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EFFECT OF PERFORMANCE AND EMISSION CHARACTERISTICS ON METHYL ESTERS OF SARDINE OIL FUELLED IN DIESEL ENGINE WITH VARIOUS BLENDS

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Abstract

This study investigates the performance and emission characteristics of a diesel engine which is fuelled with sardine oil methyl ester and diesel in a diesel engine. A single cylinder four stroke diesel engine was used for the experiments at various load and speed of 1500 rpm. An AVL 5 gas analyzer and a smoke meter were used for the measurements of exhaust gas emission. The high viscosity of sardine oil leads to problem in pumping and spray characteristics. The improper mixing of sardine oil with air leads to incomplete combustion. The best way to use sardine oil as fuel in diesel engines is to convert it into biodiesel. It can be used in diesel engines with out any engine modifications. This is because it has properties similar to mineral diesel. The results showed that break thermal efficiency is decreased and CO, NOx in the exhaust are increased when fuelled with methyl esters compared to diesel except HC emission.

Keyword: Biodiesel, Diesel engine, Sardine oil, Performance, Emission.

Introduction

Due to the gradual depletion of petroleum reserves and the impact of environmental pollution of increasing exhaust emissions, there is an urgent need for suitable alternative fuels for use in compression ignition engines (CI). Biodiesel has properties similar to those of traditional fossil diesel fuel which can be directly used in IC engines with little or no engine modifications. Studies clearly indicate that the use of biodiesel may potentially reduce the dependence on petroleum diesel fuel and improve air quality.Biodiesel is produced by the combination of alcohol which is usually alcohol with vegetable or animal oil/fats. In order to lesson harmful vehicle emission it can be utilized on its pure form as a renewable substitute for diesel engine. Biodiesel and ethanol are clean which can produced on site in local villages and in renewable resources. Another gain is that many alternative fuels can be generated while oil is a non renewable resource. Present estimates predict that world oil production will reach its peak some time in the next 10 to 15 years. Even low concentration of biodiesel reduces PM emission and provides significant health and compliance benefits wherever human receives higher levels of exposure to diesel engine. Yusuf Ali and M.A.Hanna.(1994) Alternate fuels like ethanol, biodiesel, LPG, CNG, etc have been commercialized in transport sector. Araya et al.(1987) converted sunflower and fish oil to their methyl esters, tested in a single cylinder diesel engine and concluded that, the maximum output with both methyl esters was higher (0.11 kW, 3%) than the diesel fuel. Hulya.(2003) analyzed qualitatively and quantitatively, the crude commercial fish oil, by gas liquid chromatography. The major fatty acids detected in this oil were as follows: 24.8% stearic, 23.6% palmitic, 9.84% myristic, and 6.56% octadecatetraenoic acids. The physical and chemical properties of crude commercial fish oil were established. Steigers JA.(2002) demonstrated the use of fish oil as fuel in a large stationary diesel engine . Amba Prasad rao.G and Rama mohan.P. (2005) studies the performance of DI and IDI engines with jatropia oil based biodiesel and concluded that DI engine operations with biodiesel under supercharged condition the performance are very close to diesel fuel operation. Cherng-yuan Lin and Rong-ji Li.(2009) trasesterified fish oil to produce biodiesel and they used discarded parts of mixed marine fish species as the raw material to produce biodiesel. They reported that Commercial biodiesel from waste cooking oil when compared with marine fish oil biodiesel had a large gross heating value elemental carbon and hydrogen content, cetane index, exhaust gas temperature, NOx, and O2 emission and black smoke opacity with lower elemental oxygen content. A.karthikeyan et al.(2009) studied the diesel Performance with fish oil biodiesel and its blends with diesel in proportion of 20:80, 40:40, 60:40 and 100% by volume on single cylinder water cooled four stroke diesel engines and reported that break thermal efficiency of B60 blend and B100 was close to break thermal efficiency of diesel at all loads. Dilip kumar Bora.(2009) studied the performance of single cylinder diesel engine using blends of karabi seed biodiesel by using potassium hydroxide as catalyst to facilitate estarification process and concluded B20 fuel showed better break thermal efficiency than B100 fuel, B100 also showed maximum NOX emission however B100 emitted least CO emission in comparison with B20 and diesel. More research work on the engine performance and emission characteristics is required for complete evaluation of using sardine oil methyl ester as an alternative diesel engine fuel. The specific objective of the present work is to evaluate the performance and emission characteristics of a diesel engine using sardine oil and its methyl ester, prepared by a method of transesterification process.

Experimental procedure

Tests have been conducted on a Kirloskar Engine TAF1, four strokes, single cylinders, air-cooled direct injection, and naturally aspirated diesel engine at a constant speed of 1500 rpm. The layout of experimental setup and its engine specification is shown in Figure 1 and Table 1.The engine was coupled to a generator set and loaded by electrical resistance to apply different loads on the engine. The voltage, current and power developed by engine were directly displayed on control panel. Performance and emission tests were conducted on various biodiesel blends in order to optimize the blends concentration for long-term usage in CI engines. To achieve this, several blends of varying concentration were prepared ranging from 0 percent (Neat diesel oil) to 100 percent through 25 percent, 50 percent, 75 percent and 100 percent by volume. The performance data was then analyzed from the graphs recording power output, fuel consumption, specific fuel consumption, thermal efficiency for all blends of biodiesel. The fuel properties of sardine oil methyl ester are shown in Table 2.

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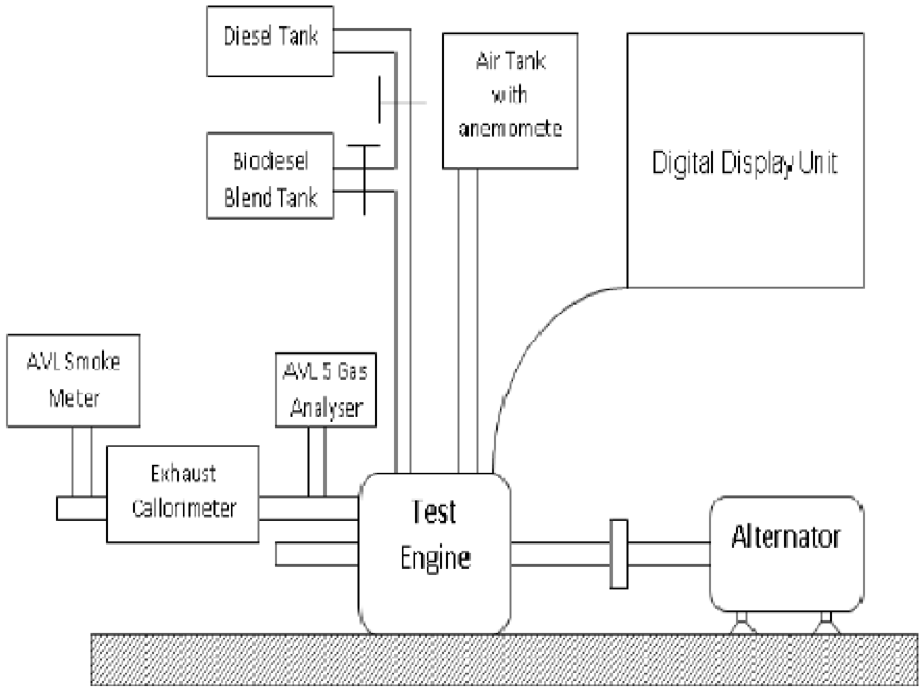

Table 1. Engine specification

Make	Kirlosker engine.
Model	TAF 1
No of cylinder	3 inline
Bore and stroke	87.5X110mm
Break power	4.4KW
Displacement	2826cc
type of cooling	Air cooled
Firing order	1-3-2
Speed	1500rpm
Compression ratio	17.5:1

Table 2. Fuel properties of Sardine biodiesel.

Serial Number	Properties	Sardine biodiesel
1.	Density (kg/m^3)	890
2.	Specific gravity	0.89
3.	Kinematic viscosity at 40 C (Cst)	4.5
4.	Calorific value (KJ/kg)	37,405
5.	Flash point (C)	58
6.	Fire point (C)	68
7.	Oxygen contents	0.72 %.
8.	Iodine value	142
9.	Moisture	0.02 %
10.	Carbon	90.02 %
11.	Hydrogen	9.19 %
12.	Nitrogen	0.01 %
13.	Sulphur	0.03 %

Results and Discussion

Brake specific fuel consumption

The variation of Brake specific fuel consumption of the engine with various blends is shown in figure 2. The BSFC in general, was found to increase with increasing proportion of B100 in the fuel blends with diesel, where as it decreases sharply with increase in load for all fuels. The main reason for this could be that percent increase in fuel required to operate the engine is less than the percent increase in brake power due to relatively less portion of the heat losses at higher loads. As density of sardine biodiesel was higher than that of diesel, which means, the same fuel consumption on volume basis resulted in higher BSFC in case of 100% biodiesel. The higher densities of biodiesel blends caused higher mass injection for the same volume at the same injection pressure. The calorific value of biodiesel is less than diesel. Due to these reasons, the BSFC for other blends were higher than that of diesel.

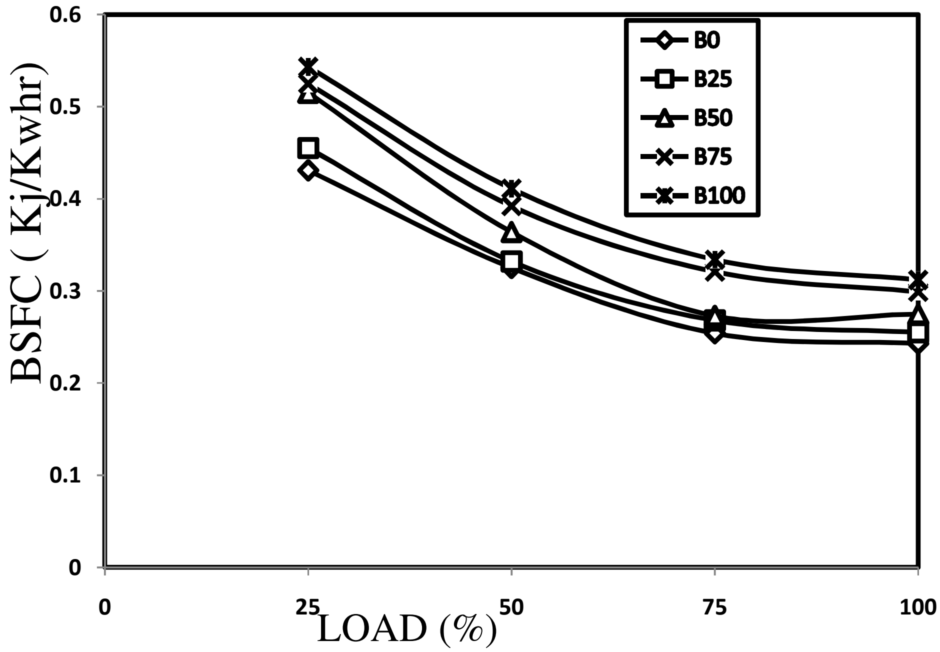

Figure 2. Comparison of Break Specific Fuel consumption vs Load with methyl ester of sardine oil

Break specific energy consumption

The variation of Brake specific energy consumption of the engine with various blends is shown in figure 3. The BSEC is calculated as the product of brake specific fuel consumption and calorific value. The BSEC consumption of the engine with SOME is higher compared to diesel at all loads. This may be due to the lower heating value, higher viscosity and density of SOME.

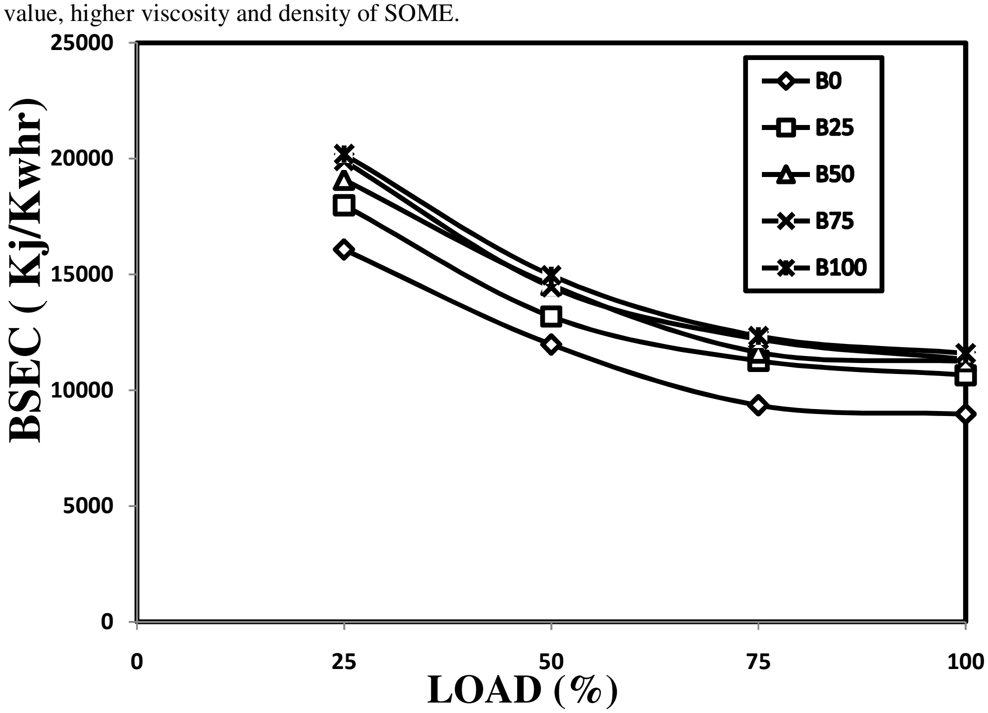

Figure 3. Comparison of Break Specific energy consumption vs Load with methyl ester of sardine oil

Break thermal efficiency

The variation of break thermal efficiency of the engine with various blends is shown in figure 4. In all cases, it increased with increase in load. This was due to reduction in heat loss and increase in power with increase in load. The brake thermal efficiency obtained for B25, B50, B75, and B100 were less than that of diesel. This lower brake thermal efficiency obtained could be due to reduction in calorific value and increase in fuel consumption compared to diesel.

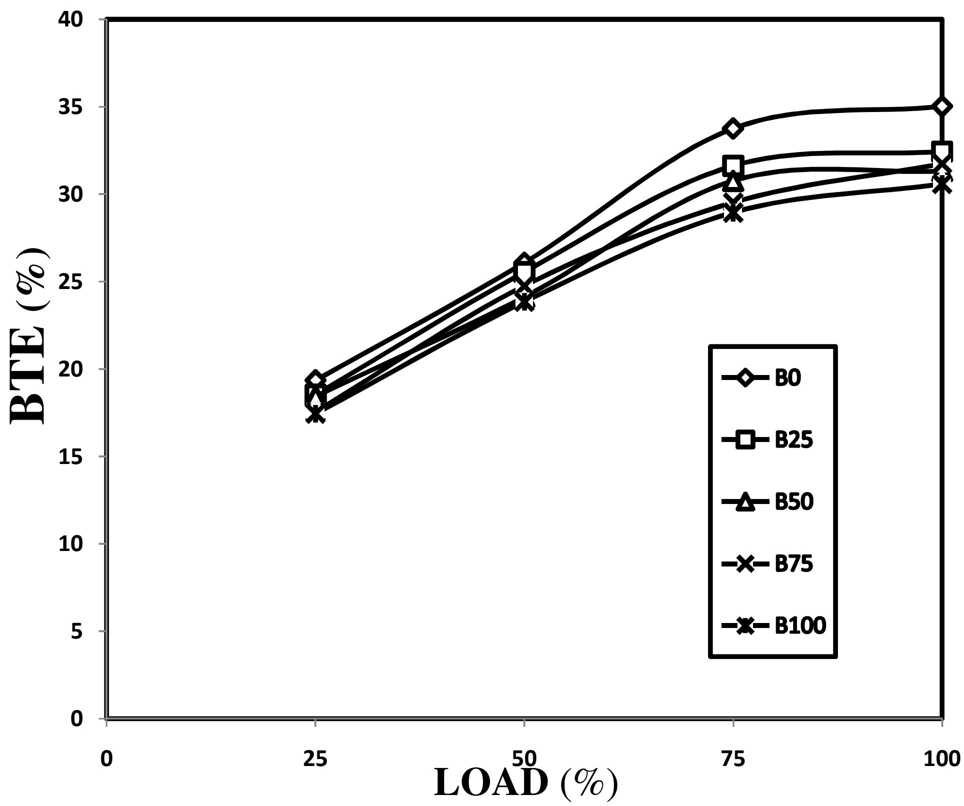

Figure 4. Comparison of Break thermal efficiency vs Load with methyl ester of sardine oil

Exhaust gas temperature

The variation of Exhaust gas temperature of the engine with various blends is shown in figure 5. In general, the EGT increased with increase in engine loading for all the fuel tested. This increase in exhaust gas temperature with load is obvious from the simple fact that more amount of fuel was required in the engine to generate that extra power needed to take up the additional loading. The exhaust gas temperature was found to increase with the increasing concentration of biodiesel in the blends. This could be due to the increased heat loss of the higher blends, which are also evident from, their lower brake thermal efficiencies as compared to diesel.

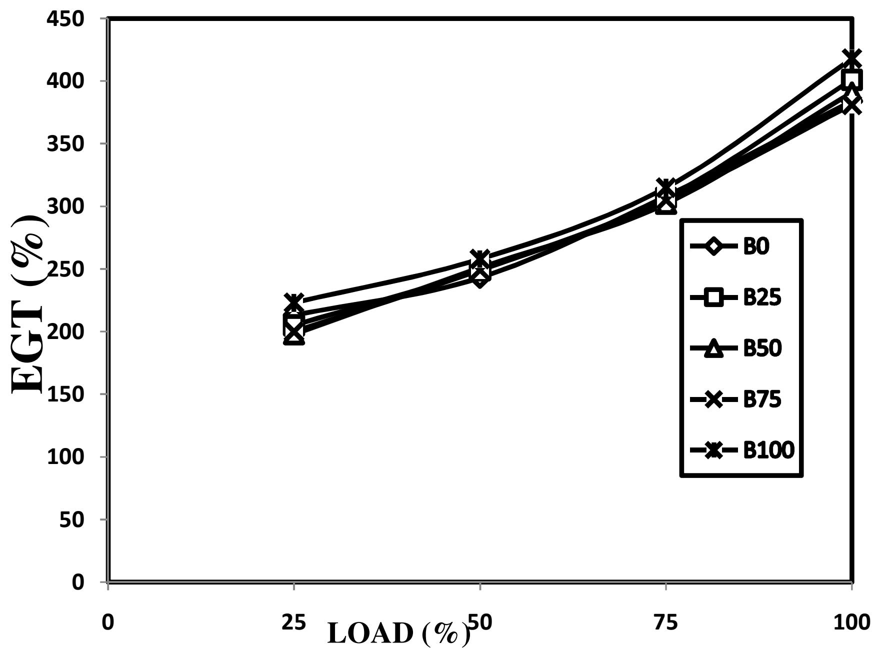

Figure 5. Comparison of Exhaust gas temperature vs Load with methyl ester of sardine oil

Carbon monoxide

The variation of Carbon monoxide of the engine with various blends is shown in figure 6. The minimum and maximum CO produced was observed from the graph for all blends. These higher CO emissions of biodiesel blends may be due to their less oxidation as compared to diesel. Some of the CO produced during combustion of biodiesel might have converted into CO_2 by taking up the oxygen molecule present in the biodiesel chain and thus higher in CO formation.

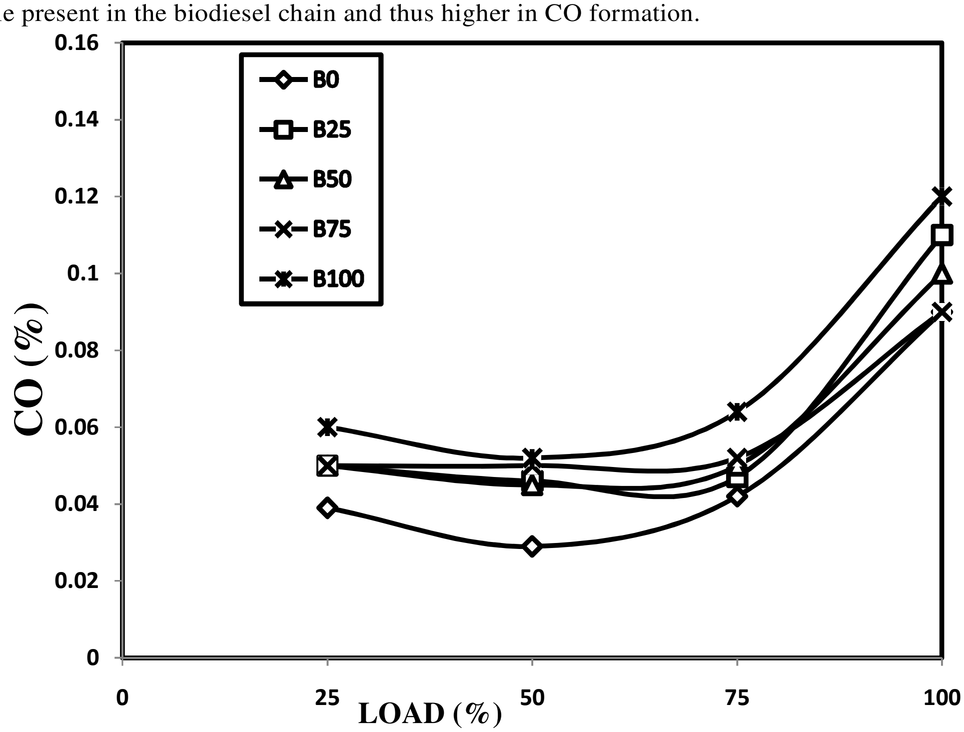

Figure 6. Comparison of Carbon monoxide vs Load with methyl ester of sardine oil

Hydrocarbon

The variation of Hydrocarbon of the engine with various blends is shown in figure 7. It can be seen that there is an increase in HC emission for all test fuel as the load increases. This is due to the presence of fuel rich mixture at higher load. There is a significant reduction in HC emission for methyl ester and their blends at all loads compare to diesel. Increasing the percentage of methyl ester in the fuel drastically reduces HC emission.

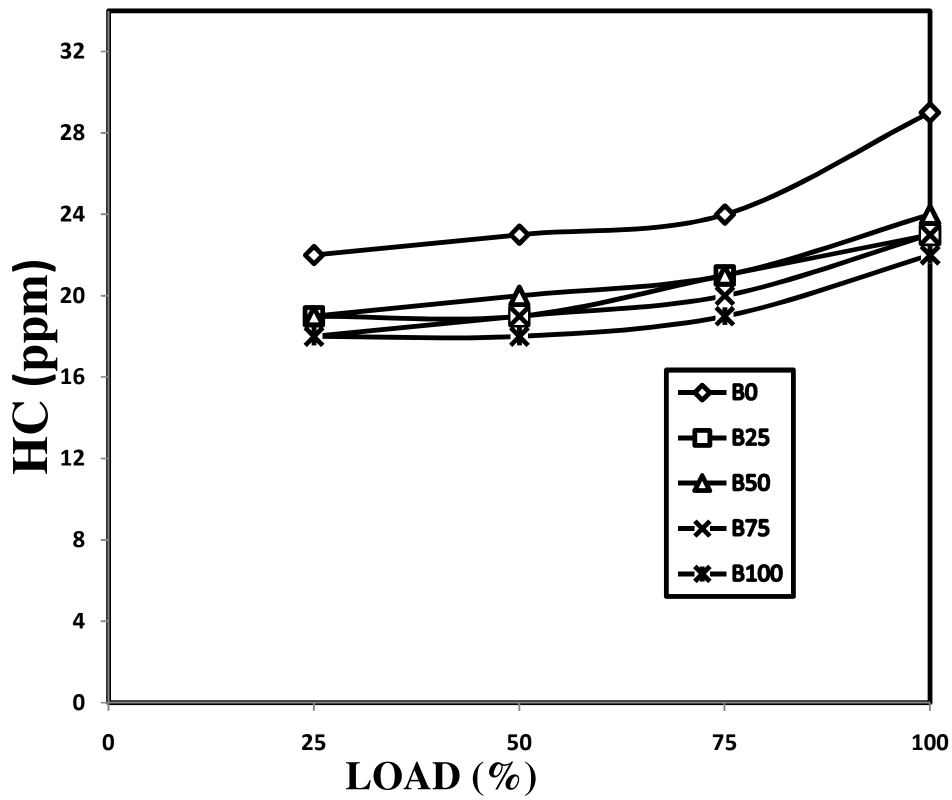

Figure 7. Comparison of HydroCarbon vs Load with methyl ester of sardine oil

Nitrogen oxides

The variation of Nitrogen oxides of the engine with various blends is shown in figure 8. It can be seen that the increasing proportion of biodiesel in the blends was found to increase NO_x emissions, when compared with that of pure diesel. This could be attributed to the increased exhaust gas temperatures and the fact that biodiesel had some oxygen content in it which facilitated NO_x formation. In general, the NO_x concentration varies linearly with the load of the engine. As the load increases, the overall fuel-air ratio increases resulting in an increase in the average gas temperature in the combustion chamber and hence NO_x formation, which is sensitive to temperature increase.

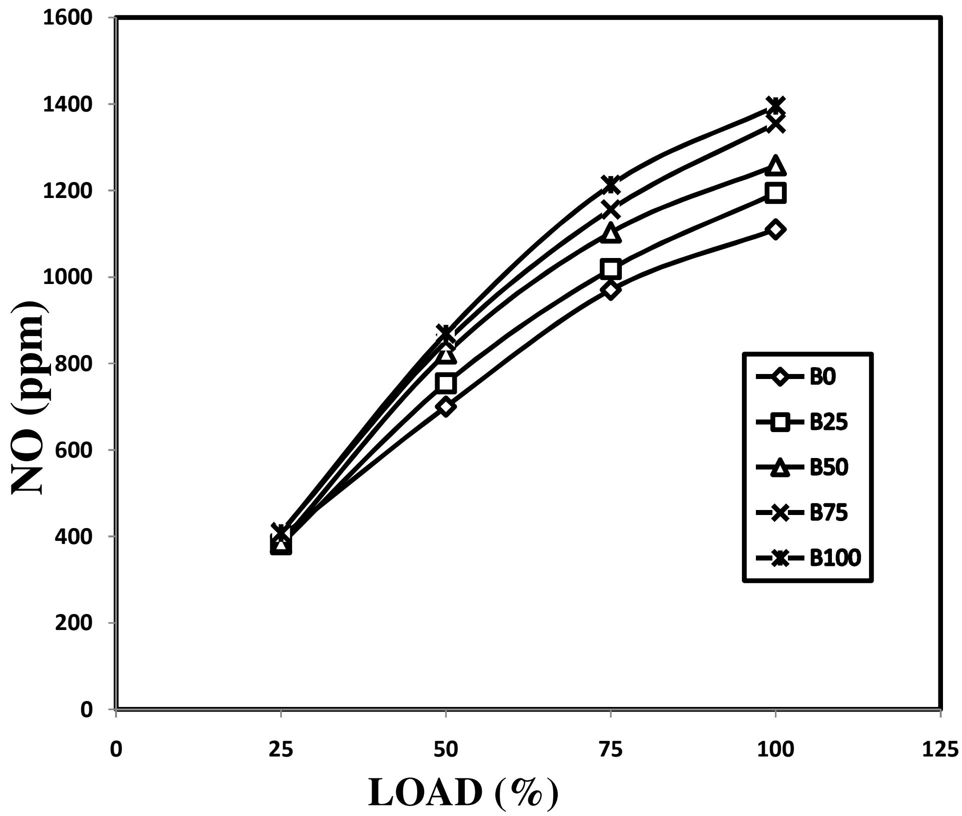

Figure 8. Comparison of Nitric Oxide vs Load with methyl ester of sardine oil

Conclusion

The following are the major conclusions that are drawn.

1. The specific fuel consumption and specific energy consumption is slightly lower than diesel for all blends.
2. The BTE for sardine oil methyl ester blends is lower as compared to diesel at all loads.
3. It is observed from the emission analysis that there is an increase in NOx emission for SOME as compare to diesel.
4. The CO emission is higher for SOME as compared to diesel.
5. HC emissions for SOME were lower as compared to diesel.

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