Evaluation of Performance and Exhaust Emission of a Diesel Engine When Fueled With Blends of Mixture of Waste Coconut Oil and Sesame Oil with Diesel

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Abstract– *Biodiesel is an alternative to conventional diesel fuel made from renewable resources, such as vegetable oils. The oil from waste coconut oil& sesame oil can be converted to a fuel commonly referred to as "Biodiesel." No engine modifications are required to use biodiesel in place of petroleum-based diesel. Biodiesel can be mixed with petroleum-based diesel in any proportion. This interest is based on a number of properties of biodiesel including the fact that it is produced from a renewable domestic source, its biodegradability, and its potential to reduce exhaust emissions. The climate change is presently an important element of energy use and development. Biodiesel is considered "climate neutral" because all of the carbon dioxide released during consumption had been sequestered out of the atmosphere during crop growth. The use of biodiesel resulted in lower emissions of unburned hydrocarbons, carbon monoxide, and particulate matter. Biodiesel also increased catalytic converter efficiency in reducing particulate emissions. Chemical characterization also revealed lower levels of some toxic and reactive hydrocarbon species when biodiesel fuels were used. The fuel consumption in the world particularly in developing countries has been growing at alarming rate. Petroleum prices approaching record highs and they will deplete within few decades, it is clear that more can be done to utilize domestic oils while enhancing energy security. The economic benefits include support to the agriculture sector, tremendous employment opportunities in plantation and processing waste coconut oil and sesame oil are known just crude plants which grow on eroded soils and require a hot climate and hardly any water to survive. These are the strong reasons, enforcing the development of biodiesel plants.*

In this paper it will be a combination of two oils sesame oil and waste coconut oil. Since waste coconut oil solidifies at atmospheric temperature it has been used with sesame oil. A mixture of sesame oil and waste coconut oil and diesel will form the blend. Performance test emission test and combustion test are performed .results are comparable with diesel

I. INTRODUCTION

Biodiesel, an alternative diesel fuel, is made from renewable biological sources such as vegetable oils and animal fats. It is biodegradable and nontoxic, has low emission profiles and so is environmentally beneficial.

One hundred years ago, Rudolf Diesel tested vegetable oil as fuel for his engine (Shay, 1993). With the advent of cheap petroleum, appropriate crude oil fractions were refined to serve as fuel and diesel fuels and diesel engines evolved together. In the 1930s and 1940s vegetable oils were used as diesel fuels from time to time, but usually only in emergency situations. Recently, because of increase in crude oil prices, limited resources of fossil oil and environmental concerns there has been a renewed focus on vegetable oils and animal fats to make biodiesel fuels. Continued and increasing use of petroleum will intensify local air pollution and magnify the global warming problems caused by CO_2. In a particular case, such as the emission of pollutants in the closed environments of underground mines, biodiesel fuel has the potential to reduce the level of pollutants and the level of potential or probable carcinogens (Krawczyk, 1996).

Biodiesel is environmentally friendly liquid fuel similar to petrol-diesel in combustion properties.

Increasing environmental concern, diminishing petroleum reserves and agriculture based economy of our country are the driving forces to promote biodiesel as an alternate fuel.

The ever rising cost of fossil fuel internationally has forced major world economies, which are also major importers of fossil fuel, to examine renewable and cheaper alternatives to fossil fuel to meet their energy demands. Biodiesel and bioethanol have emerged as the most suitable renewable alternatives to fossil fuel as their quality constituents match diesel and petrol respectively. In addition they are less polluting than their fossil fuel counterparts. Environmental concerns and the desire to be less dependent on imported fossil fuel have intensified worldwide efforts for production of biodiesel from vegetable oils and ethanol from starch and sugar producing crops.

The use of vegetable oil for energy purposes is not new. It has been used world over as a source of energy for lighting and heating since time immemorial. As early as in 1900, a diesel-cycle engine was demonstrated to run wholly on groundnut oil at the Paris exposition. Even the technology of conversion of vegetable oil into biodiesel is not new and is well established. However the unprecedented rise in fuel prices recently has made it economically attractive. The present availability of vegetable oils in the world is more than enough to meet the edible oil requirements, and surplus quantity available can partially meet requirements of biodiesel production. However, there is a considerable potential to further enhance the oilseeds production in the world to meet the increasing demand for food and biodiesel.

India is a huge importer of crude oil and spends about Rs. 1,200 billion of foreign exchange every year to meet 75% of its oil needs (Anand, 2006). This has affected its balance of payment adversely, especially after the unprecedented rise in crude oil prices. Being an agricultural country endowed with varied climates, nutrient-rich soil and ability to grow many different crops, India offers a great promise as a producer of surplus raw material for biodiesel and bioethanol production. Though presently it meets around 30- 40% of its vegetable oil requirements through imports, India has a potential and capability to produce enough vegetable oil not only to meet its edible oil requirements but also for biodiesel

II BIODIESEL

Biodiesel is an alternative fuel formulated exclusively for diesel engines. It is made from vegetable oil or animal fats or it is the name for a variety of ester based fuels generally defined as the mono alkyl esters made from vegetable oils through simple Transesterification process.

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III BIODIESEL PRODUCTION

The alternative fuels must be technically and environmentally acceptable, and economically competitive. From the view point of these requirements, triglycerides (vegetable oils) and their derivatives may be considered as viable alternatives for diesel fuels. The problems with substituting triglycerides for diesel fuels are mostly associated with their high viscosities, low volatilities and polyunsaturated character. The problems have been mitigated by developing vegetables oil derivatives that approximate the properties and performance and make them compatible with the hydrocarbons based diesel fuels through:

- Pyrolysis
- Micro emulsification
- Dilution
- Transesterification

Pyrolysis

Pyrolysis refers to a chemical change caused by the application of thermal energy in the absence of air or nitrogen. The liquid fractions of the thermally decomposed vegetable oil are likely to approach diesel fuels. The pyrolyzate had lower viscosity, flash point, and pour point than diesel fuel and equivalent calorific values. The cetane number of the pyrolyzate was lower. The pyrolysed vegetable oils contain acceptable amounts of sulphur, water and sediment and give acceptable copper corrosion values but unacceptable ash, carbon residue and pour point.

Micro emulsification

The formation of micro emulsions is one of the potential solutions for solving the problem of vegetable oil viscosity. Micro emulsions are defined as transparent, thermodynamically stable colloidal dispersions. The droplet diameters in micro-emulsions range from 100 to 1000 Å. A micro-emulsion can be made of vegetable oils with an ester and dispersant (co-solvent), or of vegetable oils, an alcohol and a surfactant and a cetane improver, with or without diesel fuels. Water (from aqueous ethanol) may also be present in order to use lower-proof ethanol, thus increasing water tolerance of the micro-emulsions.

Dilution

Dilution of vegetable oils can be accomplished with such materials as diesel fuels, solvent or ethanol.

Transesterification

Transesterification also called alcoholysis is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. This process has been widely used to reduce the viscosity of triglycerides.

RCOOR‟ + R” → RCOOR” + R‟OH

If methanol is used in the above reaction, it is termed methanolsis.But from all the above technique the transesterification is successful technique in bringing the viscosity of oil close to conventional diesel. Generally, acid catalyst like sulphuric acid is employed. Esterification is a reversible reaction. Thus water produced must be removed to drive the reaction to the right to obtain a higher ester yield.

Transesterification is the process of using an alcohol (eg- Methanol) in the presence of catalysts such as sodium hydroxide or potassium hydroxide to chemically break the molecules of raw waste coconut oil and sesame oil into methyl esters with Glycerol as a Byproduct. The excess methanol is recovered by distillation and sent to a rectifying column for purification and recycled.

The transesterification works well when the starting oil is of high quality. However, quiteoften low quality oils are used as raw materials for bio-diesel preparation. In cases where the free fatty acid content of the oil is above 1%, difficulties arise due to the formation of soap which promotes emulsification during the water washing stage and at an FFA content above 2% the process becomes unworkable.

IV MATERIALS AND METHODOLOGY

Here in this chapter starting from the raw material used for biodiesel production along with its method each step for biodiesel production is explained. Various properties of the prepared biodiesel are also discussed. Along with this it also describes the experimental methodology adopted to evaluate the performance and exhaust emission characteristics of a a diesel engine using different blends.

Materials

Following materials were used:

- Waste coconut oil and sesame oil
- Methanol (Methyl alcohol)
- Potassium hydroxide (KOH) as base catalyst

Methodology

- The sesame oil and waste coconut oil is purchased from the shop in mahalakshmi layout Bangalore for the transesterification.
- The synthesis of the biodiesel is carried out at mahatma Gandhi rural science, Bangalore. The infrastructure and lab facility required for the biodiesel production is available within the Research centre.
- Experiment was conducted on the computerized diesel engine by varying the engine load. CO, NOx, CO2 and HC emissions will be tested by AVL 444 emission analyser.
- The engine performance parameters and the emission parameters are recorded for all the combinations and compared

Preparation of Biodiesel

Initially 1 liter of sesame oil and coconut oil is heated to 100°C in order to remove the moisture content that is present in the oil.A solution of 250 ml methanol + 1.5ml of sulphuric acid is poured in the flask containing the oil and heated at a constant temperature of 65°C for about 1 hour. It is allowed to settle for at least 8 hrs.The acid waste settles down which is removed.

Based on the fat content present, suitable amount of sodium hydroxide flakes is dissolved in methanol and poured in the flask containing the oil and heated for about 1 hour. It is allowed to settle for at least 8 hours. The setup is not to be disturbed during settling. Glycerol starts to settle down and form an increasing layer at the bottom of the flask. This is referred to as separation. The top layer is the biodiesel. After transesterification the upper layer may contain traces of NaOH, methanol, and glycerol. Since the remaining unreacted methanol in the biodiesel has safety risks and can corrode engine components, the residual catalysts (NaOH) can damage engine components and glycerol in the biodiesel can reduce fuel lubricity and cause injector coking and other deposits. These being water soluble is removed by washing.

Water washing and heating

The glycerol formed is removed and distilled water is added to the apparatus and this water settles at the bottom carrying all the impurities. Water with impurities is then removed and this process is repeated for 3 to 4 times ensuring pure biodiesel. It is then heated to 110 °C to remove water content which was present during washing. The product obtained after heating is the biodiesel. Fig 1 shows the Biodiesel reactor.

Fig 1 Biodiesel reactor

V Blending

Blending is the process of mixing the biodiesel and diesel in a proper ratio. This blending can be ordinarily done with the help of a flask and volume measures. The exact proportion of oil and the diesel are separately mixed in a flask and followed by constant stirring this stirring ensures proper mixing of biodiesel and the diesel. Various blends obtained are as shown in fig 2.

Fig 2 Blends of sesame oil and waste coconut oil

Characterization of Fuels

In this section the fuel characterization includes the study of fuel properties such as density, viscosity, flash point, calorific value etc. and the tests such as fuel consumption test (Flame test) and oil bath test to know the behavior of different fuels and fuel blends. The details of experimental observations are discussed below table 1

Table 1 Properties of Pure sesame oil

Specific gravity	0.85
Flash point (°C)	273
Fire point (°C)	280
Free fatty acid	5.95 %
Acid number	11.3

Table 2 Properties of diesel and biodiesel blends

Fuel	**Specific gravity**	**Kinematic viscosity at 40°C (Cst)**	**Flash point (°C)**	**Fire point (°C)**	**Calorific value (KJ/Kg)**
Diesel	0.82	5.0 x 10-6	48	50	42933
B10	0.83	5.4 x 10-6	53	55	42016
B20	0.84	5.5 x 10-6	55	57	41249
B30	0.85	5.6 x 10-6	58	62	40386
B40	0.86	5.7 x 10-6	62	66	39522
B50	0.87	5.8x 10-6	63	68	38933

VI Engine Test Studies with Blends of Biodiesel and Ethanol

- As the brake power increased the brake specific fuel consumption decreased in all the blends.
- The brake specific fuel consumption of the B30 ess when compared to diesel.

Following fig 3 shows Graph of BP v/s BSFC

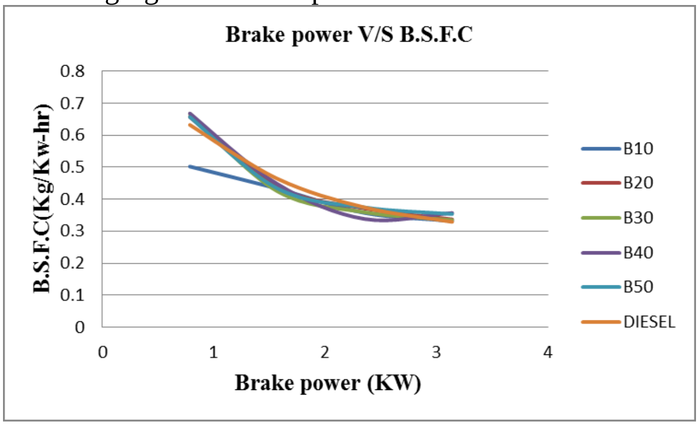

Fig 3 Graph of BP v/s BSFC

- As the brake power increased the brake Exhaust gas temperature increases in all the blends.
- Diesel has the highest exhaust gas temperature when compare to biodiesel blends.

Following Fig 4 shows Graph of BP v/s EGT

BP V/S EGT

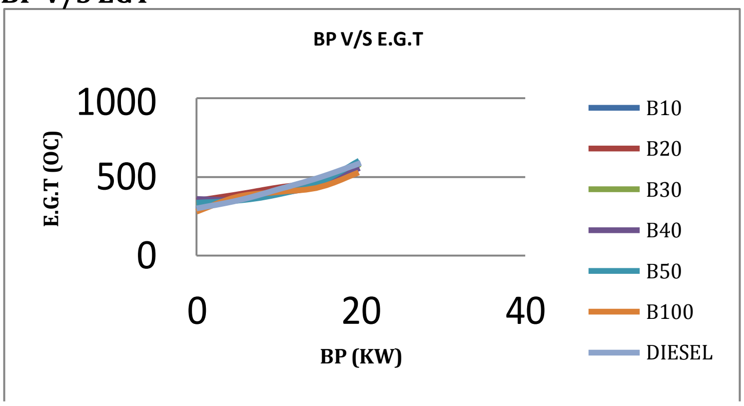

Fig 4 Graph of BP v/s EGT

- As the brake power increased the brake specific fuel consumption decreased in all the blends.
- The brake specific fuel consumption of the B30 blend is much less when compared to diesel

LOAD V/S CO

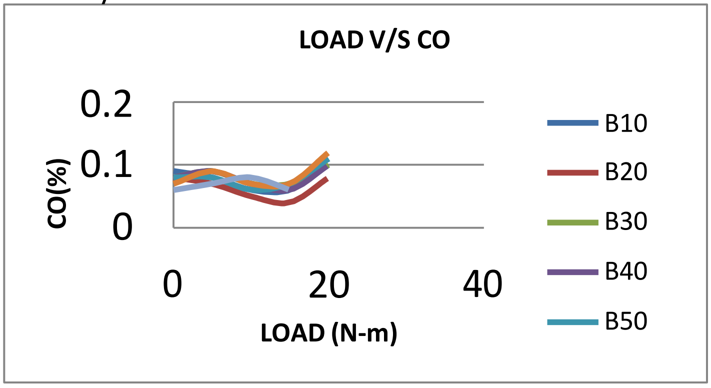

Fig 5 Graph of Load v/s Co

- The CO emission for blends is more than the diesel

LOAD V/S HC

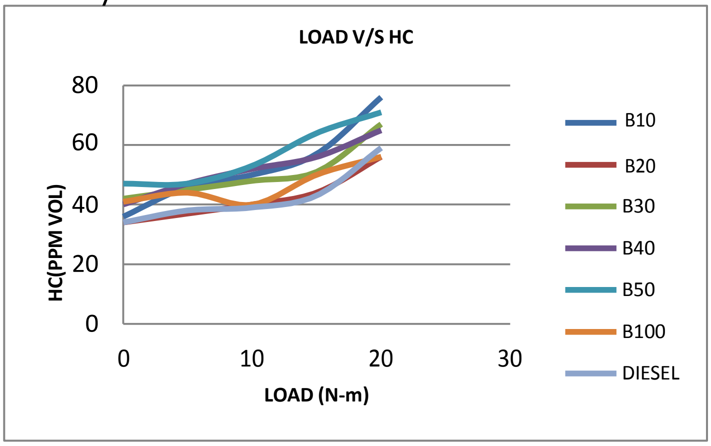

Fig 6 Graph of load v/s HC

- The hydrocarbon emission increases with the increased in brake power. The emission of hydrocarbon in diesel is less than the blends.
- The presence of oxygen in the sesame oil and waste coconut oil May be reason for reduction in HC emission

LOAD V/S CO2

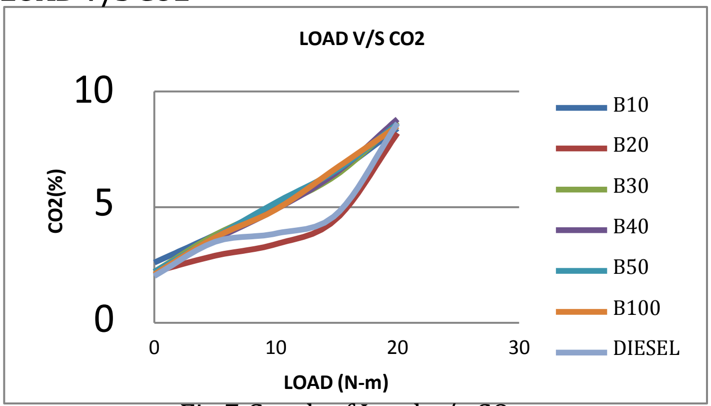

Fig 7 Graph of Load v/s CO_2

- The rising trends of CO_2 emission with loads is due to the higher fuel entry as the load increases.
- CO_2 emission decreases for all the blends compared to diesel in all loads
- At the higher loads the effects of viscosity have increased CO_2 emission for blends.

LOAD V/S O2

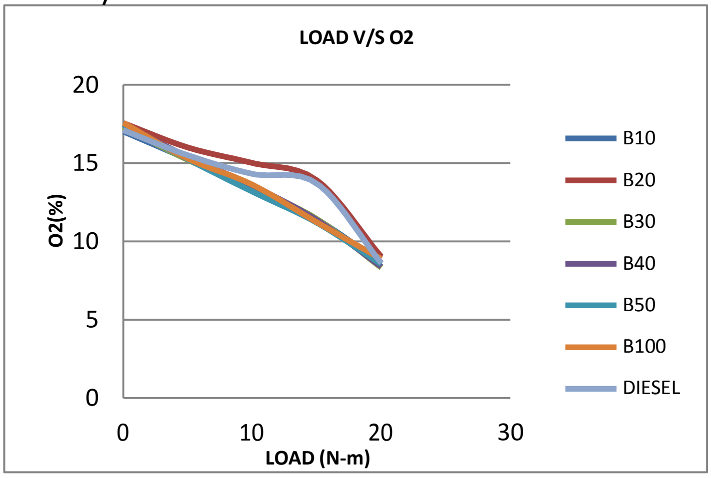

Fig 8 Graph of load v/s O_2

- The unused oxygen emissions reduced with load for all the fuel modes.
- The oxygen emissions increased slightly with increase in ethanol addition in biodiesel and there is no significant variation in percentage of oxygen for all fuel samples.

VII CONCLUSION

The overall studies based on the production, fuel characterization, engine performance and exhaust emission of sesame oil and waste coconut oil biodiesel and its Ethanol and Methanol blends BE10, BE20, B30, B40, and B50 were successfully carried out in this work. Based on this work, the following points were concluded

- The biodiesel can be produced from sesame oil and waste coconut oil by a two-step transesterification. The biodiesel yield from this method is 91%.
- The properties of the crude oil were analyzed. Determines the optimum condition for the base catalyst transesterification .
- The optimal condition for the transesterification catalyst base was 0.86 wt % NaOH to the oil as a catalyst, methanol / oil molar ratio of 6:1 and the maximum conversion was 98.57 % oil to 90 minutes.

- A significant reduction in viscosity and acid number of biodiesel was found. The property such as density, viscosity, flash point, and calorific value is comparable to the standard value of biodiesel and petroleum diesel.
- The higher volatile renewable substances such as methanol and ethanol can be blended with biodiesel, to improve the engine performance. The blends can be used in an existing diesel engine without any modification of the engine, for better performance and lower emissions. With the current diesel fuel price rise, this would be definitely economical.
- From the overall study of performance as well as emission characteristics of diesel, biodiesel and biodiesel-alcohol(ethanol and methanol) blends, we can conclude that the addition of lower percentage of ethanol and methanol in sesame oil and waste coconut oil biodiesel as in B20 is appreciable and can be successfully used as alternative to the fossil diesel.

VIII SCOPE FOR FUTURE WORK

- The future work would be to carry out science-based assessment in order to provide a comprehensive, systematic, and comparative analysis of the environmental benefits and costs of bio fuel technologies.
- A study of performance of the engine with the methyl ester of sesame oil and waste coconut oil 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.
- The performance and emission of the engine with variation of compression ratio of the engine can be studied.
- Various other biodiesels can be used as additives for alcohol blends to study the performance and emission characteristics.
- This project was carried out in a single cylinder engine for which satisfactory results were obtained. Results with multi-cylinder engine fuelled by conditioned oils can be carried out and compared with that of single cylinder engine performance and emissions.

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