Performance and Emission Characteristic of Algae Bio-Diesel as an Alternative Fuel

P. Priyanka, V. V. Prathibhabharathi, T. Krishnaiah

Abstract: The Industrial revolution started in 1760, since then the hunt for conventional resources started. The demand always increased and the rate at which it increased now we see our resources at the edge of extinction. The other alarming aspect of conventional energy was pollution. The need of sustainable and least harmful alternate sources of energy has gained attentionin the 21st century. Till date Bio-diesel is the onlyproven option because of its properties like non-Sulphur emissions and low toxicity. Bio-fuel can be obtained in many forms and by many methods. I chose Algae oil or algal bio-fuel for my experiment.
In the present work engine test are conducted on diesel direct injection engine by using algae as biodiesel, with A-10 (10 percent algae oil blended with 90% diesel on volume basis), A-20 (20 percent algae oil blended with 90% diesel on volume basis), A-30 (30 percent algae oil blended with 90% diesel on volume basis) and their effect on the performance and characteristic emissions are studied.

Keywords: Algaeoil;Emission;Dieselengine

I. INTRODUCTION

In the present scenario, due to energy crisis the supply of energy sources is a vital bottleneck to an economy. The use of fossil fuels contributes to global climate change by introducing greenhouse gases into the atmosphere. As they contain high amount of carbon, became the everlasting reason to global worming. The reserves are not replenished naturally as these fossil fuels are available in finite amount and these are products of millions of years of natural processes such as anaerobic decomposition of organic matter. The second priority is given for the alternative fuels . Raising fuel costs and pressure to reduce the environmental impacts of non-renewable fuel intensity of energy expenditure are likely to be more motivated to reduce fuel consumption or switch to combustion are the reasons for the selection of alternative fuels. The sectors include aviation, road transport and rail, marine and mining Sectors with high relative intensity of energy expenditure are likely to be more motivated to reduce fuel consumption or switch to alternative fuels. In some aspects, biofuels are more advantageous than normal diesel fuel like they are having very less sulphur content and aromatic contents, higher lubricity, higher flash point, non-toxicity and higher bio-degradability. Apart from the above advantages,there are also disadvantages by using bio-fuels which includes very high pour point, very high viscosity, the lower cetane number, lower volatility and lower calorific value.

One of the great disadvantages of bio-fuel is its highly increased viscosity, which is approximately 10-20 times greater than normal diesel fuel. More over when the engine with bio diesel is operated for short term is giving promising results but when it is operated for longer periods then more carbon deposits, injector coking with trumpet formation, piston oil ring sticking, as well as the thickness of engine lubricating oil also increases. Micro emulsification with methanol or ethanol blending in small blend ratios with diesel fuel, cracking, preheating and conversion in to bio-fuel mainly through the transisterification process are the different methods to adopted in order to avoid the above problems.

Biodiesel is a fuel which is derived from animal fats. Earlier bio-diesel were mostly madeout of soya bean, Camelina, sunflower, Rapeseed, Jatropha, oil palm etc.The application of algae for biofuels was implemented during the 1970s. Algae cost more per unit mass but are claimed to yield between 20 and 90 times more fuel. Algae grows faster than any other raw material for the production of bio-fuel. It could grow in areas where minimum availability of freshwater and even in salt water. Algae oil canot be used as a fuel in locomotives directly as we are still developing the engine compatible to do the same. We can add a mixture of gasoline or diesel with algae oil to run the present day locomotive engines and study the out come so as to find and use a compatible mixture till we develop a fully algae oil driven engine. Algae oil used in the experiment was not prepared in house.

Most of the literature review reported on the impact of emissions by the use of bio-fuels in the compression ignition engines are referred to mainly single-cylinder naturally aspirated engines have been used only one or two bio-fuel oils. But aim of the present research work steps forward in reporting on the use of algae bio-fuel oils on a single-cylinder, four stroke and water-cooled diesel engine. Widely differing chemical and physical properties of bio-fuels against those of diesel fuels, are combining with the theoretical aspects of diesel engine combustion, and are used to aid the correct interpretation of the observed engine emissions and performance wise behavior.

II. EXPERIMENTAL SETUP

A Single cylinder four stroke water cooled diesel engine is used for the experimental setup.

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Figure 1: Experimental program

Figure 2: Five gas analyzer

S.NO	Specifications of Test Engine	
1	Make:	Kirloskar AV-I
2	No of cylinder:	One
3	Type of cooling: Air	
4	Ignition:	Compression Ignition
5	Bore:	80 mm
6	Stroke:	110 mm
7	Compression ratio	16.5:1
8	Speed:	16.6:1
9	Brake Power:	3.70kW
10	Brake Horsepower:	5
11	Fuel oil:	H.S. Diesel
12	SFC:	24.5g/kWh

The experiments were conducted in a single cylinder four stroke diesel engine with a rated brake power of 4.4KW and running at a constant speed of 1500 rpm. The engine is vertically air cooled and the compression ratio of the engine is 17.5:1. The standard injection timing of the engine is 23°bTDC.Hydrocarbon and carbon monoxide were measured using five gas analyzer. The instrument consists of a probe which is inserted into the exhaust pipe. Smoke intensity was measured by means of a Bosch Smoke meter. The exhaust gas is used to measure the exhaust emission like HC, Co, Co2, O2 emission. A fixed amount of the exhaust gas was passed through a filter paper using pneumatically operated sampling pump. The exhaust gas temperature was measured by using a K- Type (Chromel-Alumel) thermocouple. The main aim is to run the engine on the test rigs and to calculate the characteristic performance and parameters of emissions of a bio-Diesel at various load conditions and the obtained results are compared with normal engine operating on Diesel as a fuel.
In the present work by using algae as a bio-deisel blend mixed with diesel by volume in different proportions are considered. The characteristic performance of the engine is measured in terms of break specific fuel consumption, break thermal efficiency, exhaust gas temperatures and emissions of the engine such as Nox, HC, CO, CO2.

III. EXPERIMENTAL PROCEDURE

The experimental procedure is as follows. With required amount of the water, the tank should be filled. With minimum 10lit of fuel the fuel tank should be filled and placed in the position. Supply water to the engine. Switch on the engine by operating the hand lever. By maintaining the speed constant, run the engine at different loads. The same procedure should be repeated.

IV. RESULTS AND DISCUSSION

Engine is allowed to run with various bio-diesel blends, time taken for the consumption of 10cm^3 fuel was calculated. The performance and emissions characteristics of the engine using algae are discussed below.

Brake thermal efficiency:

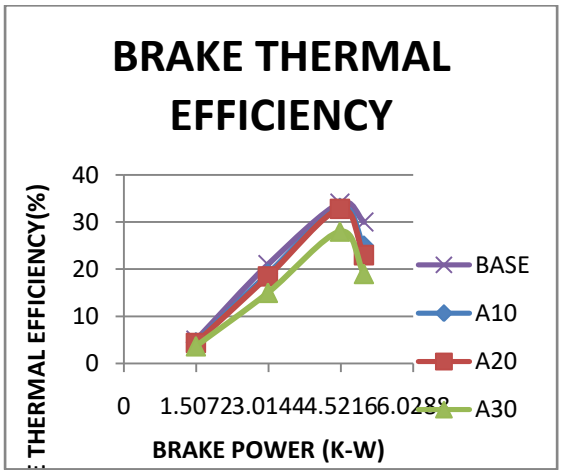

Figure 3: Brake thermal efficiency

The trend of Brake Thermal Efficiency of tested engine is recorded an increment up to three fourth load for algae bio-diesel as fuel. Further increase in load, BTHE is showing down trend due to increased fuel consumption. It also noticed from graph that, brake thermal efficiency of engine operating with bio-diesel percentage of 10 and 20% is lower than that of Diesel fuel and higher than the remaining blends.

Specific fuel consumption:

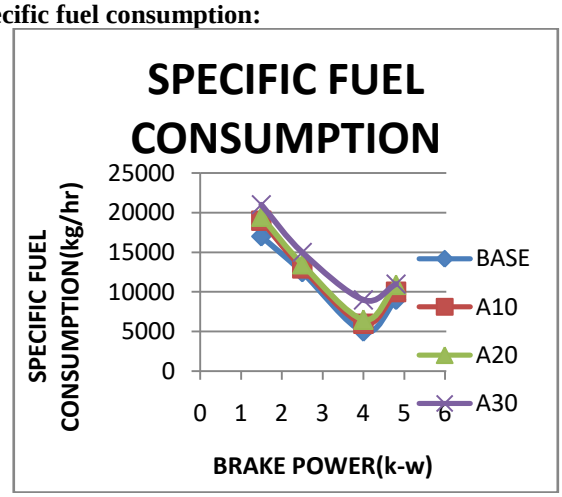

Figure 4: Specific fuel consumption

The trends of brake specific fuel consumption varying with BP is displayed in Figure 4. It is recognized from figure that BSFC of the tested engine increases with increase in quantity of bio-diesel and there is reduction with increase in load. This is mainly due to the effects of viscosity, lower heating value of blends and density of the fuel. As the bio-diesel blends percentage increases, its viscosity also increases and causes improper *atomization.* This causes the decrease in the combustion efficiency and increase in specific fuel consumption.

NOX emissions:

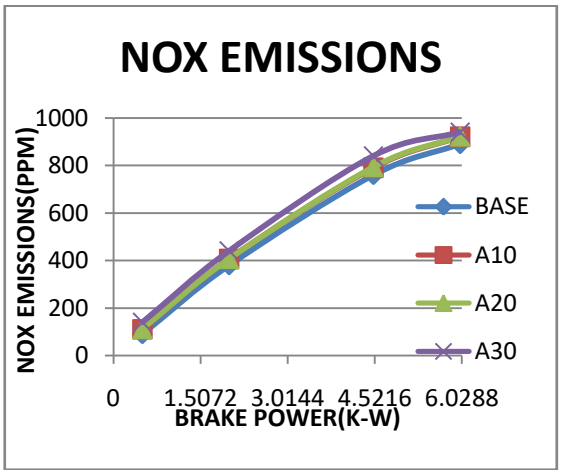

Figure 5: NOX emissions

The NOX emissions with load is shown in Figure 5. It is observed from the figure that the nitrogen oxides of the engine increases with the increase in the percentage of bio-diesel and decreasing with increase in load. It can also be observed from the figure that the NOX emissions of the engine operated with 10 and 20% bio-diesel blend are equal and is lower than the remaining blends.

CO emissions:

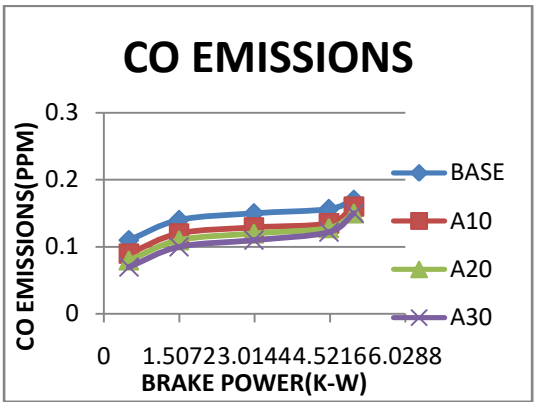

Figure 6: CO emissions

From the figure it is observed that the carbon monoxide emissions decrease. Reduction in emissions for A-30 is higher than the other. This increase is mainly, due to the presence of bio-diesel in larger percentages in the blend, due to which the oxygen percentage in the fuel increases. This excess oxygen in the fuel makes the mixture to undergo through complete combustion.

CO2 emissions:

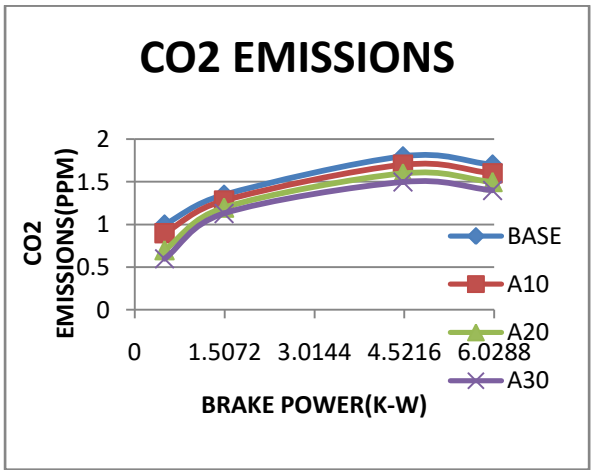

Figure 7: CO2 emissions

There is a linear variations in the carbon dioxide emissions with load of the engine, shown in (Figure 7). This is due to the fact that the presence of bio-diesel in the fuel is the major reason for the maximum portion of injected fuel to undergo through complete combustion during peak loads. The reduction in CO_2 emission for all the blended fuels is observed. It is also noted from the figure that when the percentage of bio-diesel in the blend increases the CO2 emission is decreased because bio diesel generally atomizes during combustion and releases less CO2.

Hydro carbon emissions:

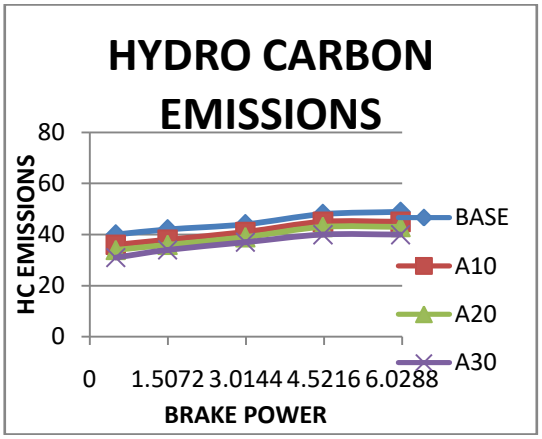

Figure 8: HC emissions

It is observed from the figure that the HC emission is decreased with bio-diesel in the blend. The maximum reduction is observed with A-30 blend followed by A-20 blends .This is due to the higher percentage of oxygen associated with bio-diesel in the blend.

Smoke intensity:

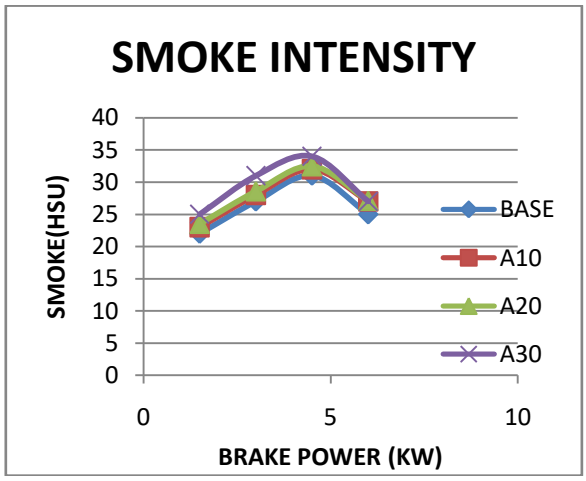

Figure 9: smoke intensity

Biodiesel from algae being highly oxygenated contains higher concentrations of oxygen which willallow faster and more complete combustion compared to fossil diesel fuel and this no doubt
influences the less amount or density of exhaust smoke to be released to the environment from the
compression ignition engine. in this study.diesel blend fuel produced less smoke density than all the algal biodiesel as the engine loads increased from 10 to 100%. All algal biodiesel samples produced very close density of smoke amongst themselves lesser than diesel blend fuel.

V. CONCLUSION

In this work, the test engine was evaluated for best performance of the engine with algae bio-diesel A20 as fuel with respect to the parameters of performance and emission characterization.

The conclusions drawn from the work are:

- The thermal efficiency of the engine is nearer to the Diesel engine for the blend A-20.
- The specific fuel consumption of the engine with A-20 as fuel is higher when compared with conventional engine with diesel as fuel.
- The CO2 emission is also higher for bio-diesel blend but less compared to diesel fuel.
- The Hydrocarbon emissions of bio-diesel blend A-20 is less than Diesel fuel.
- The emissions of CO with bio-diesel blends A-20 is less than Diesel fuel.
- Blend A-20 is the optimum blend for Diesel engines for better performance and emissions.
- Blends of A-20 is having higher performance when compare with other blends that are tested.

Among various blends of algae biodiesel tested in single cylinder four stroke diesel engine Algae-20 has the least exhaust characteristics and better performance characteristics. Hence 20% methyl ester of algae oil and 80% of diesel blend gives slightly better performance and reduced emission when compared to other diesel blends.

REFERENCES

1. H Harish; S Kumar; CR Rajanna; GS Prakash. *Int J Emerging Technol Adv Eng*. **2014**, 4(10), 255.
2. NR Banapurmath; PG Tewari; VS Yaliwal; Satishkambalimath; YS Bsavarajappa.*Renewable Energy*.**2009**, 1877-1884.
3. CY Lin**;** R Li. *Fuel Proces Technol*. **2009**, 90, 883-888.
4. S Fernando. *EB-Diesel Energy Fuels*.**2004**, 18, 1695-1703.
5. CV Mahesh; ET Puttaiah.*Int J Eng Res App*. **2012**, 2(3), 2288-2229.
6. M Gumus; C Sayin; M Canakci. *Fuel*.**2012**, 95, 486-494
7. P Kwanchareon; AL Mitchai; S Jai-In. *Elsevier Ltd*. **2006**, 9, 34.
8. R Behçet. *Fuel Process Technol*. **2011**, 92, 1187-1194.
9. ML Mathur, RP Sharma. Internal combustion Engine, **2010**.
10. Kirpal Singh. Automobile Engineering **1982**, 2.
11. HanumanthaRao,Y.V.; RamSudheer,V.S.; Hariharan,A.V.; SitaramaRaju.; and NageswaraReddy,P., Journal of the Braz. Society of Mechcanical Engineering, XXXI (3) July-September **2009** 253-260.
12. Rao, T.V.; and Ramana, P.V., Proceedings of National conference on advanced trends in Mech. Engg. Research and development, **2001** 15-18.
13. Altınet R.; and Cetinkaya. S., Energy Conversion and Management - **2001** 42 529–538.
14. Ali Yusuf; Hanna Milford, A.; Borg Joseph, E., Bio resource Technology, 52, **1995** 237–243.
15. Ranganatha, B.; and Majunath, H., International Engineering and Robotics research, 2(3) July **2013** 198-203.
16. Siva Kumar, A.; Maheswar, D. and Vijayakumar Reddy, K., Jordan Journal of Mech. & Industrial Engg., 3(3) **2009** 190 –197.
17. Sudhakarbabu, S.; Rama Chandra, R.; NagamalleswaraRao, G. and Naga Prasad Naidu, V., National conference on advanced 212 trends in Mechanical Engineering research and development (**2001**) JNTUCEA 593-596.
18. ShekarKallem; Preetham P. Chatarjee; ZahoorullaS.Md., National conference on advancements and innovations in Engineering Technology and Management – 19th & 20th March-**2014** ME-71.

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