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EXPERIMENTAL INVESTIGATION OF CI ENGINE FUELLED WITH KARANJI OIL AS BIODIESEL USING PYROGALLOL AS ANTIOXIDANT

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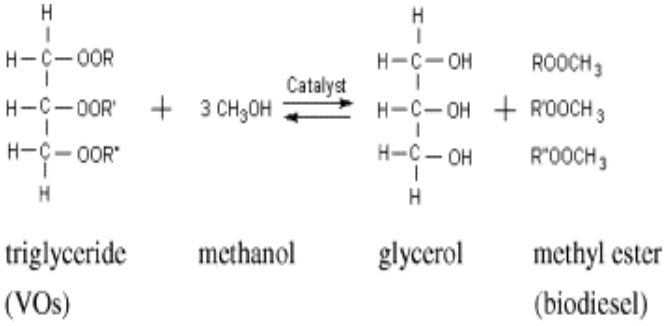
Abstract - *In current conditions energy is considered as a basic factor for financial development, social advancement and human welfare. To meet the consistently rising demand for energy, biodiesel is used as an alternative fuel got from karanji seed oil. Biodiesel derived from karanji seeds have effectively demonstrated as potential alternative for diesel engine. Anyway more research is to be done on alternative fuels using additives. In this experimental investigation is done on single cylinder compression ignition engine using karanji biodiesel prepared by transesterification process with an additive pyrogallol [C6H6O3].Pyrogallol as an antioxidant provides oxidation stability to the biodiesel. The performance and emission tests are done at different loading conditions.Tests are done using different blends namely B10,B15,B20,B10A,B15A,B20A.By the addition of pyrogallol to the biodiesel brake thermal efficiency came nearer and more to that of pure diesel performance.Emissions are also very less for all blends when compared to pure diesel.*

1. INTRODUCTION

Due to diminishing fossil fuels values and natural concerns are driving the researchers to develop alternative fuel. Now a day's karanji oils from trees are used as biodiesel rather than throwing away the seeds. This method of conversion into alternative fuel benefits us both environmentally and economically. The Karanji seed oil can be converted into biodiesel by several methods. The most common method is by using Transesterification process. In this process the oil is chemically treated with alcohol namely methanol/ ethanol in presence of the catalyst for yielding a fatty acid alkyl ester and glycerol (collected from the bottom). Mixes of biodiesel are presently well embraced and picking up in market. Biodiesel is a fuel contained mono-alkyl esters of Long-chain unsaturated fats got from karanji oil, B100, may cause some operatability issues. Viscosity, thermal and oxidation strength are the most noteworthy issues to avoid them, researchers doing research on biodiesel mixes.



1.1 Additive

Biodiesel is viewed as an inexhaustible substitute for fossil diesel; however its poor oxidative nature is a deterrent to its total acknowledgment. The biodiesel is less volatile when compared with the diesel. Regardless it is unprotective to the oxidation degradation because of auto-oxidation within the sight of oxygen. Addition of antioxidant is the only solution for this problem. Various investigations have demonstrated the significant increment in engine NOx with biodiesel fuel. Antioxidant addition may influence the engine emissions and in addition the Performance of the engine. Although biodiesel consists of natural antioxidants they are subjected to loss during refining process. At higher temperatures the antioxidants present in the biodiesel becomes invisible at fast rate, diminishes the stability. Addition of pyrogallol to the Biodiesel results in the oxidation stability.

2 Literature review

[1] 1. Dr. Narendiranath Babu T and V. Sowri Praneeth,effect of an additive in karanja biodiesel blends on the performance and charecterstics of diesel diesel engines.

[2] P. L. Naik, D. C. Katpatal, Performance Analysis of CI Engine using Pongamia Pinnata (Karanja) Biodiesel as an Alternative Fuel

3. EXPERIMENTAL SETUP AND MATERIALS

3.1. Materials:

The biodiesel used in the experiment is derived from karanji seed oil which is collected from trees. Firstly the oil is filtered for the removal of solid particles and then it is heated up to certain temperature for the removal of water content or moisture. In further step the oil is converted to

biodiesel using transesterification process. The preheated oil is added to potassium methoxide which is obtained by dissolving potassium hydroxide catalyst in methanol. The mixture obtained is stirred in a magnetic stirrer for 2 hours at 55◦C.Then it is allowed to settle for three hours. After three hours we can observe the esters are formed on the top and glycerol is settled at the bottom. Those esters are cleaned with water for the removal of impurities.Fossil diesel is blended with biodiesel in different percentages. To this final biodiesel yield antioxidant pyrogallol is added in the concentration of 1000ppm to the final biodiesel blend.

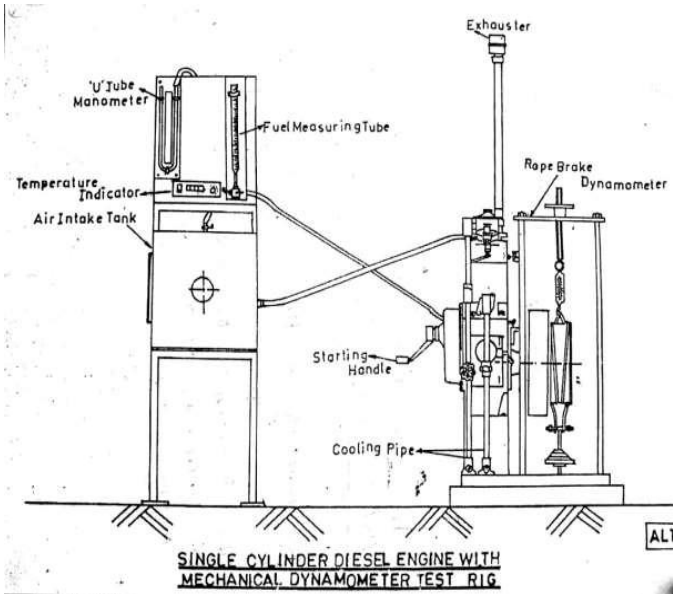
Antioxidant (pyrogallol)

3.2. Engine Setup:

Present experiment is done on four stroke single cylinder water cooled diesel engine. The engine is coupled with rope brake dynamometer arrangement to absorb the mechanical power produced by the engine. Necessary weights and spring balance are included to apply load on the break drum. Suitable water cooling arrangement for the brake drum is provided for engine cooling. A fuel measuring system consisting of a fuel tank mounted on a stand, burette and three way cocks is provided.

Table -1: Sample Table format

Features	Details
Make	kirlosker model AV
Bore(dia)	80mm
Stroke(L)	110mm
R.P.M	1500
Compression Ratio	16.5:1
Diameter of the Orifice	30mm
Diameter of the rope	0.15mm



Line diagram of kirloskar engine

3.3. Test Procedure:

Fuel level and the lubricating oil levels are checked before starting the engine. After that the three way cock is opened so that the fuel will flow to the engine. Cooling water is supplied to the engine through inlet pipe.Engine is started to run at rated speed and allowed to warm up for 5 minutes.Load the engine by adding the required weights to the hanger.Time taken for 10cc of fuelconsumption, load on the engine, manometer reading, speed at different loads were noted.Emission test was done using AVL DIGAS-444 five gas analyser.

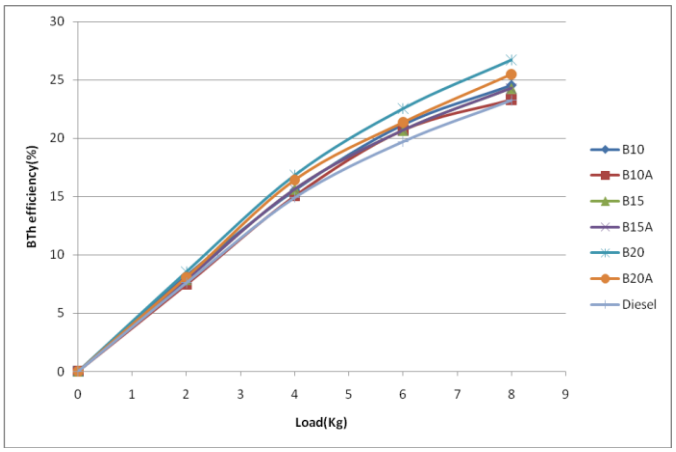
AVL DIGAS-444 five gas analyser.

4. RESULTS AND DISCUSSION

4.1. Engine Performance:

From the below graph we can clearly observe that brake thermal thermal efficiency of the engine is higher than the diesel for every blend used. Highest efficiency (26.74%) was found at 8kg load for B20 blend when compared to all other

blends of Biodiesel. By using B10 and B10A the efficiencies are 1.34% and 0.10% higher than that of diesel respectively at half load. When comes to B15 and B15A they are 2.7% and 1.044% higher than pure diesel.

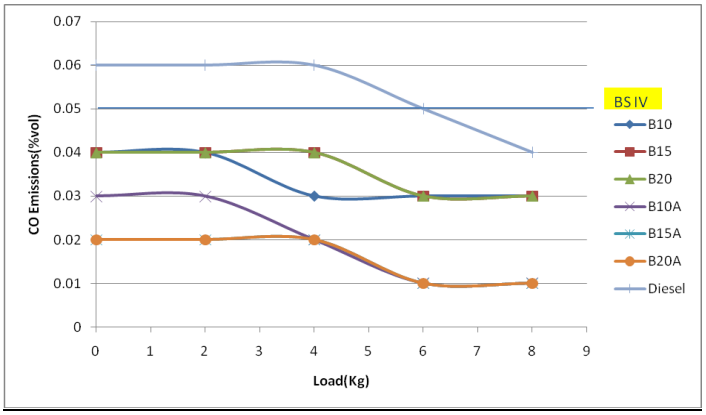


Variation of brake thermal efficiency with load for different blends

From the above observation it is clear that pyrogallol brought the biodiesel efficiency of engine slightly high to that of diesel efficiency.

4.2. Engine emissions:

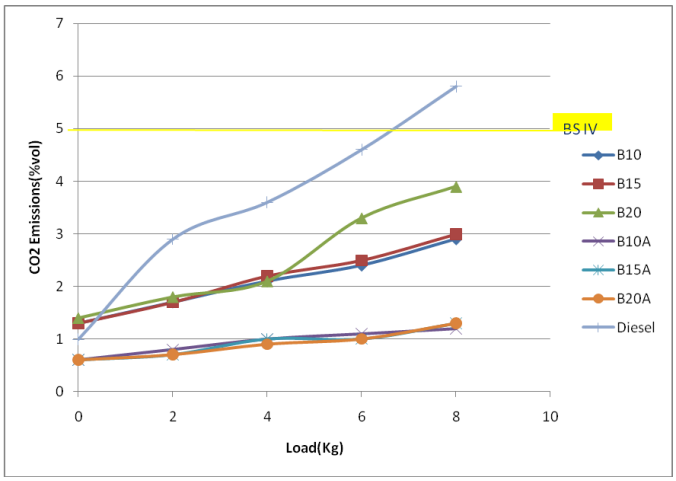
(i)CO:



Variation of CO emissions with load for different blends used and Diesel

In this emission result emission was constant or reducing after the load of 6kg. Normally, In Diesel engines CO emission is more up to certain load and reduces gradually but that is more than the permissible limits. When Bio-Diesel is used CO emissions can be reduced up to some extent. From the graph, it is clear that by using Pyrogallol additive the CO content was reduced more and is in permissible limit. During the usage of biodiesel at 8kg (50%) load CO emissions are reduced from 0.04%vol for diesel to 0.03%vol, where as by addition of Pyrogallol they are reduced to 0.01%vol.At no load case we can see the emmisions are high with diesel 0.06%vol, when comes to biodiesel the are 0.04%vol and 0.01%vol when additive is added. As well as these emissions are within the limit of BS IV standards as shown in the above figure.

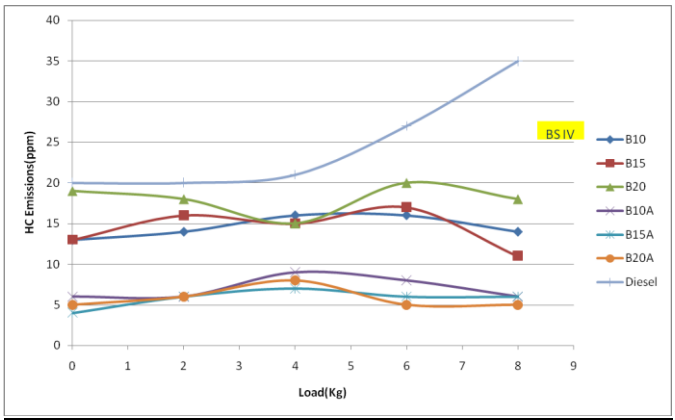
(ii) CO2:



Variation of CO2 emissions with load for different blends used and Diesel

Regarding CO2 emissions were increasing with respect to load. Diesel engine produces more under higher loads When Bio-Diesel is used it has reduced to some extent but when additive Pyrogallol is used we can observe more reduction in levels of CO2.This is happened because of less oxidation due to the presence of pyrogallol. At 8kg (50%) load we can see that the CO2 emissions are very high i.e., 5.8%vol, by using biodiesel it is reduced to 2.9%vol for B10 blend and after addition of antioxidant it reduced to 1.2%vol. As well as biodiesel emissions are within the limit of BS IV standards as shown in the above figure. And the emission is fallowing the trend that is emissions are increasing with respect to load.

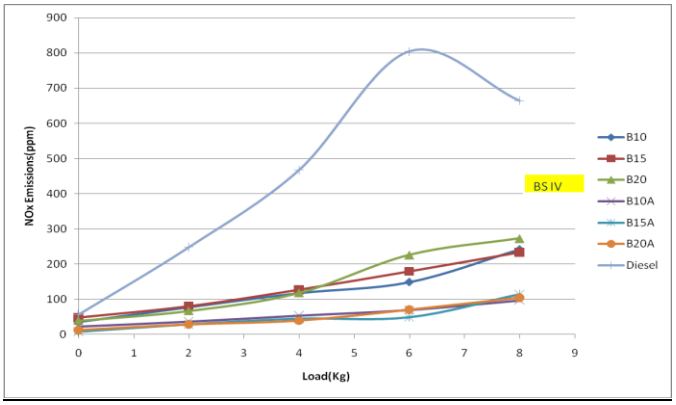
(iii)HC:



Variation of HC emissions with load for different blends and Diesel

HC Emissions are usually more in Diesel engine at higher loads. But when Bio-Diesel blends are used it is high at zero loads and it reduced gradually. Similarly when Bio-Diesel along with Pyrogalol was used HC emissions reduced to great extent.At maximum load used HC emissions for pure diesel was 35ppm they are reduced to 14ppm,11ppm,18ppm by using B10,B15,B20 blends respectively. When it comes to additive blend they are reduced to 6ppm, 6ppm, 5ppm for B10A, B15A, B20A blends respectively. Even though diesel having more than BS IV standards, biodiesel is having the emissions within the limit of BS IV standards.

(IV) NOx:



Variation of NOx emissions with load for different blends and Diesel

NOx emissions were increasing with respect to load. NOx emissions were high for Diesel because of higher temperatures at higher loads. But when Pyrogalol along with Bio-Diesel used as a fuel it reduced to a greater extent at higher loads even. At higher load i.e., 8Kg when diesel is used

NOx emissions are 664ppm, which are reduced to 242ppm, 233ppm; 273ppmfor blends B10, B15, and B20 respectively. Whereas by addition of pyrogallol there is a drastic decrease in NOx emissions to 97pm, 114ppm, 105ppm for B10A, B15A, B20A blends. And in graph we can get clearly that at some cases diesel is having the emissions more than the BS IV standards but biodiesel having emissions within limit of BS IV standards as shown in figure.

5. CONCLUSION

From the above experimental investigation it is clear that the efficiency of the engine increased for the blends of biodiesel and also the efficiency came nearer to that of diesel when antioxidant is added. Highest Brake thermal efficiency was found for B20 which is 3.5% high compared to diesel at same conditions of load i.e. at 8kg load. The Exhaust emissions i.e.,CO,CO2,HC,NOx are very less for both the cases, far more less when pyrogallol is added because of increased percentage of oxygen.CO,CO2,HC,NOx emissions are 33.4%,50%,49.62%,64.90% reduced respectively when biodiesel blend is used. In the case of Additive blends they are reduced by 66.66%, 77.51%, 85.71%, and 58.36% respectively. So it is clear that pyrogallol usage has a most prominent effect on the decrease of engine emissions

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BIOGRAPHIES

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Dr. K. Govindarajulu Professor of Mechanical Engineering, J.N.T.University, Anantapur, India, Number of Research publications: International Journals : 58 National Journals : 04 International Conferences : 19 National Conferences : 20