

# Performance Enhancement of Four Stroke C.I. Engine Operated on Sterculiafoetida Oil

K.Sasikumar<sup>1</sup>, T.Senthilkumar<sup>2</sup>PG Student, Dept. of Thermal Engineering, University College of Engineering, BIT Campus, Tiruchy, India<sup>1</sup>.Dean, University College of Engineering, BIT Campus, Tiruchy, India<sup>2</sup>.

**ABSTRACT:** Power generation from non-conventional sources like solar energy especially in India depends on the factors like the availability of the resources, public confidence and affordable price to the common man for lighting purpose. Bio-diesel from sources like sterculiafoetida belongs to the class of non – conventional energy source, which are available even in rural areas. A simple ram is sufficient to crush sterculiafoetida seeds to derive oil from them. Cultivation and harvesting of seeds from sterculiafoetida, Jatropha and pongamiapinnata can generate employment and income for the rural masses depending on agriculture. The oil is expected to satisfy emission norms of the standard of EURO-III. Besides if the oil is transesterified, the remains in the form of soap can be used for production of soap. Thus the revenue generated per kg of the sterculiafoetida seeds will be increased even further. Though it might involve a large scale campaign by the government to encourage the avocation of sterculiafoetida cultivation, once its importance has been understood by the public of the agriculture sector it will have numerous takers. Here is a solution to the long standing problem of India waiting for proper utilization and it does seem that it is finding takers at least in the form of big companies like Daimler Chrysler, The Indian Oil Corporation and CSIR. In the present work mentioned properties of sterculiafoetida oil and its performance, combustion and emission analysis in compression ignition engine. Normally biofuel has high viscous for which transesterification process consider for biodiesel production. This property causes a problem in the flow and mixing with the petroleum diesel while using it as blend.

**KEYWORDS:** Bio-Diesel, Performance of IC Engine And Engine Analysis.

## I.INTRODUCTION

[1] A.S. Silitonga et al (2013) This paper introduces new non-edible oil extracted from S. foetida oil to be used as a biodiesel feedstock. The summary of the experimental results are described as follows: (a) The biodiesel production from crude S. foetida oil is via two stage acid (H<sub>2</sub>SO<sub>4</sub>) catalyst esterification and alkaline (NaOH) catalyst transesterification. The conversion yield of S. foetida biodiesel was obtained up to 93.55%. (b) The optimum condition was 12:1 methanol to oil ratio of with 1 wt.% alkali catalyst at 55°C for 2.5 h. The fuel properties of SFME fulfilled the ASTM D 6751 and EN 14214. Finally, further research and study need to be carried out before S. foetida can become an alternative fuel in the future.[2] Basumatary Sanjay (2013) A major challenge for economic viability of biodiesel industries is the high cost of edible vegetable oils which is impossible to afford for underdeveloped countries. Large-scale production of biodiesel from edible oils may cause negative impact to the world such as food crisis leading to economic imbalance. Hence, non-conventional and non-edible oils definitely have the advantage over edible oils as potential feedstocks for biodiesel production. In this review, various non-conventional potential feedstocks are identified and listed for use in future biodiesel industries. It is the time for all concerned to concentrate for the development and setting up of bio-refineries for large-scale production of biodiesel.

[3] Vivek and Gupta A K (2004) The study has enabled us to confirm that Karanja oil can be used as a raw material to obtain biodiesel, which can be used as fuel in diesel engine. The engine performance with biodiesel is similar to that of diesel, while emissions are less in the case of biodiesel. Optimum parameters for high conversion are: pressure 1 atmos, temperature 68 -70°C, reactant ratio 8-10 (moles of MeOH: Moles of oil), reaction time 30-40 min; catalyst (KOH) 1.5 5% w/w. There are two aspects of the cost of biodiesel (i) cost of raw material (vegetable oil) and (ii) cost of

## International Journal of Innovative Research in Science, Engineering and Technology

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processing. The cost of raw material (vegetable oil) accounts to 60 – 70 % of the cost of biodiesel fuel. Using non – edible oil like karanja oil (in place of vegetable oil) will surely improve the economics of the process (Biodiesel production) [4] Nadir Yilmaz et al (2014) Biodiesel–diesel–ethanol blends with ethanol concentrations of 3%, 5%, 15% and 25% with equal concentrations of biodiesel and diesel equal were used to fuel a diesel engine. Effects of low and high concentrations of alcohols, along with variation of engine loads were investigated. Results indicate that emissions strongly depended on not only engine operating conditions, but also fuel blends concentrations. Cooling effects and oxygen contents of alcohols were two of the most important factors in the outcomes. Overall, alcohol blended fuels increased CO emissions as compared to diesel fuel for all operating conditions. While ethanol blended fuels reduced NO emissions for all concentrations, unburned HC emissions depended not only on ethanol concentrations, but also operating conditions. Overall, high concentrations of ethanol increased HC emissions, and vice versa. But at over 50% load, ethanol decreased HC emissions for all concentrations. Reduction of HC emissions occurred for all concentrations at over 70% load.[5] Chongkhong et al (2007) A process for the production of biodiesel from relatively low cost PFAD a residual product from the refining of crude palm oil has been evaluated. The final product is a light brown material meeting the requirements of the Thai biodiesel standard. A range of methanol to PFAD ratios and acid catalyst concentrations were established that would produce a high-quality product in reasonable CSTR residence times, and at lower temperatures which we considered to be a more economic solution.

[6] Forson FK (2004) An experimental investigation was conducted to explore the performance of jatropha oil and its fuel blends with diesel in a direct-injection single-cylinder diesel engine and the results obtained suggest the following conclusions: (a) Pure jatropha, pure diesel and blends of jatropha and diesel oil exhibited similar performance and broadly similar emission levels under comparable operating conditions. (b) Introduction of jatropha oil into diesel fuel appears to be effective in reducing the exhaust gas temperatures since the jatropha oil could be considered to be emulsified as water was introduced into the milled jatropha seed during the extraction process. (c) The jatropha oil can be used as an ignition-accelerator additive for poor diesel fuels when 2.6% by volume of the jatropha is introduced into pure diesel fuel. (d) The jatropha oil has substantial prospects as a long-term substitute for diesel fuels. The 97.4% diesel/2.6% jatropha fuel blend competed favourably with diesel fuel and offers a reasonable, if not even a better, substitute for pure diesel fuel. [7] Marchetti JM et al (2007) For the alkyl catalyzed reaction, it was found that this is a very good process of production with relatively high conversion. Transesterification kinetics for acid catalyzed reaction of soybean oils. The conversion is about 60%, not very high compared to those of some other authors. This could be so because of differences in the time at which they have done their experiments, temperature, alcohol and raw oil used. However, there is a possible production process. In the case where supercritical alcohol was used, it was demonstrated that one gets a higher reaction rate for esterification than for transesterification. Another advantage of this process is that the free fatty acid will be changed completely into esters. The use of lipase is a great viable method for production of ester from different sources of oil or grease. Research on this topic is still in progress due to the enzyme flexibility and adaptability to new process.

[8] Mangesh G et al (2007) Transesterification of canola oil with mixtures of methanol and ethanol were carried out successfully using KOH as a catalyst. Rate of transesterification of canola oil with mixed alcohols was faster than with pure methanol. When mixtures of methanol and ethanol were used for transesterification reaction, along with methyl some ethyl esters were formed. However, the formation of ethyl esters was much slower than the methyl esters. Properties of mixed esters such as acid value, viscosity, density were within the limits of ASTM standards. Heating value, cloud and pour points of mixed esters were close to those of methyl and ethyl esters. Lubricity of ethyl ester was better than that of methyl when added 1 vol% to the base fuel. Similarly, lubricity of mixed ester MEE (3:3) was better than that of pure methyl ester. Further investigation in use of mixed ester as lubricity additive is in process. [9] Gerhard Knothe (2008) Several approaches exist for improving the properties of biodiesel fuels by modifying fuel composition. The use of esters other than methanol and physical procedures, such as winterization, improve cold flow, with economics being an issue when using other alcohols and reduced oxidative stability and cetane numbers being issues in the case of winterization. Inherent genetic modification of the fatty acid profile offers the best possibility of addressing several or all fuel property issues simultaneously. For biodiesel, methyl palm tolerate and esters of decanoic acid are strong candidates for improving fuel properties besides methyl oleate. However, several other issues likely need to be evaluated when considering such modified feed stocks and fuels.

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[10] Demshemino S. Innocent et al (2013) Biodiesel is a renewable alternative fuel that can be used in a diesel engine either pure or in blends with petroleum diesel. It has the potential of replacing petroleum diesel in the future, or being used in blends with petroleum diesel to improve performance and reduce toxic exhaust emissions. In terms of environmental assessment and renewability, biodiesel has a contribution in reducing particulate matter emission, reduced emission of greenhouse gases, and decrease in air pollution. Biodiesel when applied as a fuel in a diesel engine works like petro-diesel or in some cases even gives better results compared to petro-diesel fuel. We have reviewed past research works comparing performance and exhaust emission characteristics of biodiesel and petro-diesel from different sources. Because of the growing concern for a clean and healthy environment, most modern research has been centered on reducing the toxic exhaust emissions generated from burning petroleum and improving the performance of petro-diesel through blending with biodiesel.

## II. METHODOLOGY

The specifications of the engine we have used are...

Make : Kirloskar

RPM :1500

Bore :80mm

Stroke :110mm



## III. RESULT AND DICUSSION

**Engine performance:** Experimental investigations of sterculiafoetida oil on single cylinder four stroke diesel engine are done and also several parameters such as maximum brake thermal efficiency (BTE), minimum specific fuel consumption (SFC), maximum and minimum nitrous oxide (NO<sub>x</sub>), Hartridge smoke unit (HSU), crank angle for maximum cylinder pressure occur and Rate of heat release have been determined. Figures 2 and 3 project the results of optimum blending ratio of biofuel with diesel.

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**Brake thermal efficiency:** The variations of brake thermal efficiency with determined brake power for diesel and biodiesel blend (25%, 50%, 75%, 100%) are shown in Figure 2. It is observed that the BTE of B25 is much closer to diesel parameters in all the determined BP. BTE of the fuel B25 increases when BP increases. It reaches 30% at 5.2 kW, which is very close to the diesel fuel performance. BTE of B50, B75, and B100 show much variation compared to B25.

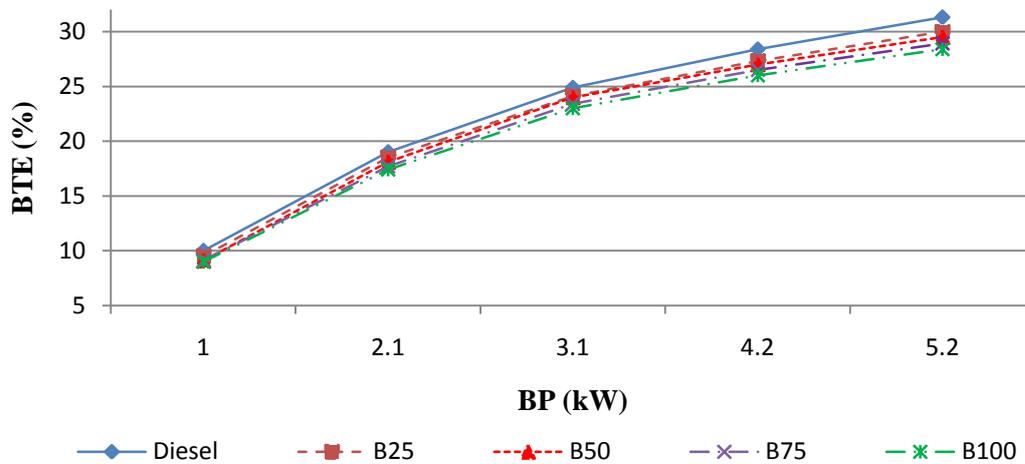


Figure 2 Brake Thermal Efficiency

**Specific Fuel Consumption:** The variation of SFC for Diesel and Biodiesel (25, 50, 75, and 100) with respect to BP are shown in Figure 2. The trend SFC with respect to BP for all the five parameters is decreasing. Specific fuel consumption for diesel is observed as 0.693 kg/kWhr at a maximum determined brake power of 5.2 kW. B25 is placed next to the lowest fuel consumption, generating 0.77 kg/kWhr at determined brake power of 5.2 kW which is apparent by very close to diesel value.

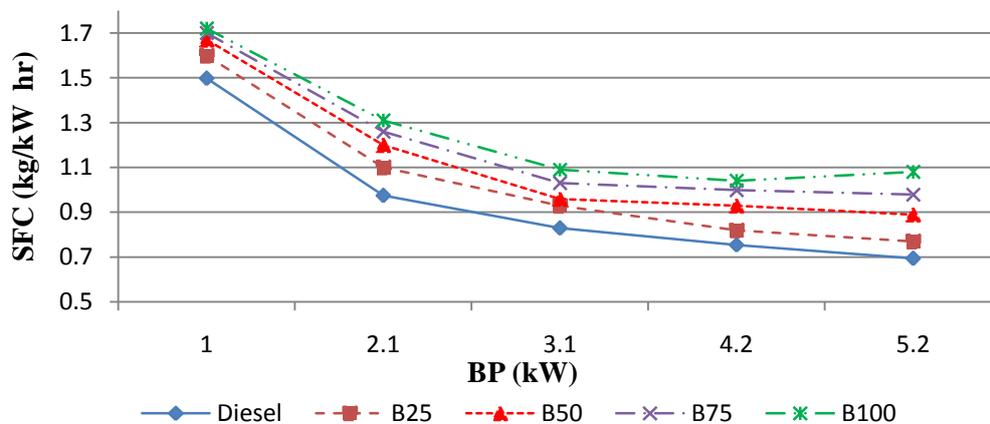


Figure 3 Specific Fuel Consumption

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### Engine Emission:

**Nitrous oxide:** As described in the literature survey, biodiesel blends can be considered as sole fuel for engine. The variation of NO<sub>x</sub> for diesel, B25, B50, B75 and B100 with respect to BP is shown in Figure 3. Normally, biodiesel has 10% NO<sub>x</sub> emission due to the complex composition of biodiesel.

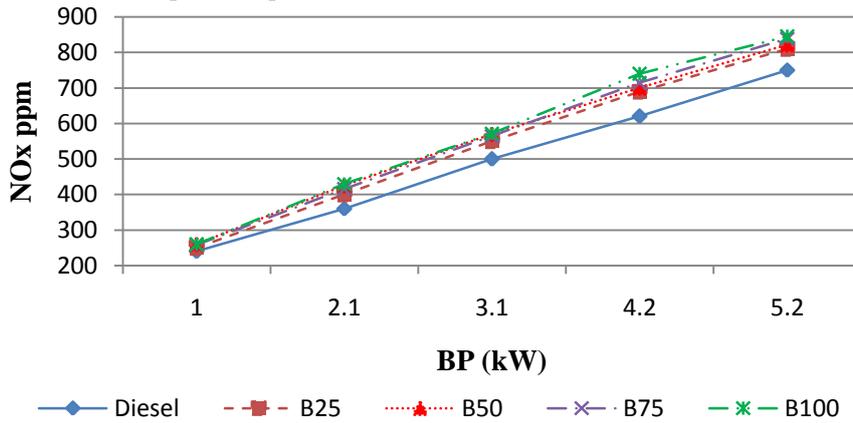


Figure 4 Nitrous Oxide

Figure 4 displays the variation of NO<sub>x</sub> with brake power for different biodiesel blends. B100 has a maximum of NO<sub>x</sub> value (845ppm) at maximum to determine a brake power of 5.2 kW. B25 has a minimum NO<sub>x</sub> value (810ppm) compare with other biodiesel blend at maximum to determine a brake power of 5.2 kW. B50 has produced NO<sub>x</sub> level of 839 ppm and B75 has produced 822 ppm. Hence B25 is identified as a suitable blend which can be used for further experimental investigations.

**Smoke Opacity:** The smoke opacity (HSU) for diesel, B25, B50, B75 and B100 is plotted in Figure 4. B100 has produces less smoke opacity at maximum determined brake power. B25 has produces maximum smoke opacity compare with other biodiesel blend at maximum determined brake power. This is due to the biofuel having higher oxygen content.

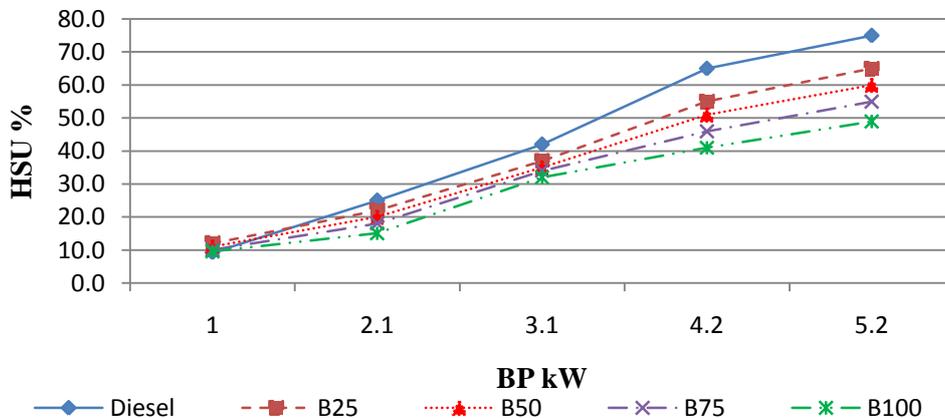


Figure 5 Smoke Opacity

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## IV. CONCLUSION

The maximum brake thermal efficiency for engine fuelled with pure diesel was 31.3% and for the engine fuelled with biodiesel of *sterculiafoetida* oil (B25) it was observed to be 30% at maximum determined brake power. The maximum brake thermal efficiency has been reduced for biodiesel-fuelled engine by 1.3% compared with the engine fuelled by diesel, due to the lower energy content and lower calorific value of biodiesel. The specific fuel consumption for the diesel fuelled engine is 0.693 kg/kWh and for the engine fuelled with biodiesel of *sterculiafoetida* oil it is observed to be 0.77 kg/kWh at full load condition. The specific fuel consumption for diesel fuelled engine is minimum compared with other testing parameters. The biodiesel increased specific fuel consumption of 0.077 kg / kWh compared with diesel SFC.  $\text{NO}_x$  for diesel-fuelled engine is 750 ppm and for the engine fuelled with biodiesel of *sterculiafoetida* oil it is observed to be 810 ppm at maximum determined brake power. The smoke opacity for diesel-fuelled engine is 75% and for the engine fuelled with biodiesel of *sterculiafoetida* oil it is observed to be 65% at full-load condition. In full load condition, the smoke opacity for biodiesel-fuelled engine decreased by 10% compared with engine fuelled by diesel due to the *sterculiafoetida* oil that has oxygen molecules.

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