg load CO_2 emission of diesel is low. Blends B20 & B50 emit very near about same emission compared to pure diesel (beyond 3.5kg).

- The engine performance characteristics with simarouba seed biodiesel blends such as, brake thermal efficiency of B20 is greater. Break specific fuel consumption is low than diesel on further increasing in load & B20 has almost constant volumetric efficiency.

The above comparative study clearly reveals the possibility of using simarouba seed biodiesel in a diesel engine. We observed that the simarouba seed blend B20 gives optimum performance and good emission characteristics than diesel. Thus, B20 is found to be an optimum blend.

6. Future Scope

Our current work mainly focuses on performance analysis of simarouba Biodiesel as fuel. Whereas there are many such oil which we can use as an alternative fuel sources. Research says there are thousands of species of plants available in nature from which we can extract the fuel, it just need to be find out. Adequate research must be done for choosing the right biofuel and the right proportion of its blend with diesel. Also one has to consider the economic point of view and the viability of the biofuel. Considerable amount of work must be done in determining the affect the biodiesel can cause in the world fuel market.

The future of Biodiesel is growing. More companies are offering this solution to the consumers. At this stage, only diesel powered automobiles can use the new fuel. This is expected to change in the upcoming years. Already there are several types of companies using Biodiesel as their main source of transportation. Test by the govt. have proven this type of fuel is overall more functional and safe than petroleum based products. As fossil beds run dry, everyday scientists come closer to new alternatives. Soon Biodiesel will become the new source of power.

Through the research and constant testing, Biodiesel is more productive than the petroleum based fuel. It has been discovered that this type of products will become the new source of power. Not only for diesel automobiles but for the other power sources individuals desperately require living and surviving. Before long, this type of supply will not only be used in vehicles but also in our homes and factories.

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