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Performance Evaluation and Emission Testing of Sea Mango 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, Sea Mango seed oil is converted into their respective methyl ester through transesterification process. Experiments are conducted using various blends of Biodiesel of sea mango 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 Sea Mango 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, B50, B90 and B100 are carried by varying load. Analysis showed that B50 blend give better results than other blends. From this study, it is concluded that optimized blend is B50 and could be used as a viable alternative fuel in single cylinder direct injection diesel engine without any modification.***

Keywords: Sea Mango, transesterification, biodiesel blends

1. Introduction

Renewable energy is energy obtained from sources that are essentially inexhaustible. Examples of renewable resources include wind power, solar power, geothermal energy, tidal power and hydroelectric power. The most important feature of renewable energy is that it can be harnessed without the release of harmful pollutants. Non-renewable energy is the conventional fossil fuels such as coal, oil and gas, which are likely to deplete with time.

We are living in twenty-first century and already running out of fuel, inflation in the market. Global warming is the biggest and the most devastating man made phenomenon the earth has ever experienced, and its consequences are far too dangerous than itself. The word itself says it's meaning which is rise of global temperature of earth, and it's now become a chain reaction. It all started when we live in the pre industrialized world. With the beginning of the eighteen 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 gas is carbon dioxide, water vapour, ozone, methane, nitrous oxide. The main sources of greenhouse gases are power plants, 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 be turn worst if the avg temp of the earth increased just by 4^0C. 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 relay 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, and then? 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 Bio Diesel 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, Soapnut, Sea Mango, 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 sea mango seed oil Bio Diesel.

2. About Sea Mango (Cerbera Manghas)

Figure: Sea Mango Fruit

Cerbera manghas (Sea mango) also sometimes called Cerbera odollam, is a tree belonging to the poisonous Apocynaceae family. Cerbera odollam grows well in coastal salt swamps and creeks in south India and along riverbanks in southern and central Vietnam, Cambodia, Sri Lanka, Myanmar, Madagascar and Malaysia. The Cerbera odollam tree grows to a height of 6–15 m and has dark green fleshy lanceolate leaves. The large white flowers have a delicate perfume, reminiscent of jasmine. The fruit, when still green, looks like a small mango, with a green fibrous shell enclosing an ovoid kernel measuring approximately 1.5 cm to 2 cm and consisting of two cross-matching white fleshy halves. On exposure to air, the white kernel turns violet, then dark gray, and ultimately brown or black. The oil content from Cerbera odollam seeds is 54%. The fatty acid composition of cerbera odollam oil is mainly oleic (48.1%), followed by palmitic (30.3%), linoleic (17.8%) and stearic (3.8%) .

The oil is extracted from seeds of sea mango & after transesterification biodiesel is produced, various blends are prepared and their properties are measured at IBDC Baramati. The values are given in the table below

Sr.	Test Description	Ref. Std. ASTM 6751	Reference		Diesel	Sea mango biodiesel blends			
			Unit	Limit	B00%	B10%	B50%	B80%	B100%
1	Density	D1448	gm/cc	0.800-0.900	0.830	0.836	0.848	0.866	0.876
2	Calorific value	D6751	MJ/Kg	34-45	42.50	42.25	41.20	39.60	38.50
3	Cetane no.	D613	-	41-55	49.00	49.39	49.65	49.81	50.70
4	Viscoisity	D445	mm2/sec	3--6	2.700	-	-	-	5.2
5	Moisture	D2709	%	0.05%	NA	NA	NA	NA	NA
6	Flash point	D93	^{o}C	-	64	-	-	-	153
7	Fire point	D93	^{o}C	-	71	-	-	-	168
8	Cloud point	D2500	^{o}C	-	-4	-	-	-	9
9	Pour pont	D2500	^{o}C		-9	-	-	-	3
10	Ash	D	%	-	0.05	-	-	-	0.05

3. Experimental Setup

3.1 Engine Specifications

Sr. No.	Parameter	Specification
1	Manufacturer	Comet Make
2	Engine	1 cylinder, 4 stroke, CI
3	Bore Diameter	80mm
4	Stroke Length	110mm
5	Brake drum diameter	300mm
6	Dimensions of fuel tank	210 x 150mm
7	Dia. Of orifice meter	15mm
8	Sp. Fuel consumption	0.23kg/kW.hr
9	Rated speed	1500RPM
10	Rated power	3.7KW

3.2 Objective of project

The main objective of this project was to study the use of Sea Mango (Sea Manghus) Bio Diesel in CI engine experimentally. Preparation of bio diesel blends were from non-edible oil using transesterification process. The use of sea mango oil biodiesel blended with mineral diesel as substitute for conventional mineral diesel.

The purpose of the project is to analyse the effects on diesel engine performance when fuelled with the blends of biodiesel and diesel in various proportions on volume basis. The fuel blends investigated for performance analysis are 100% diesel (B00), blend of 10% biodiesel and 90% diesel (B10), blend of 50% biodiesel and 50% diesel (B50), blend of 90% biodiesel and 10% diesel (B90) and 100% biodiesel (B100) 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 like

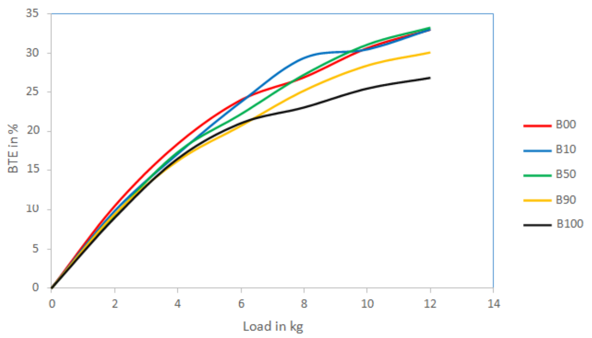
1. Brake thermal efficiency.
2. Brake specific fuel consumption.
3. Volumetric efficiency.
4. Emission of CO, CO2, HC.

Tests were carried out on single cylinder, four stroke diesel engine

4. Results and Discussion

After conducting trials various parameters are measured, performance characteristics are compared as given below

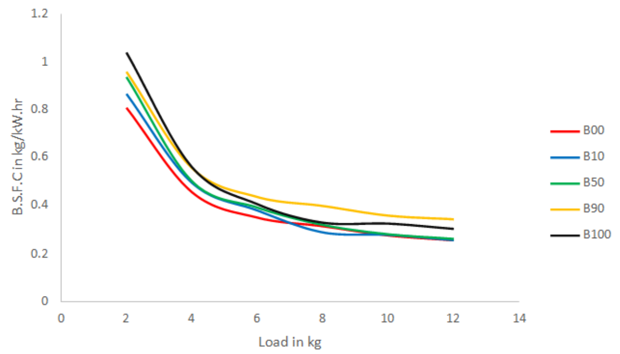
4.1 Brake Thermal Efficiency



Variation of brake thermal efficiency with load

The variation of brake thermal efficiency with brake power for diesel and blends of Sea Mango 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 biodiesel & pure diesel is 27 % and 32 %. Brake thermal efficiency of all the blends are lower than that of diesel, this is attributed to more amount of fuel consumption for blends as compared to diesel. At full load conditions, the brake thermal efficiency of diesel is more than all blends. Brake thermal efficiency of B50 blend is very close to diesel for entire range of operation.

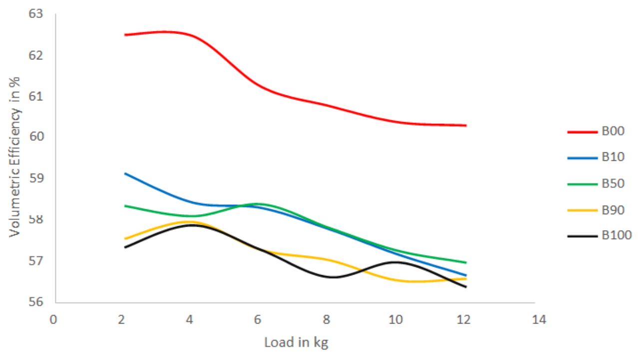
4.2 Brake Specific Fuel Consumption



Variation of brake specific fuel consumption with load

As power developed increases the specific fuel consumption decreases for all the tested fuels. The specific fuel consumption of sea mango seed biodiesel blends are higher than diesel because of lower calorific value and high density of biodiesel. From the graph it is clear that the specific fuel consumption is more for initial loads and further it is almost constant for remaining loads.

4.3 Volumetric Efficiency

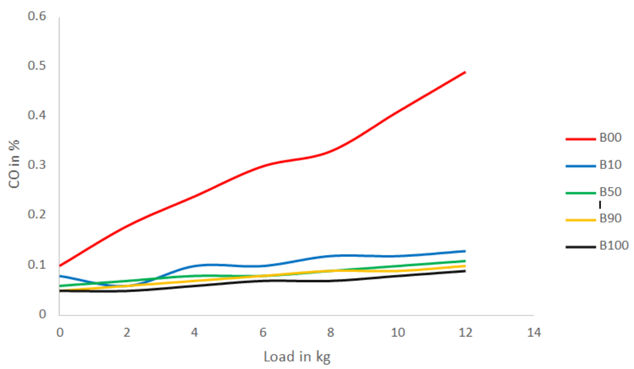


Variation of volumetric efficiency with load

The volumetric efficiency of tested fuel sample are maximum at the starting of load applied and then its start decreasing at the end. The volumetric efficiency of diesel is maximum with the applied load as compared to other tested sample of Sea Mango oil. Also blend wise as the percentage of Sea Mango increases in blends the volumetric efficiency decreases.

4.4 Emission characteristics

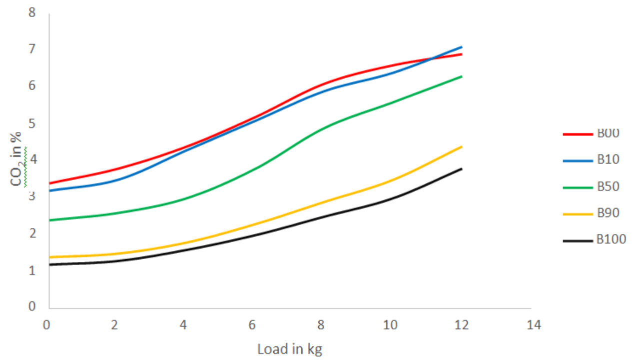
a) Carbon Monoxide (CO)



Variation of carbon monoxide with load

Fig. shows the variations of CO emission with respect to load on the engine. Biodiesel which contains more number of oxygen atoms leads to more complete combustion. CO emission of all blends is lower than that of diesel. CO emission of diesel and biodiesel blends is in between 0.05 to 0.15 while on the other hand CO emission in diesel is in between 0.1 to 0.5 which leads to higher emission of CO. Pure biodiesel means B100 has lowest CO emission %.

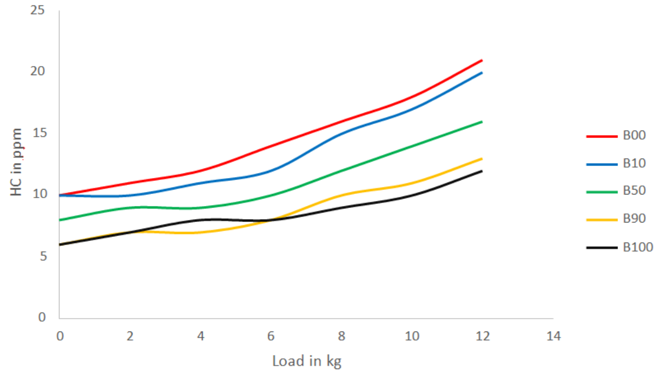
b) Carbon Dioxide (CO2)



Variation of carbon dioxide with load

The variation of carbon dioxide with load for diesel and blends of sea mango seed biodiesel are shown in figure. CO2 emission increased with increase in load for all blends. The lower percentage of blends emits less amount of CO2 in comparison with diesel. Blends B100 emit very low emission, this is due to the fact that biodiesel in general is a low carbon fuel and has a lower elemental carbon to hydrogen ratio than diesel fuel. In general biodiesels themselves are considered carbon neutral because, all the CO2 released during combustion had been sequestered from the atmosphere for the growth of the vegetable oil crops.

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 B100 biodiesel blends the emission of HC is less than that of the diesel. 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 sea mango 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 sea mango 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.
- CO emission of all blends is lower than that of diesel, CO emission of diesel and biodiesel blends at maximum load is in between 0.05 to 0.15 %
- The CO2 emission of sea mango seed biodiesel is less in comparison with diesel. Blends B10 emit very near about emission compared to pure diesel. Other biodiesel emits less carbon dioxide.
- The engine performance characteristics with sea mango seed biodiesel blends such as, brake thermal efficiency is lower than diesel while B10 and B50 blends has slightly equal efficiency with diesel sample. Break specific fuel consumption is slightly equal or higher than diesel.

The above comparative study clearly reveals the possibility of using sea mango seed biodiesel in a diesel engine. We observed that the sea mango seed blend B50 gives optimum performance and emission characteristics. Thus, B50 is found to be an optimum blend.

6. Future Scope

Our current work mainly focuses on performance analysis of Sea Mango Biodiesel as fuel. Whereas there are many such oil source which we can use 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 needs to find out. Adequate research must be done on the choosing the right biofuel and the right proportion of its blend with diesel. Also one has to consider the economic point of view and thus viability of the biofuel. Considerable amount of work must be done in determining the affect the biodiesel can cause in the world fuel market.

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