JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Experimental Performance of Bael Biodiesel as A Fuel in A CI Engine

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***Abstract*- In this study, diesel automobiles that were fueled with a new type of biodiesel called Bael biodiesel were compared for their overall performance. Bael oil is made from the seeds of the bael tree, which are then pressed to extract the oil contained within them. In that article, the effects of diesel, "bael seed oil methyl ester" (BSOME), and its blends (B20, B40, B60, B80 & B100) on the performance, toxicity, and ignition of a diesel engine are investigated. Due to the oil's greater acid quality, BSOME was created by mixing bael seed oil with methanol in an acid and alkali catalytic process. This led to the development of BSOME. In comparison to diesel, the thermal efficiency of the brakes in BSOME and its blends is lower, but overall emissions are lower as well. This study demonstrates that conventional CI engines, with a few minor adjustments, are capable of operating on a mixture of diesel and biodiesel referred to as B20 (20 percent bael biodiesel and 80 percent diesel).**

***Keywords:* Smoke meter, Diesel, Bael seeds, Pressure transducer, Diesel engine, etc.**

1. INTRODUCTION

In the midst of the ongoing problem in the world's energy supply, the use of fuels derived from biological sources presents yet another viable option. This complicated situation in the energy sector can be accredited to a number of interrelated factors, such as the ever-increasing population of the world, the rapid expansion of the automotive industry, rising incomes and rising living standards, as well as the growth of the industry. Additionally, this situation can be attributed to the fact that there are more people living longer. The price of crude oil has been consistently climbing higher, despite the fact that it has also been showing consistent signs of volatility. Over the course of the last few decades, the price of fuel has been subject to a wide range of fluctuations as well as there has been a significant rise in acceptance of environmental issues. Because of their simple mechanism, incredible performance, low cost of fuel oil, high compression ratio, large power margin, great thermal performance, and high level of dependability, CI engines are widely utilised as a power source for on-land and underwater transportation structures. Diesel engines have developed throughout the course of human history to become the internal combustion engines with the highest power output and the lowest fuel consumption. However, engines are also criticised for exposing a large number of people to hazardous air pollutants such as NOx and HC. This is because the smoke that engines produce is a byproduct of their operation.

Using a 4-stroke engine, a single-cylinder, Agarwal et al. [1] associated engine toxicity & performance characteristics of oils such as linseed, rice bran, & mahua against those of clean diesel. The oils were evaluated against one another. The findings demonstrated that, with a few notable exceptions, the biodiesel efficiency and emission characteristics for various blended fuels, such as BSEC, BTE, and smoke concentration, were proven to be remarkably equivalent to those of clean diesel. Ramadhas et al. [2] investigated whether or not rubber seed oil might function properly in a "Compression Ignition" (CI) engine. The findings of testing indicated that rubber seed oil methyl ester is suitable for use in CI engines as a substitute for conventional fuels. In a direct injection CI engine, Sahoo et al. [3] utilised high-velocity biodiesel & its blends in addition to polanga oil methyl ester. In a CI engine, Li et al. [4] investigated the use of biofuel derived from "Eruca Sativa Gars" (ESG). There was a decrease of 33.33 percent in both the levels of HC and CO in B100. Despite this, there was a rise in the levels of both NOx and CO2, with the former rising by 13.21% and the latter by 10.71 percent.

Prakash et al. [5] evaluated the engine's performance as well as its effect on the surrounding environment by using a CI engine that was driven by diesel and karanja bio-diesel blend. Raheman and Ghadge [6] conducted research on the transesterification capabilities of mahua oil (B100) and mahua oil blends using a Ricardo E6 engine. Dorado et al. [7] conducted research to determine the levels of efficiency and pollutants produced by a CI engine that was fueled by olive oil (biodiesel). The concentration of noxious gases decreased by 32 percent, the concentration of carbon dioxide decreased by 8 percent, and the concentration of “Sulphur dioxide” (SO2) decreased by percent. They arrived at this conclusion based on the fact that transesterification using olive oil has been utilised as an alternative to diesel in CI engines.

The effectiveness of twin vertically elevated diesel engines was evaluated by Srivastava and Verma [8] using karanja transesterification & blends. Comparing karanja biodiesel fuel's BTE (24.9 percent) to that of regular diesel (30.6 percent), we find that the former is slightly lower. Small increases in BSFC and increases in waste product temperatures were seen after bio-diesel was introduced. Karanja fuels produced 17 percent more CO, 41 percent more HC, and 12 percent more NOx than diesel did while under heavy power. The offered study examines the effectiveness of diesel blends on a CI engine without any adjustments. “Sachdeva Institute of Technology in Farah, Mathura,” conducted research.

2. EXPERIMENTAL SETUP

Figure 1 depicts a description of the research arrangement as well as the many apparatuses used in the study. Figure 2 presents an illustration of the CI engine's overall appearance. Figures 3 and 4 show images of a bael tree and bael seeds, respectively.

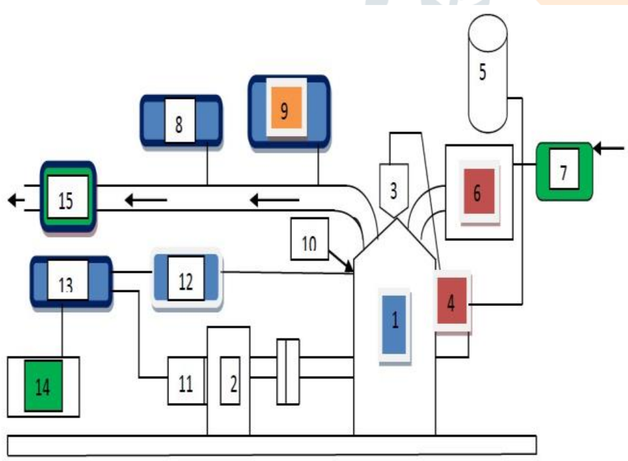

Fig. 1 Diesel engine photographic view

1. Diesel engine
2. Eddy current dynamometer
3. Injector
4. Fuel pump
5. Fuel tank
6. Air tank
7. Air filter
8. AVL smoke meter
9. AVL Di gas analyser
10. Pressure transducer
11. TDC Encoder
12. Charger amplifier
13. Indimeter
14. Monitor
15. Exhaust silencer

The Kirloskar engine has numerous applications in contemporary life. Because of its robust design, the Kirloskar model is capable of withstanding the kinds of intense forces that are frequently encountered by scientists in the course of their research. The model of this engine may also have the necessary alterations made to it quickly and easily. For the purposes of the experiments, a naturally aspirated, four-stroke, CI engine producing 5.2 kilo Watts at 1500 rpm was utilised. In the piston ignition cylinder, you'll find a design similar to this hemispherical shape. The pulsation of the CI engine is effectively muted as a result of the utilisation of an injection container. This minimises the possibility of airflow anomalies occurring within the manifold, which in turn results in the pulsation being muted. A consistent suction force is maintained by the system, which in turn guarantees a constant flow of air via the intake manifold. A manometer is used to measure the pressure drop that is induced by the orifice, and the flow rate is determined by the orifice itself. Both Table 1 and Table 2 contain a variety of engine parameters, as well as the quality of diesel and bael oil, respectively.

Fig. 2 Diesel engine photographic view

Table 1 Engine specification

Manufacturer	Kirloskar TV – I
Type	4-stroke
Speed	1500 rpm
Compression ratio	17.5:1
Fuel	Diesel
Injection Pressure	220 bar

Table 2 Diesel and bael oil properties

	BSOME	Bael oil	Diesel
Density (g/cc)	0.875	0.88	0.855
Gross calorific value, MJ/kg	40.51	43.25	43.67
Flash point (^{0}C)	127.5	-	46.5
Cetane index	52.5	-	45.5

Fig. 3 Bael seeds

Fig.4 Bael seed

3. RESULTS AND DISCUSSION

After that, findings of tests are reported for both regular diesel and bael biodiesel-diesel blends that were performed on a normal engine configuration (220 bar inject pressure, 23°BTDC injection time, & 17.5:1 compression ratio).

The differences in BTE that can be seen between loadings of diesel (B0) and biodiesel blends are displayed in Figure 5. As a result of the reduction in the ignition delay, blending engines could once again begin firing before TDC. When compared to B0, the maximum load causes a 1.98 percent decrease in BTE for B20, a 5.0 percent decrease for B40, a 7.77 percent decrease for B60, a 9.02 percent decrease for B80, and an 11.56 percent decrease for B100. The B100 mixture of increased heat, higher oxygen, & fuel produced the virtually same amount of BTE as the B80 mixture when subjected to larger loads. The BTE is slightly less than the B0, which is to be expected given that biodiesel blends have a lower caloric content than normal diesel.

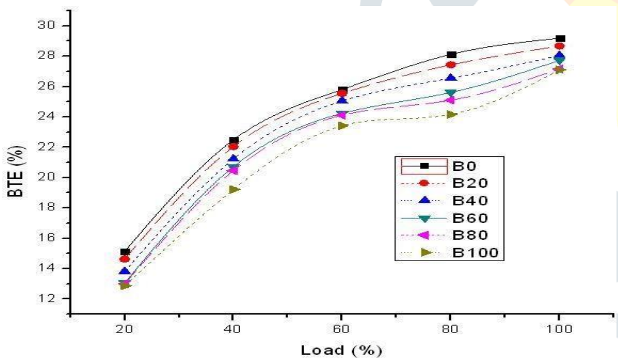

Fig.5 BTE Variation with load

The change in BSEC that can be seen across loads is shown in Figure 6. Under heavy loads, the BSEC rises by 2.94 percent for a B20, 6.19 percent for a B40, 10.09 percent for a B60, 11.18 percent for a B80, and 14.45 percent for a B100. At every load, it was discovered that mixed fuels in general have a greater BSEC than pure diesel does. This is due to the higher concentration of mixed fuels and the lower calorific content of pure diesel. As a direct result of this, fuel efficiency declined as the load grew since the air-to-fuel ratio became lower.

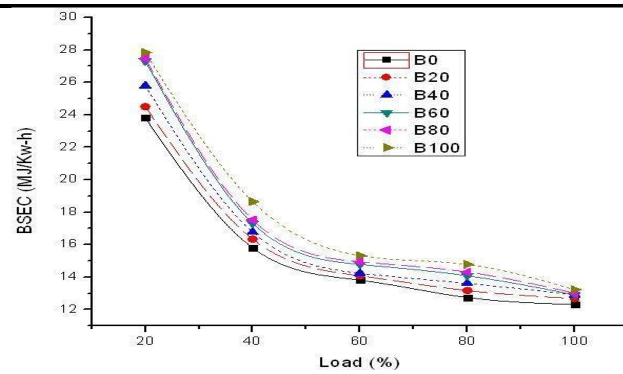

Fig. 6 BSEC Variation with load

Figure 7 displays varied temperatures of waste products as a consequence of loading with diesel (B0) and biodiesel blends. These temperatures are shown as a function of the loading process. Because more fuel was required to satisfy the demand for power when the machine was operating at full load, the temperature of its exhaust gas rose. The increase in EGT could not be prevented by increasing the percentage of biodiesel in the blend. Ineffective atomization leads to the formation of larger fuel molecules, which in turn extends the amount of time it takes for the flame to spread. The exhaust gas temperature (EGT) of the B0 is at its lowest at certain loads; this may be due to the fuel-intensive nature of such loads.

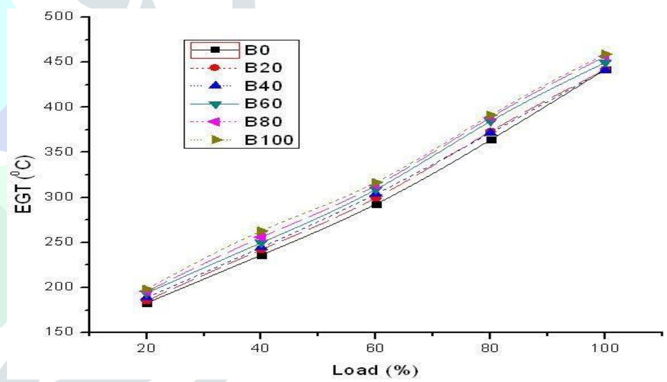

Fig. 7 FGT Variation with load

Figure 8 illustrates the difference in the number of hydrocarbon emissions produced by loaded diesel (B0) and biodiesel blends. When compared to diesel at full load, the percentage reduction in HC emissions caused by B20, B40, B60, & B100 is as follows: 10.90 percent, 14.26 percent, 16.48 percent, 18.78 percent, and 20.61 percent, respectively. Emissions of gaseous hydrocarbons have the potential to irritate the surrounding natural environment. Because of this, the risk of something like this occurring is decreased whenever biodiesel has been utilised.

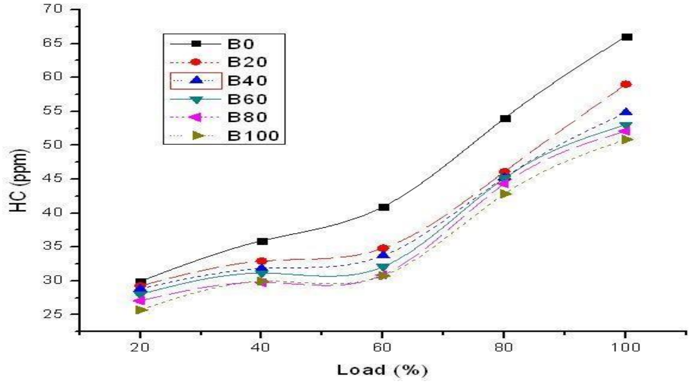

Fig. 8 HC emissions Variation with load

The fluctuation in NO emissions that occurs with loading is shown in Figure 9, and it applies to both diesel (B0) and blended fuels. When diesel is put under load, compared to B20, B40, B60, B80, & B100, it is feasible for NOx emissions to rise by 4.19, 9.82, 15.29, 18.22, and 20.4 percent respectively. The lungs may experience irritation due to the emissions of NOx. In order to avoid causing respiratory distress, it is essential to keep NOx emissions to a minimum when operating a vehicle that runs on biodiesel.

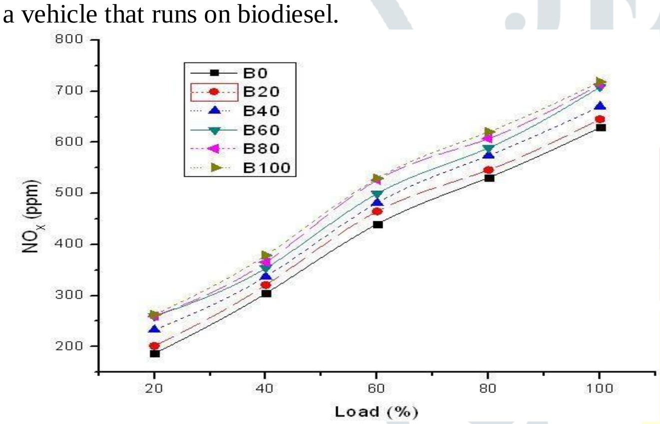

Fig. 9 NO emissions Variation with load

The quantity of loading has an effect on how much of an increase or decrease there is in the relative amount of smoke emissions produced by diesel (B0) and biodiesel blends, as displayed in Figure 10. In light of this, the utilisation of biodiesel in motor vehicles brings about a reduction in the possibility that this will occur. Figure 11 illustrates how the quantity of loading affects the CO emissions produced by diesel (B0) and bio-diesel blends of varying concentrations. When put under these conditions, biodiesel blends result in a decrease in the amount of CO emissions produced. The most important factor contributing to this advancement is the general decline in air-fuel ratios, which occurred despite growing load capacities. When the fuel capacity was at its maximum, there was no need to add any additional air to the system, which resulted in high levels of CO being produced.

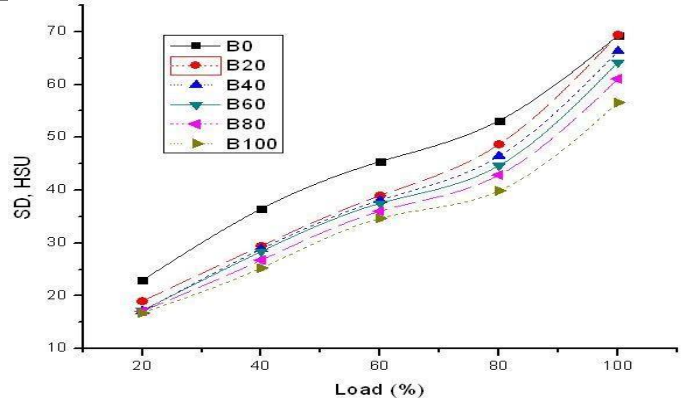

Fig. 10 SD Variation with load

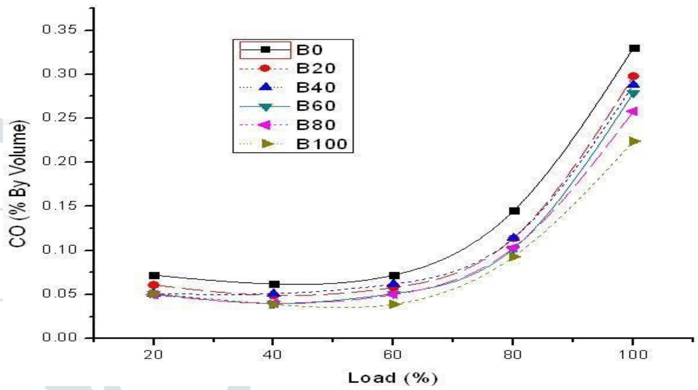

Fig. 11 CO emissions Variation with load

Fig. 12 illustrates shifts in emissions of CO_2 that occur in response to changing load levels. Since CO2 output levels dropped after reaching their high. When compared to B0, the CO2 emissions for B20 are 3.37 percentage points higher, B40's are 5.13 percentage points higher, B80's are 5.58 percentage points higher, and B100's are 8.65 percentage points higher.

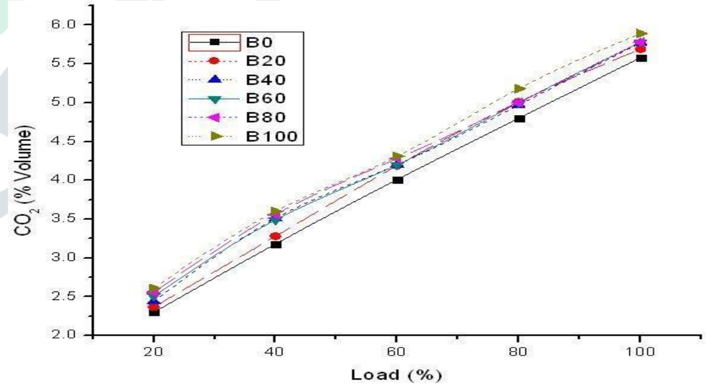

Fig. 12 CO_2 emissions Variation with load

4. CONCLUSIONS

Researchers investigated a diesel engine with a single cylinder to see how much power it was capable of producing, how much pollution it might generate, and how efficiently it used the fuel. According to the findings of the research, BSOME is suitable for direct application in internal combustion engines without the need for any modifications. The BSFC became more favourable as the proportion of biodiesel in the blend increased; hence, the blend was deemed more environmentally friendly. Despite the fact that BSOME and its mixes generate a higher level of nitrogen oxide emissions than gasoline, they offer favourable combustion and efficiency characteristics.

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