Available online at: http://www.ijmtst.com/vol6issue04.html

International Journal for Modern Trends in Science and Technology

ISSN: 2455-3778 :: Volume: 06, Issue No: 04, April 2020

Performance and Emissions characteristics of DI Diesel engine using different blends of Grape seed biodiesel

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To Cite this Article
Sk. Mohammad Shareef and P. Lakshmi Prasanna, "Performance and Emissions characteristics of DI Diesel engine using different blends of Grape seed biodiesel", International Journal for Modern Trends in Science and Technology, Vol. 06, Issue 04, April 2020, pp.:217-222.

Article Info
Received on 014-March-2020, Revised on 06-April-2020, Accepted on 17-April-2020, Published on 20-April-2020.

ABSTRACT

Diesel engine is an internal combustion engine which had made life easy and faster in modern life. These engines consuming lot of diesel fuel and have been increasing the atmospheric pollution. The availability of the diesel fuels is limited and in near future they may get exhausted. Hence there is a need for an alternate source of fuel which is abundant and environmentally friendly. The vegetable oils are the promising alternative among the different diesel fuel alternatives. Biodiesel is produced from vegetable oils or animal fats which are biodegradable and non-toxic. It has considerably reduced emissions when compare to diesel. Grape seed oil is a vegetable oil, generally grape seeds had 20% of oil content. So, the wasted grapes after wine manufacturing had no value. After processing the wasted grape pulp with pressing followed by solvent extraction was the method most widely employed to extract the oil from seeds. The extracted oil was treated with one of the methods which was used for the conversion oils to mono-alkyl esters. Here extracted fuel is transesterified to form the biodiesel. Which was one of the easy methods to work and economically feasible. The properties of grape seed oil were tested. The experimental work was done on 4-stoke single cylinder DI diesel engine with different percentages of grape seed oil combine with diesel. And calculated Performance characteristics like brake power, Specific fuel consumption, mechanical efficiency and Emission characteristics like HC, CO, NOx, CO 2 for particular blends like B10, B15, B20, B25, B30 are measured

KEYWORDS: *Diesel engine, Grape seed oil, Trasertification, Biodiesel, Performance and emissions*

I. INTRODUCTION

In the Modern technology for the purpose of transportation, there is an increase in usage of fossil fuels to run the automobiles, taxies, trucks and heavy vehicles in order to create the comfort, flexibility and time saving purpose. For running automobiles many energy sources are used such as solid, liquid and gaseous fuels. Among these, liquid fuels are widely used in order of reduced, engine modifications, emission effects, and exhaust problems. If we use the solid fuels in engine there are certain complications such as handling of the fuel as well as disposing off the solid residue or ash after combustion.

If we use the gaseous fuels, there are some problems such as storage and handling problems

and also in the aspect of storage of gas in expensive and risky task. In the order of the above complication's liquid fuels are more preferable to the run of automobiles.

But for running of automobiles, generally the engines are designed to use with gasoline and diesel fuels. But as the crude gasoline and diesel fuels are extinguishing and become costly day to day by their heavy usage, we have to go for another type of alternate fuels which are renewable sources.

A lot of research is going on all over the world on the potential use of many vegetable oils- neem, Grape seed oil, castor, soya bean, cottonseed, rapeseed, sunflower, palm oil, Aloevera oil, coconut oil etc. the vegetable oils are one of the renewable, non-toxic and biodegradable and produce low particulate emissions.

Grape seeds contain about 10-20% of oil, which is usually, extracted with solvent and refined before use in order to remove unacceptable materials with the least possible loss of oil.

A.Preparation of biodiesel from crude grape seed oil by transertification:

- Oil sample extracted was used for bio-diesel production using a base-catalyzed transesterification reaction.
- Oils containing low-free fatty acids level, would require 0.30-1.5% of the oil weight as base catalyst. It would require 1/5 the of its weight or volume of the alcohol for treating triglycerides to produce fatty acid methyl esters.
- A hydrous NaOH was added to methanol, stirred continuously till it dissolved.
- Extracted grape seed oil (1 liter) was heated in the container up to the temperature in the range of 550C to 800C.
- Prepare the solution of methyl alcohol (200 ml for 1 liter of grape seed oil) and base catalyst as Sodium hydroxide (3.8 grams of NaOH for 1liter of grape seed oil). For removing the excess glycerin and soap content and to form mono alkyl esters.
- Then the prepared mixture is left for 24 hours for settlement of glycerin at the bottom of the container. And the required methyl esters are moved to the top side of the container.
- The formed methyl esters are filtered separately, and bottom glycerin is filtered separately. The final product thus formed is biodiesel and it can be washed with H2O or HCl and is warmed in order to remove any soap content in the product
- Then the required grape seed biodiesel is prepared, which can be directly used in diesel engine.

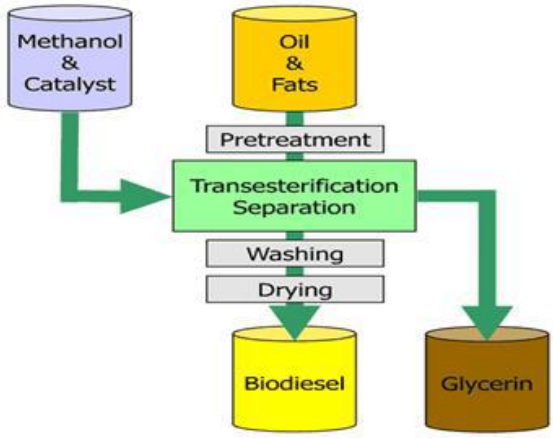

Fig 1. Bio-diesel preparation flow chart

Table 1. Properties of Grape seed oil

Properties	Grape Seed Biodiesel
Kinematic viscosity(m^2/s)	9.2
Density(kg/m^3)	889
Calorific value (Kj/Kg^{0}c)	39080
Flash Point(^{0}C)	72
Fire Point(^{0}C)	93

Fig 2. The Separated grape seed biodiesel from glycerin content

II. EXPERIMENTAL PROCEDURE

The details of the experimental set up are presented in this chapter. The experimental setup is fabricated to fulfill the objective of the present work. The various components of the experimental set up are presented in this chapter.

A.Experimental Setup

The experimental set up consists of the engine with electrical loading type, air cooled, and dynamometer coupled with generator.

The experimental work is carried on naturally aspirated 4-stoke single cylinder DI diesel engine with specifications tabulated in table and with

clear indication of several key components with tested engine set up.

Table 2. Engine Specifications

TYPE	SPECIFICATIONS
Engine Model	Kirloskar Engine
Applied Load Type	Electrical Load
Type of dynamometer	Coupled with generator
Type of cooling	Air cooled
Rated Speed	1500rpm
Brake horsepower	6.5hp
Stoke length	110mm
Bore Diameter	80mm
No of cylinders	1

Fig 3. Experimental Set up of the 4-strokesingle cylinder DI diesel Engine

B. Experimental Procedure

Experimental procedure was explained below.

1. The engine is started at no load condition and allowed to work for at least 10 minutes to stabilize.
2. The readings such as time taken for 10cc fuel consumption, ammeter & voltmeter readings etc. were taken as per the observation table.
3. The load on the engine was increased by 20% of FULL load using the engine controls and the readings were taken as shown in the tables.
4. Step 3 was repeated for different loads from no load to full load.
5. After completion of test, the load on the engine is completely relieved and then the engine is stopped.
6. The results were calculated.

The above experiment is repeated for various blends on the engine. The experimental procedure is similar as foresaid. While starting the engine, the fuel tank is filled in required fuel proportions up to its capacity. The engine is allowed to run for 20 min, for steady state conditions, before load is performed. Finally, the engine is run by blend (200atm) at various Brake Powers and the corresponding observations are noted.

The test is carried on the new Kirloskar Engine for the following fuel blends.

- 100% Diesel.
- 10% Grape seed biodiesel+90% Diesel
- 15% Grape seed biodiesel+85% Diesel
- 20% Grape seed biodiesel+80% Diesel
- 25%Grape seed biodiesel+75% Diesel
- 30%Grape seed biodiesel+70% Diesel

C. The Procedure for emissions measurement:

While running the engine for every blend taken the different emissions obtained from engine.

The types of emissions obtained from the engine are

- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Carbon Dioxide (CO2)
- Oxygen available(O2)
- Oxides of Nitrogen (NOx)

D. Emissions Testing

Automotive Emission Analyzer:

This Equipment is used to measure the gas emission density of an automobile enabling to diagnose the automobile status and its preventing maintenance so that it can be provide a function to prevent air pollution in advance. It is a five-gas analyzer which can detect five gases, those are CO, HC, CO_2, O_2 and NO_x. It is also giving air-fuel ratio and air surplus rate. It gives accurate and instantaneous results especially when compared to the similar commercially available equipment. Its high measuring range and good resolution meets the requirements that a research work needs.

Fig 4. Exhaust Gas Analyzer

Procedure:

1. Switch on the analyzer and wait for some time to warm up and for zero settings.
2. Check for any leakage by inserting the cap at the tip of the probe and ensure that initialization process is done.
3. Select the engine type, and then the system will enter in measurement mode
4. Insert the probe in the exhaust pipe, then pump will suck the gas which is having different emissions with the respective concentration will be displayed on the screen.

III. Results and Discussions

A.Performance Characteristics

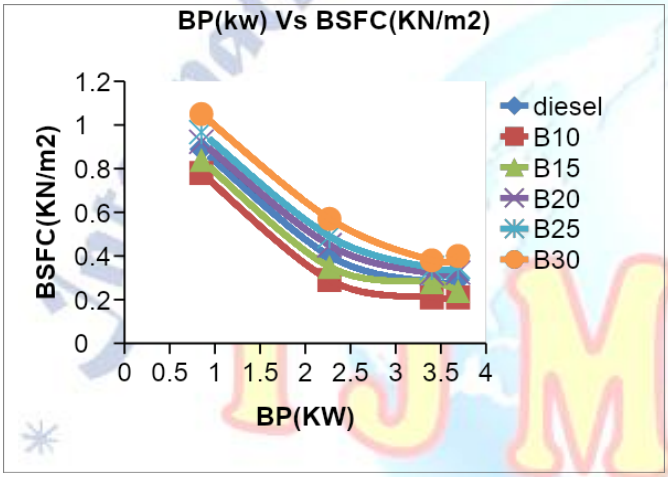

Fig 5. Brake Power Vs Brake Specific Fuel Consumption

The Fig 5 is showing the result of BSFC for different blends grape seed biodiesel with diesel. The fuel consumption of Blend B10 is slightly lower than that of diesel because Grape seed oil is quite high in density than diesel hence this leads to lesser fuel consumption for same power outputs.

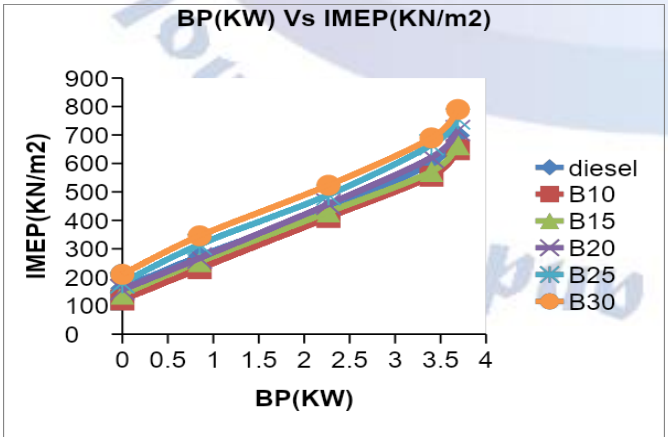

Fig 6. Brake Power Vs IMEP

The Indicated mean effective pressure is the average pressure produced in the combustion chamber during the operating cycle. The gradual variation of the indicated mean effective pressure with respect to the brake power is observed from the Fig 6 IMEP of the diesel is more when compare to the different blends of grape seed oil due to high density and high viscosity of grape seed oil of 100%blend, which gives poor atomization. B10 gives nearer values to the diesel when compare to other blends.

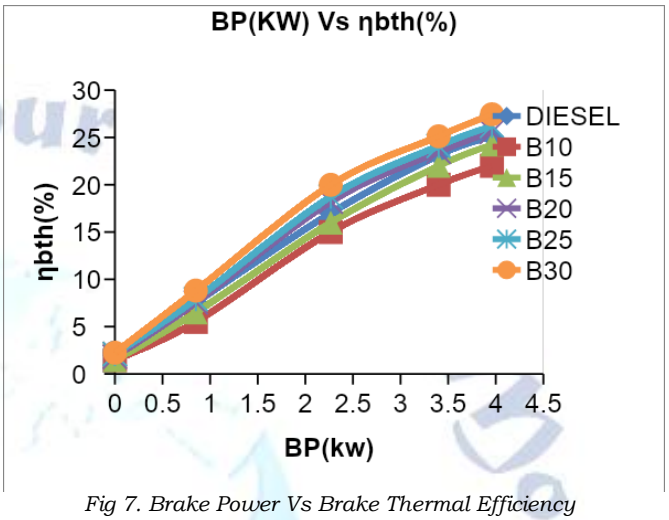

Fig 7. Brake Power Vs Brake Thermal Efficiency

Fig 7 is showing the result for BP Vs BTH of different blends of grape seed biodiesel with diesel. The maximum brake thermal efficiency of the diesel is 26.27%, which is more when compare to the different blends of grape seed biodiesel. The blend B10 is giving the value of BTE is 26.12% which is near to the diesel. Percentage of grape seed biodiesel in diesel increases, reduced the brake thermal efficiency due to low calorific value of the grape seed biodiesel when compare with diesel.

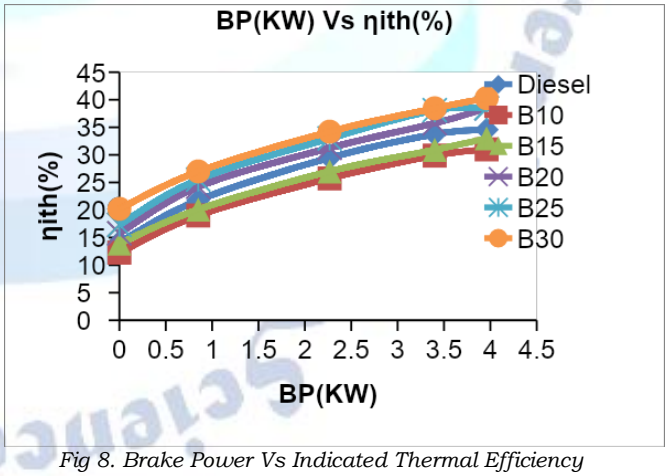

Fig 8. Brake Power Vs Indicated Thermal Efficiency

From the Fig.8 (BP Vs ηith), the indicated thermal efficiency of the Pure diesel is higher than grape seed biodiesel because of lower the calorific value of GSO when compare with diesel and increase in the friction power. The maximum indicated thermal efficiency of the diesel obtained is 34.57 % and the blend B10 is giving the value of ηith is 34 %, which is near to the diesel.

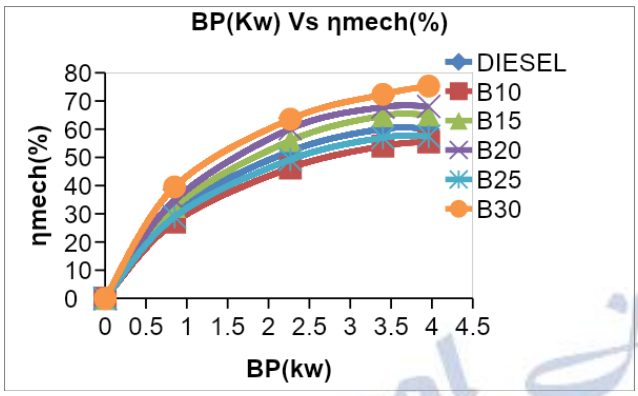

Fig 9. Brake power versus mechanical efficiency

From the Fig 9 it is observed that the mechanical efficiency of blend B10 is slightly more the diesel, because the viscosity of blend B10 is less than and nearer value to that of diesel. so B10 is having higher mechanical efficiency than diesel.

B. Emissions Characters

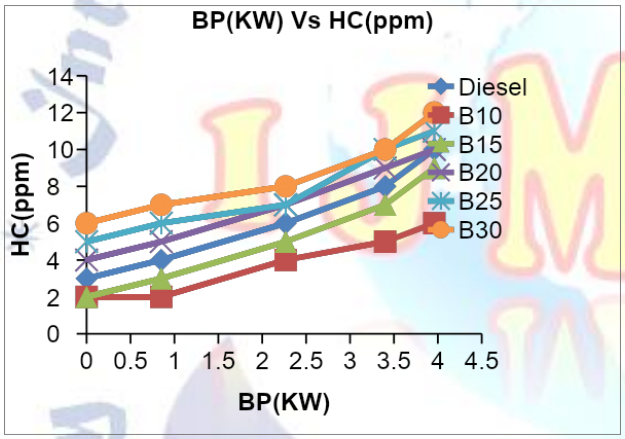

Fig 10. Brake Power Vs HydroCarbons

From the Fig 10 (BP Vs HC) It is observed that HC emissions are increased with increase in load. the hydrocarbon emissions of blend B10 is less than that of diesel because the blend B10 is having less density than diesel, there due to homogeneous mixture and complete combustion takes place which leads to lesser HC emissions at this blend.

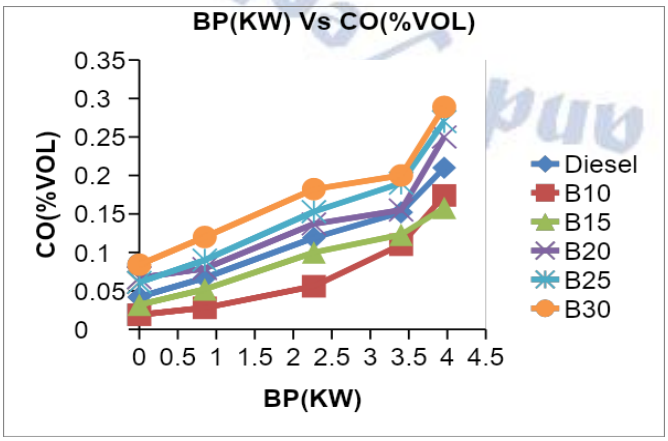

Fig 11. Brake Power Vs CO(%vol)

From the Fig 11 (BP Vs CO) The CO emissions of blend B10 are lesser than diesel among all blends because as the fuel B10 has less volatile nature so due to more availability of oxygen, complete combustion of carbon compounds takes place which leads to lesser the CO emissions.

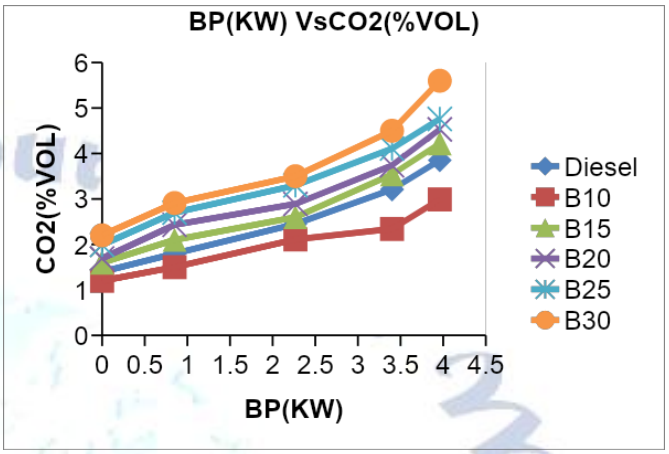

Fig 12. Brake Power Vs CO2(%vol)

From the Fig 12 (BP Vs CO_2) TheCO2 emissions of blend B10 are slightly higher than that of Diesel because of availability of more oxygen, the unburned carbons left after combustion combines with excess oxygen leads to formation of CO2 emissions.

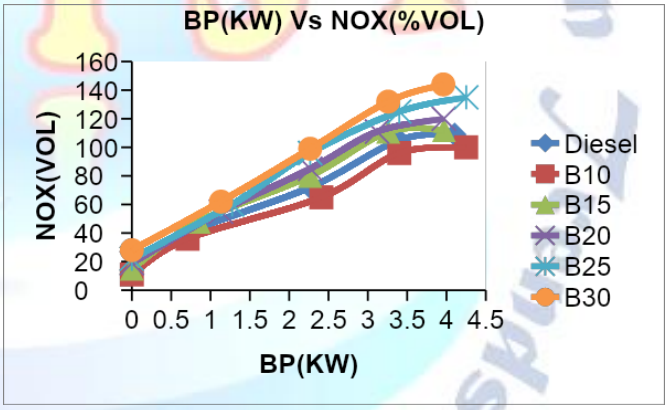

Fig 13. Brake power versus NOx (% vol)

From the Fig 13 the NOx emissions of blend B10 are more, Due to higher heat release and high pressure and temperatures employed during combustion results in increase of NOx emissions when compare to diesel.

IV. Conclusions

The Conclusion based on the experimental results obtained while operating single cylinder air cooled diesel engine fueled with grape seed biodiesel and its blends.

- The grape seed oil extracted from grape seed wastage was treated by transesterification process to form mono-alkyl esters.

- The transesterified oil and diesel was combined and prepared different blends with proportions like B10, B15, B20, B25, and B30. The prepared blends tested on the 4-stroke single cylinder direct injection diesel engine. The graphs are plotted for the obtained results.

- The analysis it was concluded that performance characteristics such as the brake thermal efficiency of diesel engine is improved when it is fueled with Grape seed biodiesel blends. The maximum brake thermal efficiency of the diesel is 26.27%, which is more when compare to the different blends of grape seed biodiesel. The blend B10 is giving the value of BTE is 26.12% which is near to the diesel. The diesel has BTE higher only by 0.15%.
- The mechanical efficiency is higher for blend B15,B20,B25,B30 but among all B10 has slighter higher value i.e. and near value obtained when compare with the diesel .and The indicated thermal efficiencies is high for diesel when compare with B10, is nearer values to diesel with lower Specific fuel consumption for the blend B10 among all blends.
- While considering the emissions HC and CO are reduced and CO2 and NOx emissions were slightly higher than that diesel at the blend B10. Remaining blends had lower performance and higher emissions when compare with diesel.
- By comparing the properties of all the blends with diesel, blend B10 is having the nearer values to the diesel and given the best results.

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