Performance and Emission Analysis of Duel Biodiesel on Vcr Engine

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Abstract- *The increase in the use of vehicles as well as the industrial needs leads us to find more efficient alternative fuel to reach the energy demand. This is due to the depletion of conventional fuel resources. The environmental issues we are facing now are also made us to go towards the alternative fuels. Many experiments were conducted so far on different vegetable oils and animal fats already. In this present study, an attempt was made to combine two different vegetable oils from Jatropha oil and Rice Bran oil blended with diesel. The experiments were conducted on a single cylinder, four stroke, Variable Compression Ratio(VCR) C.I. engine with water cooling at different compression ratios to examine the performance and emission characteristics. The results so obtained were compared with that of Diesel and Jatropha biodiesel at the same working parameters. The comparison gives an increase in the Brake power, Mechanical efficiency, Brake thermal efficiency and a decrease in the Specific Fuel Consumption with duel biodiesel of B10 and B30. But the emissions of CO, HC, CO_2, unused O_2 and Smoke of duel biodiesel are higher than diesel and Jatropha biodiesel.*

Keywords- VCR CI engine - performance, emission analysis, vegetable oils blended with diesel.

I. INTRODUCTION

In its most general sense, biodiesel has been used to refer to any diesel fuel substitute that is derived from renewable biomass. In the past few years, biodiesel has taken on a more specific definition and currently refers to a family of products made from vegetable oils or animal fats and alcohol, such as methanol or ethanol. These are called alkyl esters of fatty acids. In order for these alkyl esters of fatty acids to be considered as viable transportation fuels, they must meet stringent quality standards; otherwise they become standard industrial chemicals that are not suitable for diesel applications. Thus alkyl esters of fatty acids that meet transportation fuel standards are called biodiesel. The present energy crises caused by continuous depletion of scarce fossil fuels has resulted into global price hike of crude petroleum and is bound to affect the economy of many countries. Apparently vegetable oils have been gaining worldwide attention as an alternative energy source because they are environment friendly and renewable in nature. India is ranked fifth in the world after China, Japan, Russia, and United States of America in terms of fossil fuel consumption. Recently in India launched "National Mission on Biodiesel" with a view to find economical and renewable liquid fuel based vegetable oils. Biodiesel and bio ethanol have emerged as the most suitable for renewable alternative to fossil fuel as their equality constituents match diesel and petrol.

II. CHARACTERISTICS OF BIODIESEL

1.Biodiesel is a fatty acid ethyl or methyl ester and has properties similar to petroleum diesel fuels. The specifications of biodiesel are such that it can be mixed with any diesel fuel.2.Cetane Number of the biodiesel is in the range of 48-60 and the sulphur content is typically less than 15ppm.3.Studies conducted with biodiesel on engines have shown substantial reduction in particulate matter (25%-50%).4.However a marginal increase in NO_x(1-6%) is also reported. But it can be taken care of either by optimization of engine parts or by using De-NOx catalyst.5.HC and CO emissions were also reported to be lower. Non regulated emissions like PAH etc. were also found to be lower. Thus, biodiesel can supplement the supply of environment friendly fuels in our country in future.6.In conventional diesel fuels, the reduction in sulphur content is compensated by adding additive for lubricity.7.Flash point of biodiesel is high (>100^{o}c). Its blending with diesel can be utilized to increase the flash point of 35^{0}c well below the world average of 55^{o}c. this is important from the safety point of view.

It is observed from the trend of energy use of developing countries that the energy needs are growing exponentially because of rapid increase in population, economic growth and individual energy consumption. The ever-increasing expenditure on the fuel oil imports is causing economic imbalance, price hike and hardships for the people. At the same time, emissions produced from the use of fossil fuels are contributing a lot for the irreparable damage of the

environment and ecosystem. Even if the stringent set norms for energy conservation and emissions have not been able to bring the situation in the right track. Hence other viable options need to be explored. In this context alternative energy technologies offer a promising solution. In this context alternative energy technologies offer a promising solution.

III. LITERATURE REVIEW

Ankur Nalgundwar et al [1] used the mixture of palm and Jatropha oil as duel biodiesel with diesel and evaluated the performance and emissions on a single cylinder four stroke air cooled direct injection CI engine at different blends (B10, B20, B40, B50, B60, B80, and B100). Result indicated that lower blends of duel biodiesel up to 20% have good performance near to that of diesel. B10 sample given an increase in the brake power and a decrease in specific fuel consumption when compared to diesel. B40 and B80 biodiesels showed an increase in brake specific fuel consumption but an increase in brake thermal efficiency. The samples of B10, B20 and B30 showed a reduction of CO emissions and the higher blends produced an increase in CO emissions than diesel. Lower biodiesel blends showed higher CO_2 emissions than higher biodiesel blends. Also lower biodiesel blends showed less increase in NOx emission than that of higher biodiesel blends samples. He concluded that B10, B20, B30 biodiesels of duel biodiesel can be used as alternative fuel in diesel engine without any engine modification.

Jatropha oil

Jatropha Curcas has been identified for India as the most suitable Tree Borne Oilseed (TBO) for production of biodiesel both in view of non-edible oil available from it and its presence throughout the country. Jatropha Carcas is resistant to drought, pests and produces seeds containing 27-40% oil, averaging 34.4%. The remaining press cake of Jatropha seeds after oil extraction could also be considered for energy production. The oil from Jatropha curcas is mainly converted into biodiesel for use in diesel engines.

Fig1: Jatropha oil production

The cake can be used for fish or animal feed (if detoxified), biomass feedstock to power electricity plants, or as biogas or high-quality organic fertilizer. Furthermore, it has been found that Jatropha curcas can be planted in arid and hot regions such as the desert areas of Egypt, India and Madagascar and contribute a reduction of up to 25 of CO2 per hectare per year from the atmosphere (over a 20year period), while still producing bio fuel and also the dry cakes from oil extraction.

Rice Bran Oil

Rice is the main cultivation in subtropical southern Asia and it is a staple for a large part of the world's human population, especially in East, south and Southeast Asia, making it the most consumed cereal grain. Rice cultivation is well suited to countries and regions with low labor costs and high rain fall, as it is very labor intensive to cultivate and requires plenty of water for cultivation.

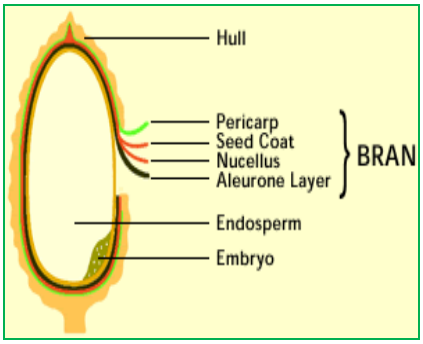


Fig2: Rice Bran

According to International Rice Research Institute, India had produced 132,013,000 metric tons of rice in a land area of 44,000,000 ha. And thus India is in second place of world rice production after China which is in the First place. Rice bran oil is edible oil that is extracted from the germ and inner husk (called bran) of rice. Rice bran is a moist, oily inner layer of rice grain which is heated to produce rice bran oil. Being edible oil the cost of rice bran oil is more than that of diesel in the present market, but if it is commercialized as fuel and produced in a large scale basis then there is a possibility that its cost can be reduced and become a reliable and viable alternative to diesel.

Experimental setup of VCR engine

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by

specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ−PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set-up has stand-alone panel box consisting of air box, two fuel tanks for duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement. The setup enables study of VCR engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance.

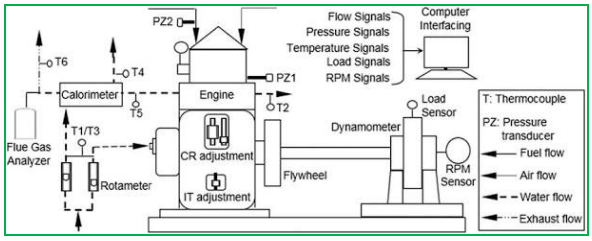
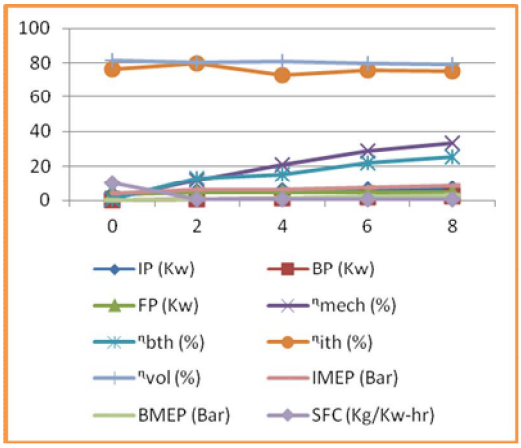


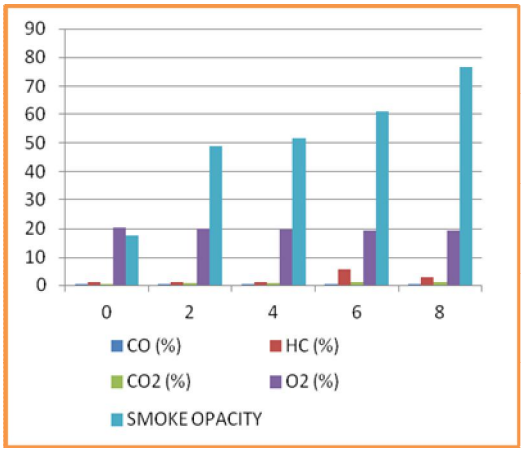
Fig3:Line diagram of VCR engine setup

The engine was first operated on diesel fuel with no load for few minutes at rated speed of 1500 rpm and compression ratio 17.5:1. The baseline parameters were obtained at the rated speed by varying 0 to 8 of load on the engine. The diesel was replaced by Jatropha oil biodiesel (J10) with blend of 90% diesel and 10% biodiesel and test was conducted by varying 0, 2, 4, 6, 8 kg load on engine and compression ratio 16:1, 17:1 and 18:1. Then the test was conducted with blend of 80% diesel and 20% biodiesel (J20) and similarly on J30. The brake power was measured by using an eddy current dynamometer. The fuel flow measurement was done by using a fuel pipe and fuel cock and measuring time for 20 cc of fuel consumption. All the parameters like Indicated power (IP), Brake power (BP), Friction power (FP), Mechanical efficiency, Volumetric efficiency, Indicated thermal efficiency, Brake thermal efficiency, Indicated mean effective pressure (IMEP), brake mean effective pressure (BMEP), Air-Fuel ratio(A/F), Specific fuel consumption (SFC), Torque etc. were directly from I.C engine combustion analysis software. The exhaust gas inlet and outlet temperature was measured by using an iron-constantan thermocouple. The exhaust emissions such as Carbon monoxide, Hydrocarbons, Carbon dioxide and unused oxygen were measure by AVL 4 gas analyzer. The smoke opacity is measured with AVL smoke meter.

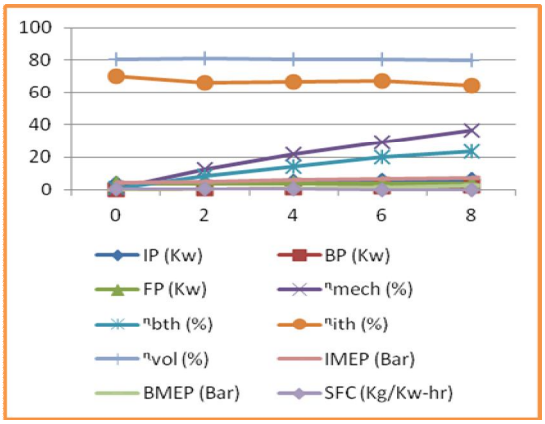
The results from the engine with a blend of diesel, Jatropha biodiesel and Duel biodiesel are compared with the baseline parameters obtained during engine fuelled with diesel fuel at rated speed of 1500 rpm and compression ratio 17.5:1.



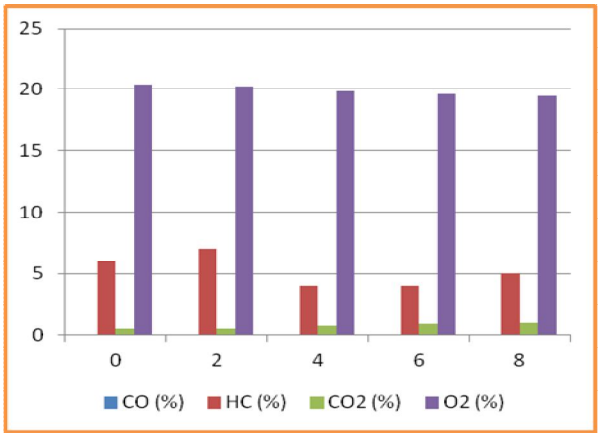
Graph:1; Load Vs Performance analysis curves for Base line CR (17.5:1)



Graph:2; Load Vs Emissions curves for Diesel diesel at Base line CR (17.5:1)



Graph:3; Load Vs Performance analysis Curves for J10 CR 16:1



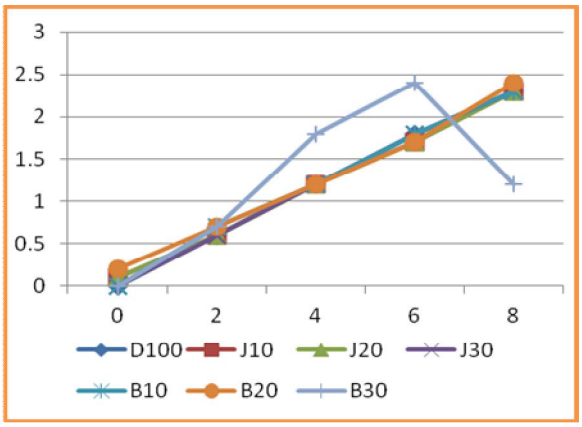
Graph:4; Load Vs emission curves for J10 CR 16:1

Performance Analysis Using Pure Diesel And Its Blend Of Jatropha And Duel Biodiesel

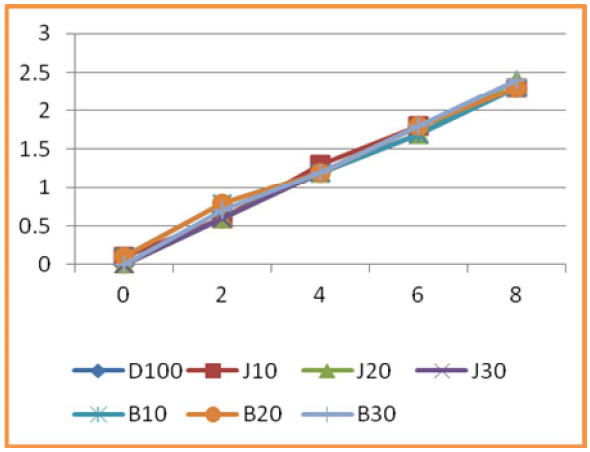
In this stage various performance parameter characteristics are discussed in below for diesel, Jatropha-diesel blends and Duel biodiesel.

Brake Power

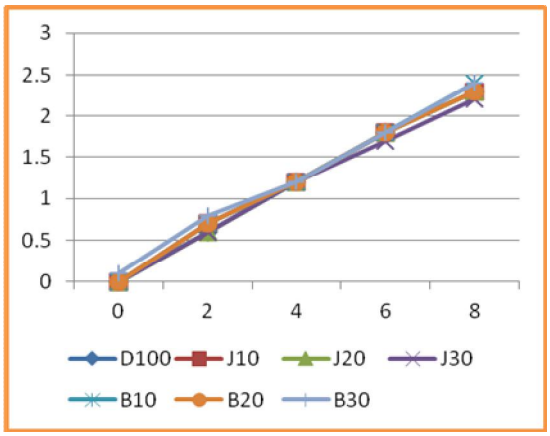
Comparison of Brake Power for various blends with respect to load was made for duel biodiesel blends of B10, B20, and B30 at CR 16:1 and Jatropha blends of B10, B20 and B30 at CR of 16:1, 17:1, 18:1. Now all these blends were compared with pure diesel at CR 17.5:1 as shown in figure below. It is observed from the graph that duel biodiesel blend B30 at CR 16:1 given good results at low and medium load on the engine. At high loads B20 has given good results. At CR 17:1 and 18:1 duel biodiesel blend B30 given good results than D100, J10, J20 and J30.



Graph:5; Load Vs B.P. for D100 at CR 17.5 and B10, B10, B20, B30 and J10, J20, J30 at CR 16:1



Graph:6; Load Vs BP for D100 at CR 17.5 and B20, B30 and J10, J20, J30 at CR 17:1



Graph:7; Load Vs BP for D100 at CR 17.5 and B10, B20, B30 and J10, J20, J30 at CR 18:1

Mechanical Efficiency

Comparison of mechanical efficiency for various blends with respect to load and various compression ratios were made. From which we got better performance results for blend B10 at CR 16:1 similarly for blend B20 at CR17:1 and B30 at CR 16:1. Now all these blends were compared with pure diesel at CR 17.5:1 as shown in figure below. It is observed from the graph that at CR 16:1, 17:1and 18:1 duel biodiesel blend B30 given good results than D100, J10, J20 and J30. At CR 17:1 all the blends of duel biodiesel given good results than D100.

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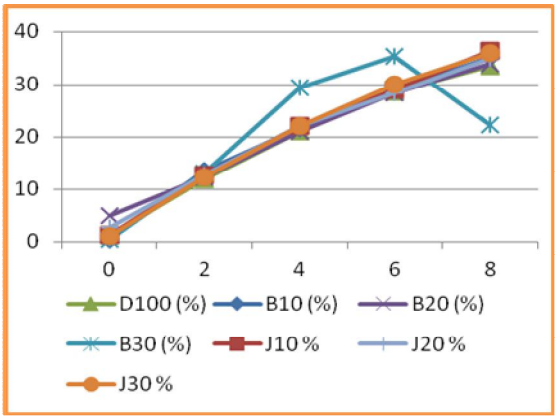
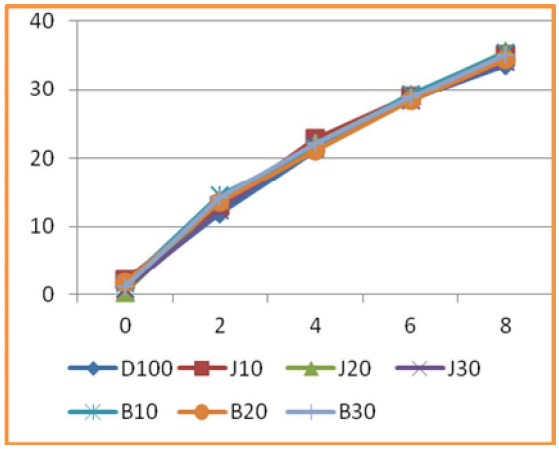
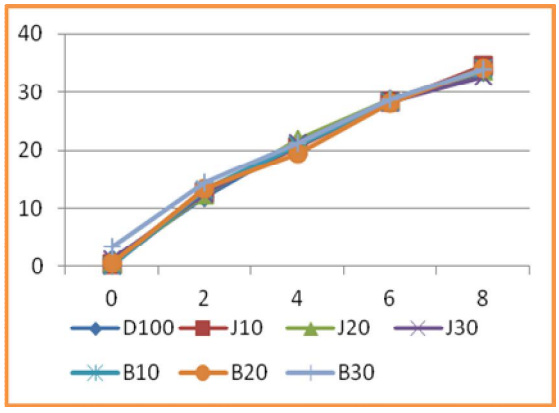


Graph:8; Load Vs η_{mech} for D100 at CR 17.5 and B10, B20, B30 and J10, J20, J30 at CR 16:1



Graph:9; Load Vs η_{mech} for D100 at CR 17.5 and B10, B20, B30 and J10, J20, J30 at CR 17:1



Graph:10; Load Vs η_{mech} for D100 at CR 17.5 and B10, B20, B30 and J10, J20, J30 at CR 18:1

IV. CONCLUSION

The performance and emission tests were conducted on VCR C.I. engine at different loads with almost constant speed of 1500 rpm with three different duel biodiesel blends as B10, B20 and B30. The results of Brake power, Mechanical efficiency, Brake thermal efficiency, volumetric efficiency, Specific fuel consumption, exhaust gas temperature and the emissions of the engine vise CO, HC, CO_2, unused O_2 of duel biodiesel were compared with pure diesel and Jatropha biodiesel blends.

The comparison showed that the Brake power, Mechanical efficiency, Volumetric efficiency, SFC, Exhaust gas temperature were higher with B30 at all compression ratios (16:1, 17:1, 18:1) than pure diesel and jatropha blends. Brake thermal efficiency is higher with B10 than diesel and Jatropha biodiesel blends. The emissions of CO, O_2 were low with B10 and B30. The emissions of CO, HC, and Smoke were low with B20 and B30. But all the emissions were higher than pure diesel and jatropha biodiesel.

So the duel biodiesel of Jatropha and Ricebran oil at the blends B10 and B30 can used as alternative fuel on the C.I. engines with compression ratios 16:1, 17:1 and 18:1 without any engine modifications. Out of these three CRs, at 18:1, B10 and B30 gives best results than pure Diesel.

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