Result Analysis of Diesel-Engine operating with renewable source of energy which is Biodiesel blended with Diesel.

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Abstract

We are facing serious threat of environmental degradation because of emissions from fossil fuels like diesel. There is a strong environmental awareness now to keep harmful emission within safe limits. Renewable sources of energy present a promising alternative to substitute diesel fuels. Bio-diesel is one of such candidate for the exploitation as an alternative to diesel fuel.

There is a good scope of utilizing bio-diesel developed through the methyl alcohol and jatropha oil as an alternative diesel fuel. The neat jatropha oil has a very high viscosity therefore it cannot be used in internal combustion engine. Viscosity of oil is reduced by reacting oil with alcohol. We have analyzed the output of bio-diesel and its blends with diesel oil and found that B20 has the similar properties of that of the diesel. Compared to diesel oil its thermal efficiency is slightly lower but results in significant improvement in other properties. Hence this is a very good alternative of diesel fuels. It reduces the dependence on conventional fuels and also decreases significantly the pollution of environment.

1.0 Introduction

For various purposes Energy consumption is increasing globally in various forms. The consumption intensity is directly proportional to the development of the society. Today, more and more developing countries are prospering through economic reforms and are becoming industrially advanced. For any country, fuel is critical to any strategic plan for national security and economic development. In developing countries like India, the fuel has assumed serious economic considerations in the forms of budget deficits caused by oil imports and ecological degradation caused by pollution.

With the exception of nuclear energy and hydro electricity, the majority of the world's energy needs are supplied through petrochemical sources, coal and natural. All of these sources are finite and exhaustible. The depletion of world petroleum reserves and increased environmental concerns has stimulated recent interest in alternative sources of petroleum based fuel. Bio-diesel has arisen as a potential candidate for a diesel substitute due to the similarities it has with petroleum based diesel.

The possibility of substituting cleaner burning alternatives as bio-diesel derived from vegetable oils [1] for gasoline and diesel has drawn the attention of the automobile industry over the past decade. Fuels today have opened an interesting debate about the relative merits of conventional and non conventional fuels. Conventional fuels have many advantages. The intrinsic energy content in gasoline and diesel is more per gallon than in other fuel. Most importantly, India's transportation infrastructure has been designed and optimized for petroleum fuels. Their drawbacks however, include emissions of reactive hydrocarbon (HC), Carbon Monoxide (CO) and Nitric Oxides (Nox), which contribute significantly to the air pollution that plagues all the large Indian cities. Carbon dioxide (CO2) emissions add to the atmosphere build up of greenhouse gases and increase the potential for global

warming. Renewable fuel sources hold the potential for many benefits for the environment and local economic development. Environmental benefits can include lower tail pipe emissions from vehicles and a reduction of green house gases based on the overall Carbon dioxide balance. Economically, renewable fuels offer the possibility to reduce dependence on foreign crude sources and imported fuel, while boosting local agricultural industry.
Different vegetable oils both edible and non-edible such as soyabean oil, sunflower oil [2], palm oil [3], mahua oil [4], karanja oil [5], jatropha oil [6] have been considered as alternative fuels for diesel engine. Transesterification is the commonly used commercial process to produce clean and environmental friendly bio-diesel fuel [7].

As far as India is concerned, usage of non edible oils for the production of bio-diesel is found to be best suited given the deficit supply of edible oils and their cost of production. Among the non edible oils, Tree Borne Oil Seeds (TBOS) like jatropha, pungam, mahua etc. gained importance. Among them jatropha curcas, an excellent shrub having natural spread across the globe, is one of the promising biofuel crop ideally suitable for growing in the waste lands of our country. Extensive plantation of jatropha converts unproductive lands into green oil fields. Jatropha has long productive life of around 40 years and yields the bio-diesel source, the seed from third year onwards.

2.0 Experiments and Methodology

2.1 The method of **Production of Jatropha Oil Methyl Ester (JOME)**

Trans esterification reaction was performed on raw jatropha oil to prepare jatropha oil methyl ester. It is a chemical process of transforming large, branched triglyceride molecules of vegetable oils and fats into smaller, straight chain molecules almost similar in size to the molecules of the species present in diesel fuel. The reaction between raw jatropha oil and methyl alcohol takes place in presence of NaOH as catalyst. Bio-diesel from jatropha was produced in the laboratory scale set up which consists of heating mantle, reaction flask and mechanical stirrer.

- **Mixing of alcohol and catalyst.**

  The catalyst is typically sodium hydroxide (caustic soda). It is dissolved in the alcohol using a standard agitator or mixer.

- **Reaction**

  The alcohol / catalyst mix was then charged into a closed reaction vessel and the oil or fat is added. The system from here on was totally closed to the atmosphere to prevent the loss of alcohol. The reaction mix was kept just above the boiling point of the alcohol (around 160^{o}F) to speed up the reaction. Reaction time varied from 1 to 8 hours. Excess alcohol was normally used to ensure total conversion of the fatty oil to esters. The contents were allowed to settle in the vessel. After settling the lower layer of glycerol was separated. The liquid remaining in the vessel was impure methyl ester which was washed with clean warm water to remove the impurities. Finally, the methyl esters were heated upto 105^{o}C to remove moisture present in it.

2.2 Experimentations

The important properties of jatropha oil were determined and compared with diesel. The effect of blending (with diesel) was studied. After that, performance test was carried out on a single cylinder, 4 stroke water cooled, direct injection, stationary C I engine. It is mounted on a rigid base frame and a rope dynamometer is connected to it. The technical significations of test engine are cited in Table 1. Constant speed engine performance tests were carried out on this engine with diesel and different fuel blends.

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Table 1

Technical Specifications of the engine

Engine type	TV1
Type	Water cooled, 4 stroke stationary engine
No. of cylinders	1
Combustion	Direct Injection
Length of stroke	25cm
Cylinder diameter	18cm
Constant speed	1500rpm
Rated power	5KW

2.3 Test Fuel Characterisation

In present investigation, jatropha oil was used. Pure diesel was used as a reference fuel. The blends of 20% jatropha oil & 80% diesel was prepared on volume basis. Also the blends of 50% jatropha oil and 50% diesel was prepared on volume basis. The important properties of test fuels, which were found experimentally, are shown in Table 2.

Table 2

Diesel properties and Bio-diesel properties from Jatropha and their blends

Types of Oil	Kinematic viscosity (cst)	Density Kg/m^3	Heating value MJ/kg
Neat Diesel	2.8	840	43.89
100% JOME	4.12	871	42.64
50% JOME	3.48	859	43.25
20% JOME	3.08	853	43.82

Jatropha oils have a higher flash point than diesel, and this is a very safe factor in the transportation and storage. High flash point also attributes to its lower volatility characteristics. Jatropha oils have inferior calorific values than diesel. This is due to presence of oxygen in their molecules [8]

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3.0 Results and discussion

Jatropha oil methyl ester (JOME) and its blends were used separately as the fuel for compression ignition engine without any engine modifications. The performance and emissions of the engine with diesel, blends of bio-diesel and diesel and neat bio-diesel are presented and discussed below.

3.1 Performance Analysis

3.1.1 Brake Thermal Efficiency (BTE)

Fig 1 shows the brake thermal efficiency of JOME and its blends. BTE of JOME and its blends is lower as compared to that of diesel at rated load. The BTE of blends of JOME lie between those of diesel and JOME at all loads. Since the engine is operated under constant injection advance and JOME has a smaller ignition delay combustion is initiated much before TDC is reached. This increases compression work and heat loss and thus reduces Brake thermal efficiency of the engine.

3.1.2 Brake Specific Fuel Consumption (BSFC)

Fig 2 shows the BSFC of JOME, various blends of JOME diesel and diesel. The specific fuel consumption for JOME and its blends is slightly higher than that of diesel. We attribute this to the lower calorific value of JOME than that of conventional diesel.

3.2 Emission Analysis

3.2.1 Nitrogen Oxides emission (NOx)

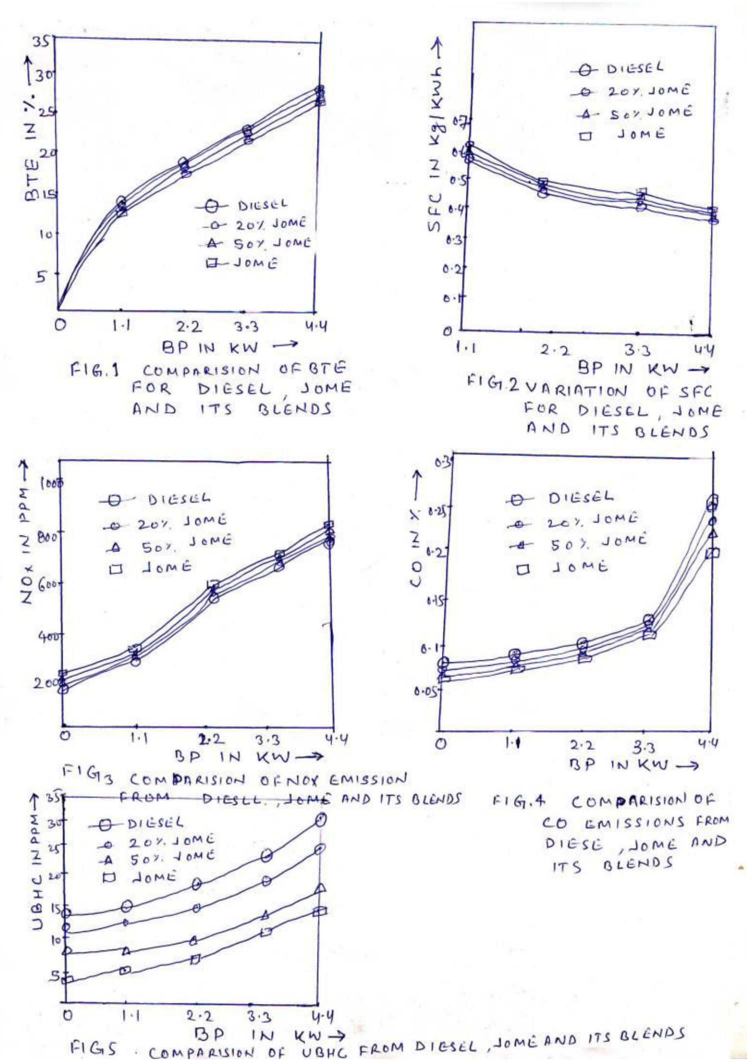
Fig 3 shows that with increase in percentage of JOME in the fuel there is increase in the emission of nitrogen oxides NOx. The NOx increase for JOME may be attributed to the oxygen content of the JOME since the oxygen present in the fuel may provide additional oxygen for NOx formation. Another reason for the increase in Nox could be the possibility of higher combustion temperatures arising from improved combustion. So it is highly possible that higher peak cycle temperatures are reached for JOME and its blends compared to diesel. However, NOx can be controlled by adopting Exhaust gas recirculation and by employing suitable catalytic converters.

3.2.2 Carbon monoxide emission (CO)

Fig 4 shows that with the addition of JOME to diesel, carbon monoxide emissions are greatly reduced. It decreases with increase in % of JOME in the blend. Carbon monoxide is predominantly formed because of the lack of oxygen. Since JOME is an oxygenated fuel, it produces better combustion of fuel and this results in the decrease in CO emission. Reduction of CO is a strong advantage in favor of JOME.

3.2.3 The emission of Un-burnt hydrocarbons (UBHC)

It is compared the unburnt hydrocarbon emissions with JOME and its blends with respect to diesel in fig 5. Over the entire range of loads for JOME and its blends UBHC emissions are reduced. It decreases with increase in % of JOME in the blend. Due to JOME is an oxygenated fuel, it promotes combustion and results in reduction in UBHC emissions.



4.0 Conclusions

The properties of bio-diesel and their blends with respect to diesel are compared. Testing done on the set up using a direct injection compression ignition engine to investigate the performance and emissions of fuel derived from jatropha oil. The following conclusions are derived from the present study.

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1. The specific fuel consumption is increased due to lower heating value of JOME. The brake thermal efficiency decreases with increase in percentage of JOME in the fuel.
2. with increase in percentage of JOME in the blend. emissions of CO and UBHC decreases Due to higher oxygen content in the JOME.
3. , The large oxygen content in the JOME produces better combustion and increases the temperature of combustion chamber. This increases nitrogen oxides emission of JOME with respect to diesel.
4. The delay in ignition of JOME and its blends is found to be lesser with respect to that of diesel.
5. Viscosity of JOME was found to be higher than that of diesel. After heating the viscosity is reduced.
6. The present study shows that the blend containing 20% JOME is the optimum blend. It can be successfully substituted for diesel for short term operation in an unmodified C I engine.

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