Experimental Investigation Of Sesame Oil Ethyl Esters On 4-Stroke Single Cylinder Water Cooled Diesel Engine Added With Iso-Butanol

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Abstract

Increased energy demand and the concern about environment friendly technology, renewable bio-fuels are better alternative to conventional fuels. A process for the production of ethyl ester from Sesame oil containing 6.1% free fatty acid (FFA) for the use as a biodiesel was studied. These studies were carried out on transesterification reaction of Sesame oil with ethanol to produce biodiesel. The reaction parameters such as ethanol/Oil molar ratio, catalyst concentration and reaction time were optimized for the production of sesame oil ethyl ester (SOEE). The experiment investigation has carried out on single cylinder diesel engine to determined the properties , performance parameters and emissions of different blends of sesame oil ethyl ester diesel. To improve the process of ignition Iso Butanol is the ignition improver added in the process of experimentation for determining better results.

Keywords: Sesame oil, blended fuel, ethanol, Iso-Butanol

1. INTRODUCTION

Diesel fuel has an essential function in the industrial economy of a developing country and used for transport of industrial and agricultural goods and operation of diesel tractors and pump sets in agricultural sector. The requirement of petro diesel in India is expected to grow from 39.815 MMT in 2001-02 to 52.324 MMT in 2006-07 and just over 66 MMT in 2011-12. The domestic supply of crude oil will satisfy only about 22% of the demand and the rest will have to be met from imported crude. This has stimulated recent interest in alternative sources to replace petroleum-based fuels. Of the alternative fuels, bio-diesel obtained from vegetable oils holds good promises as an eco-friendly alternative to diesel fuel Vegetable oil is a promising alternative fuel for CI engine because it is renewable, environment friendly and can be produced in rural areas. The use of non-edible vegetable oils compared to edible oils is very significant in developing countries because of the tremendous demand for edible oils as food and they are too expensive to be used as fuel at present. The term, bio-diesel, was first introduced in the United States during 1992 by the National Soy Development Board (presently National Biodiesel Board), which has pioneered the commercialization of biodiesel in the USA.

India is a developing country. In the current scenario, India's oil consumption by end of 2007 is expected to reach 136 million tonne(MT), of which domestic production will be only 34 MT. India will have to pay an oil bill of roughly $50 billion, assuming a weighted average price of $50 per barrel of crude. In 2003-04, against total export of $64 billion, oil imports accounted for $21 billion. India imports 70% of its crude needs mainly from gulf nations. The majority of India's roughly 5.4 billion barrels in oil reserves are located in the Bombay High, upper Assam, Cambay, Krishna-Godavari. In terms of sector wise petroleum product consumption, transport accounts for 42% followed by domestic and industry with 24% and 24% respectively. India spent more than Rs.1,10,000 crore on oil imports at the end of 2004. Focusing our attention on the fossil fuels, World oil and gas reserves are estimated at just 45 years and 65 years respectively. Coal is likely to last a little over 200 years.

Global climate change due to fossil fuel emissions is a great concern of the present day. The accumulation of polluted gases like NO x, CO and particulate matter in the atmosphere cause acid rain, global warming and health hazards. In its fourth assessment report, the same mechanical press cannot be used for different type of seeds. Therefore, several methods have been proposed in recent years like solvent extraction technique, ultra sonication etc. A great variety of new approaches, based on different principles such as supercritical fluid extraction, microwave irradiation, closed system at high temperature and pressure have been developed in the last few years. Another problem with non-edible vegetable oil seeds is that they contain high free fatty acids and are not suitable as a feed stock for production of biodiesel by conventional alkaline transesterification method. Therefore, to use high free fatty acid and high moisture contain oil as a feed stock for production of biodiesel, several techniques have been proposed in recent years like acid catalyzed lipase catalysed and super critical transesterification.

The transesterification reaction proceeds with catalyst or without catalyst by using primary or secondary monohydric aliphatic alcohols having1-8 carbon atoms as follows:
Triglycerides + Monohydric alcohol = Glycerine + Mono-alkyl ester

Fig -1: Sesame crop and seeds

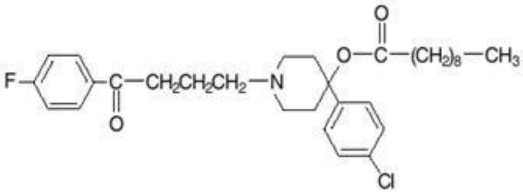
2. BIODIESEL PRODUCTION

Biodiesel is oxygenated compounds, defined as the mono alkyl esters of long chain fatty acids are also called ethyl esters derived from lipid feedstock for example vegetable oils, animal fats or even waste cooking oil. Pure oils are not suitable for diesel engines because they can cause the carbon deposits and pour point problems and they can also cause the problems like engine deposits, injector plugging, or lube oil gelling . So to use the oils in the diesel engines, they are chemically treated and that chemical process is known as transesterification. The transesterification which is also known as alcoholysis is the reaction of fat or vegetable oil with an alcohol to form esters and glycerol. Mostly a catalyst is also used to improve the rate and yield of the reaction. Since the reaction is reversible in nature, excess alcohol is used to shift the equilibrium towards the product. Hence, for this purpose primary and secondary monohydric aliphatic alcohols having 1-8 carbon atoms are used.

Table -1: Properties of Blends and diesel

Properties	Diesel	Oil	SOEE	B10	B20	B30	B40
Density (gm/cc)	0.835	0.91	0.89	0.85	0.855	0.86	0.87
Kinematic Viscosity (cst)	1.382	4.25	3.6	1.87	2.970	3.210	3.670
Flash point (°c)	50	260	185	42	42	45	47
Fire point (°c)	66	360	192	50	55	60	65
Calorific value (kJ/kg)	42500	39300	40220	42180	41860	41540	41220
Specific gravity	0.835	0.91	0.89	0.85	0.855	0.86	0.87

The chemical reaction of transesterification processes is shown below in fig.2 where R represents a mixture of various fatty acid chains depending on the specific oil in use. Subscript 3 represents the number of moles needed



to satisfy the formation of ethyl esters. The properties of different blends are given the table.1

Fig -2: Chemical Structure

3. EXPERIMENTAL SETUP

The engine used was a single cylinder, naturally aspirated four stroke, and direct injection diesel engine with a bowl in piston combustion chamber. The specifications of the engine used are given in Table 2. With the liquid fuel injection, a high-pressure fuel pump was used, a three hole injector nozzle. Engine was directly coupled to a dynamometer. exhaust gas temperatures measured by thermocouple which indicates reading on digital display, loads are applied by rope brake dynamometer at constant rpm 1500 which is measured by contact type tachometer. Smoke was measured by a opax 2000 II smoke meter Before running the engine to a new fuel, it was allowed to run for sufficient time to consume the remaining fuel from the previous experiment. The smoke meter was also allowed to adjust its zero point before each measurement. To evaluate performance, some operating parameters like speed, power output and fuel consumption were measured. Fig3 is the Experimental setup of four stroke, single cylinder, water cooled diesel engine.

Fig -3: Experimental setup

Make	Kirloskar
Power	5hp
Speed	1500rpm
no. of cylinders	1
compression ratio	16.5:1
Bore	80mm
orifice dia	20mm
type ignition	compression ignition
method of loading	rope brake
method of starting	crank shaft
method of cooling	Water

Table -2: Engine specifications

4. ADDING OF IGNITION IMPROVER

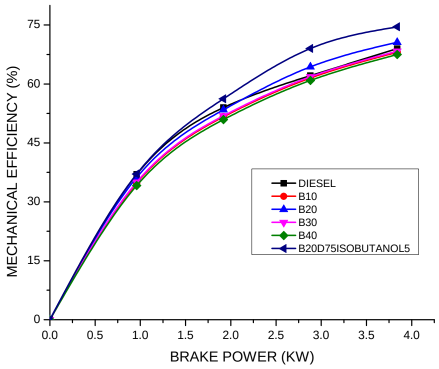
After obtain optimum blend from the experimental observations and results it was concluded B20 was best in terms of performance and emissions parameters. Optimum blend B20 addition of 5isobutanol (Ignition improver) ,experiments were conducted on the specified diesel engine at constant speed using B20D75-5isobutanol blend and note down the observation at zero load, spring balance reading, speed, time taken for 20cc of fuel consumption and the manometer readings. With the help of smoke meter and multi gas analyser note down exhaust emissions were recorded in the form of tables. By varying loads in steps 1/4, 1/2, 3/4 and full loads note down all the readings in diesel engine, smoke meter and gas analyzer, observations recorded.

While doing experiments fill the B20D75-5isobutanol fuel into the tank mounted on panel frame, on engine check the lubricating oil in the engine sump with help of dip stick and set optimum flow rate of water in rota-meter.

5. RESULTS AND DISCUSSION

5.1 Mechanical Efficiency

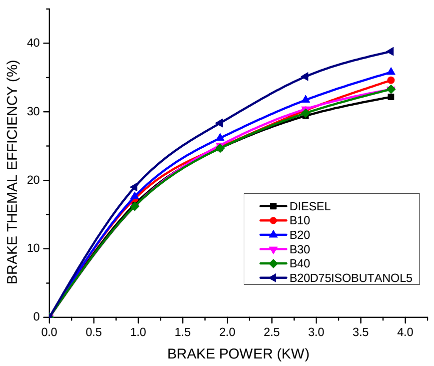
The variation of mechanical efficiency with brake power is shown in figure. The plot it is reveals that as the brake power increases mechanical efficiency increases. When compared to after other blends and compared to other blends B20(68.69) it give maximum efficiency. blend added with ignition improver isobutanol5% slightly increases (69.31) at full load conditions than B20 fuel.



Graph -1: Mechanical Efficiency vs Brake Power

5.2 Brake Thermal Efficiency

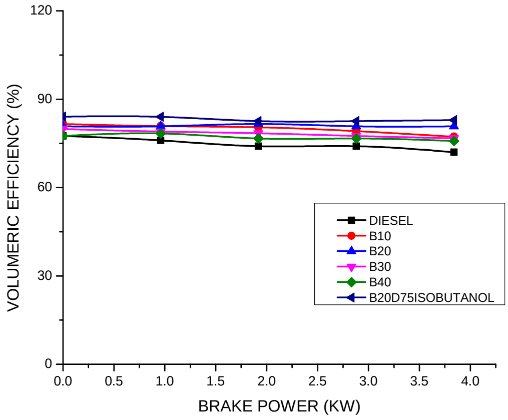
The variation of brake thermal efficiency with brake power is shown in figure. The plot it is reveals that as the brake power increases brake thermal efficiency increases . The maximum thermal efficiency for B20 at full load (35.79%) was higher than that of diesel (32.16%). The increment of BTE was observed with B20D75isobutanol5 at full load is (3.02%) higher than B20..



Graph -2: Brake power Vs Brake Thermal Efficiency

5.3 Volumetric Efficiency

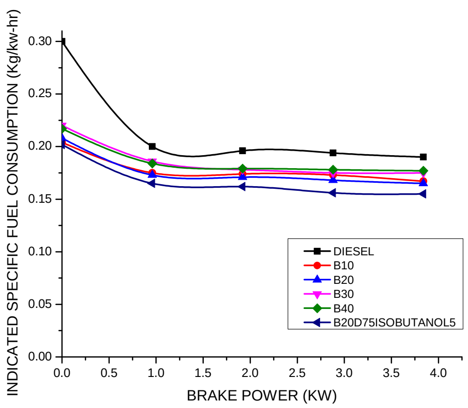
The variation of volumetric efficiency with brake power is shown in figure. The plot it is reveals that as the brake power increases volumetric efficiency decreases It is observed diesel contains 80.22 at full load, in case of B20 at full load 81.5%.therfore the increases in volumetric efficiency 8.07% while using B20 and added to the isobutanol5% .it gives volumetric efficiency is 81.75% for B20D75isobutanol5 is increases compared B20.



Graph -3: Brake Power Vs Volumetric Efficiency

5.4 Indicated Specific Fuel Consumption

The variation of indicated specific fuel consumption with brake power is shown in figure. The plot it is reveals that as the brake power increases indicated specific fuel consumption decreases. ISFC in B20 blend was reduced from 0.025 kg/kW-hr compared to diesel fuel at full load condition. The obtained blend B20 is added to the isobutanal5% then the combustion takes place very high. So the B20D75isobutanol5 blend gives the less amount of indicated specific fuel consumption is 0.155kg/ kW-hr and compared to B20 and other blends.

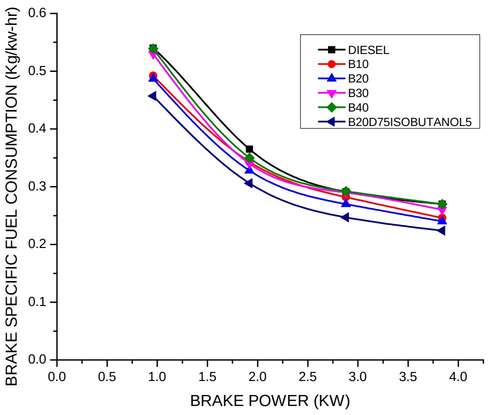


Graph -4: Brake power Vs Indicated Specific Fuel Consumption

5.5 Brake Specific Fuel Consumption

The variation of brake specific fuel consumption with brake power is shown in figure. The plot it is reveals that as the brake power increases brake specific fuel consumption decreases .It can be observed that the

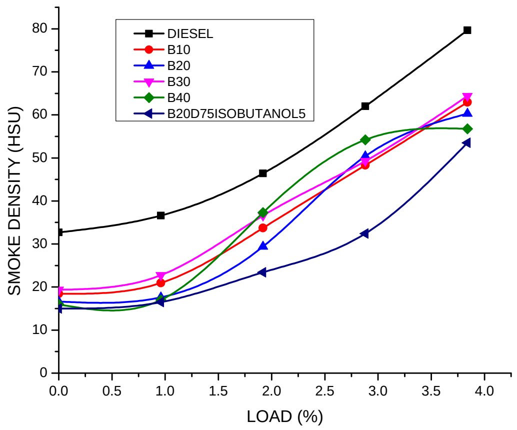
BSFC of 0.27 kg/kW-hr were obtained for diesel and 0.24 kg/kW-hr B20 at full load. It was observed that BSFC decreased compared to other blends. So the obtained blend added to the ignition improver isobutanol5% than decrease BSFC (0.22) compare to blend B20.



Graph -5: Brake Power Vs Brake Specific Fuel Consumption

5.6 Smoke Density(H.S.U)

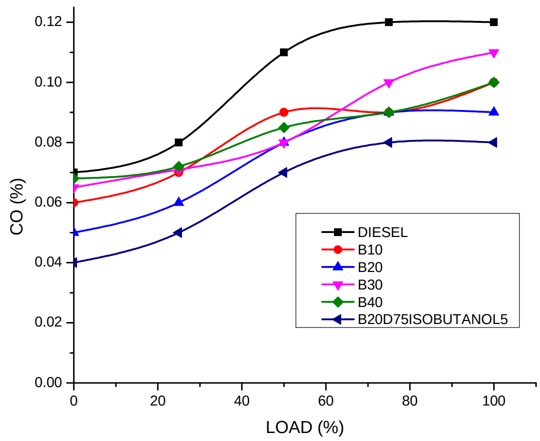
The variation of smoke density with load is shown in figure. The plot it is reveals that as the load increases smoke density decreases .The smoke density of sesame oil blend B20 slightly decreased when compared to the diesel at full load condition.



Graph -6: Load Vs Smoke density(H.S.U)

5.7 Carbon Monoxide(CO)

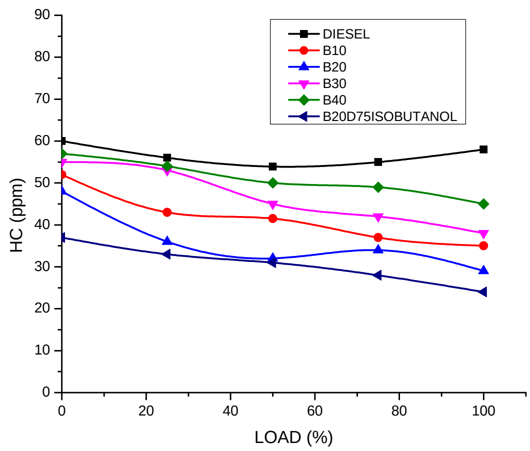
The variation of carbon monoxide with load is shown in figure. The plot it is reveals that as the load increases carbon monoxide decreases. The carbon monoxide of sesame oil blend B30 slightly decreased when compared to the diesel at full load condition. The CO content is decreased for B20 blend at full load compared with diesel and added to the isobutanol5. The B20D75isobutanol5 blend contains 0.08% of CO which is less than diesel and B20. This is because of pure combustion takes place while adding isobutanol5%.



Graph -7: Load Vs Co

5.8 Hydro Carbons(HC)

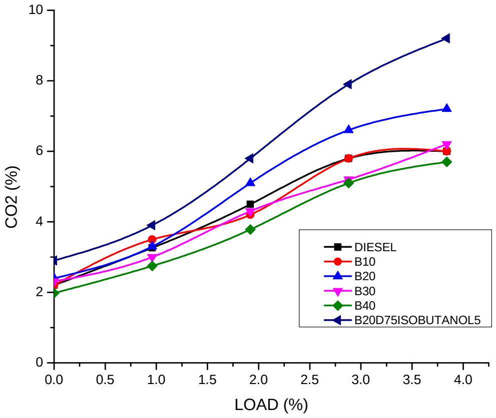
The variation of hydro carbons with load is shown in figure. The plot it is reveals that as the load increases hydro carbons decreases. At full load diesel contains 6.0 % of CO_2 emissions where as in case of B20 it is 7.2 %.The increase in CO_2 emissions is 1.2 %. The CO_2 emissions increased with load for all the fuel modes. At varying loads, the oxygen content in the SOEE improves the combustion process, which leads to a complete combustion and hence increased CO_2 emission than that of diesel and added to the isobutanol5% for B20.



Graph -8: Load Vs HC

5.9 Carbon Dioxide(CO2)

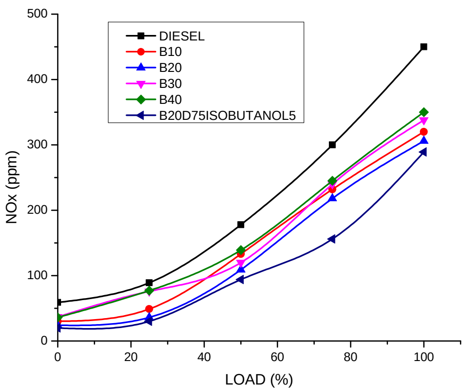
The variation of carbon dioxide with load is shown in figure. The plot it is reveals that as the load increases carbon dioxide decreases . At full load diesel contains 6.0 % of CO_2 emissions where as in case of B20 it is 7.2 %.The increase in CO_2 emissions is 1.2 %. The CO_2 emissions increased with load for all the fuel modes. At varying loads, the oxygen content in the SOEE improves the combustion process, which leads to a complete combustion and hence increased CO_2 emission than that of diesel and added to the isobutanol5% for B20. Then increased to combustion takes place increase the CO_2 compare to other blends.



Graph -9: Load Vs CO2

5.10 Nitrogen Oxide (NOx)

The variation of N0x with load is shown in figure. The plot it is reveals that as the load increases N0x Decreases. . The amount of NOx produced for B20 is 306 ppm, where as in case of diesel fuel is 450 ppm for diesel fuel. The N0x of sesame oil blend B20 slightly decreased when compared to the diesel at full load condition.



Graph -10: Load Vs NOx

6. CONCLUSION

- The experiments are conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500rpm) with varying 0% to 100% loads with diesel and different blends of Sesame oil like B10,B20, B30 and B40.
- The performance parameters such as ηMECH, ηBTE, ηVOL, BSFC and ISFC were calculated from the observed parameters and shown in the graphs.
- The emissions characteristics such as carbon monoxide(CO),hydro carbons(HC),carbon dioxide(CO2),nitrogen oxide (NOx),smoke density(H.S.U) are also decreased, will compared to diesel and other blends.
- It is observed that having 20% Sesame oil blend with addition of ignition improver Iso Butanol with diesel CI engine gives energetic results for as performance parameters. And emissions characteristics also decreases will compared to diesel at 20% Sesame oil blend with diesel.

REFERENCES

[1] The B, Mishra R, Gu,F, Ball AD. Water injection effects on the performance and emission characteristics of a CI engine operating with biodiesel. Renewable Energy 2012; 37:333-344.

[2] Tornqvist M, Ehrenberg L. On cancer risk estimation of urban air pollution. Environmental health perspectives 1994;
102(Suppl 4): 173.

[3] Iwai K, Adachi S, Takahashi M, Moller L, Udagawa T, Mizuno S, Sugawara I. Early Oxidative DNA Damages and Late Development of Lung Cancer in Diesel Exhaust Exposed Rats. Environmental Research 2000; 84(3): 255-
264.

[4] Dybdahl M, Risom L, Bornholdt J, Autrup H, Loft S, Wallin H. Inflammatory and genotoxic effects of diesel particles in vitro and in vivo. Mutation Research / Genetic
Toxicology and Environmental Mutagenesis. 2004; 562(1): 119-131.

[5] Vincent R. Acute Cardiovascular Effects in Rats from Exposure to Urban Ambient Particles, STATEMENT: Synopsis of Research Report 104. Safe Environments
Programme, ERA Grant Number: R828112C104, Environmental Protection Agency, 2003.

[6] Herchel, T.C.; Machacon,; Seiichi Shiga,;
TakaoKarasawa,; Hisao Nakamura. Performance and emission characteristics of a diesel engine fuelled with coconut oil –diesel fuel blend. Biomass Bioenergy, 2001, 20, 63-69.

[7] Kalam, M.A.; Husnawan, M.; Masjuki, H.H.
Exhaust emissions and combustion evaluation of coconut oil–powered indirect injection diesel engine. Renewable Energy, 2003, 28, 2405 –2415.

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