PERFORMANCE AND EMISSION ANALYSIS OF PALM AND JATROPHA BIOFUEL BLENDS WITH DIESEL ON AN UNMODIFIED CI ENGINE.

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Abstract

The shortage of petroleum reserves today in collaboration with the abundance in availability of plant and forest based non edible vegetable oils has increased the demands of using these vegetable oils as substitutes of diesel. The common vegetable oils that can be used are palm, jatropha, coconut, castor etc. In my research, by careful literature survey, I have used Palm and Jatropha oil blends and their combined blends with diesel. But before testing the Biodiesel in a Compression Ignition engine we had make sure that the biodiesel derived from neutralized jatropha and palm oil is suited for use in diesel engines given that its kinematic viscosity, flash point, cloud point, and calorific value conform to the recommended international standards. After this conformation, we have carried out the performance and emission analysis to get an idea about the practicality of the use of Jatropha and Palm oil as an alternative fuel. This paper present experimental results in which different oil blends were tested in an unmodified CI engine to evaluate its performance and emission characteristics with respect to engine speed.

Keywords: Biodiesel, Performance Analysis, Jatropha, Palm , Emission Analysis

1. Introduction

Due to gradual depletion of world petroleum reserves and the impact of environmental pollution of increasing exhaust emissions, there is an urgent need for suitable alternative fuels for use in diesel engines. Due to excessive dependency on non renewable fossil fuels for transportation and other purposes has increased environmental pollution and has had a detrimental effect on the energy security of the world. Due to this, vegetable oil is a promising alternative because it has several advantages—it is renewable, environ-friendly and produced easily in rural areas.[1-3] Therefore, in past few years efforts have been made to use vegetable oils as fuel in engines. Undoubtedly, the use of non-edible vegetable oils compared to edible oils is very significant because of the tremendous demand for edible oils as food and they are far too expensive to be used as fuel at present.

In Indian scenario, we see that the country is not self-sufficient in edible oil production. Hence, some non-edible seeds available in the country seems to be a more viable option to be tapped for biodiesel production.[4] Biodiesel, which is made from renewable sources consists of simple alkyl esters of fatty acids.[5]With abundance of forest and plant based non edible oils being available in our country such as jatropha, palm and castor oils, an attempt has been made to use these as substitutes of diesel.[6]

This research paper aims to give an in-depth analysis of properties, performance and emission of the unmodified C.I engine when operated by jatropha and palm blends as fuel.

1.1 OBJECTIVES

-Preparation of blends of trans-esterified palm and jatropha oil with diesel.
- Testing of various fuel blends according to ASTM standards.
- To carry out performance analysis of the tested fuels on unmodified C.I Engine.
- Validation of the results with literature survey.

2. MATERIALS & METHODS

2.1 Materials

Oils of Jatropha and Castor were obtained by mechanical pressing of seeds, which were collected from the plantation at Paritosh Harbals, Dehradun, Uttarakhand, India. All of the transesterification process was done in Laboratory of University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India.

2.2 Production Process:-

2.2.1 Transesterification

Is the process of chemically reacting a fat or oil with an alcohol in a presence of a catalyst. Transesterification-ion reaction is carried out in a batch reactor. Alcohol used is usually methanol or ethanol. Catalyst is usually sodium hydroxide or potassium hydroxide. The main product of transesterification is biodiesel and the co-product is glycerine. The best combination of the parameters was found as 6:1 molar ratio of Methanol to oil, 0.92% NaOH catalyst, 60 ^{0}C reaction temperature and 60 minutes of reaction time.

2.2.2 Separation

After transesterification, the biodiesel phase is separated from the glycerin phase; both undergo purification .

2.3 Biodiesel production

In this study, the base catalyzed transesterification is selected as the process to make biodiesel from Jatropha oil. Transesterification-ion reaction is carried out in a batch reactor.[7]

For transesterification process 500 ml of Jatropha oil is heated up to 70 ^{0}C in a round bottom flask to drive off moisture and stirred vigorously. Methanol of 99.5 % purity having density0.791 g/cm^3 is used.[8] 2.5 gram of catalyst NaOH is dissolved in Methanol in bi molar ratio, in a separate vessel and was poured into round bottom flask while stirring the mixture continuously. The mixture is maintained at atmospheric pressure and 60°C for 60 minutes. [9]

After completion of transesterification process, the mixture is allowed to settle under gravity for 24 hours in a separating funnel. The products formed during transesterification were Jatropha oil methyl ester and Glycerin. The bottom layer consists of Glycerin, excess alcohol, catalyst, impurities and traces of unreacted oil. The upper layer consists of biodiesel, alcohol and some soap. The evaporation of water and alcohol gives 80-90 %pure glycerin, which can be sold as crude glycerin is distilled by simple distillation. [10]

Jatropha methyl ester (biodiesel) is mixed, washed with hot distilled water to remove the unreacted alcohol; oil and catalyst and allowed to settle under gravity for 25 hours.[10] The separated biodiesel is taken for characterization.

3. Physical Properties

3.1 Test of fuels

The engine research laboratory of the Department of Mechanical Engineering, University of Petroleum and Energy Studies, Dehradun, India was used to carry out the transesterification process, blending and property analysis test of fuels. Six samples were considered for research.
These were
(a) 5% palm biodiesel with 95% diesel fuel (PB5),
(b) 10% palm biodiesel with 90% diesel fuel (PB10),
(c) 5% jatropha biodiesel with 95% diesel fuel (JB5),
(d) 10 % jatropha biodiesel with 90 % diesel fuel (J10),
(e) 5 % combined(jatropha and palm) biodiesel with 95 % diesel fuel (PBJB5), and
(f) 10 % combined(jatropha and palm) biodiesel with 90 % diesel fuel (PBJB10).
These blended percentages are volume-based proportions.

Physical properties	**Diesel**	**PB5**	**PB10**	**JB5**	**JB10**	**PBJB5**	**PBJB10**
Flash point ^{0}C	65	81	93	84	95	72	90
Cloud Point(celsius)	4	5	8	6	9	5	7
Pour Point(celsius)	-6	-4	-3	-5	-4	-5	-3
Viscosity (centistokes)	3.16	3.80	4.05	3.72	3.88	3.52	3.80
Calorific Value(MJ/kg)	44.34	43.52	42.80	44.26	43.59	44.56	43.94

Table 1: Comparison of physical properties of pure diesel & jatropha & palm biodiesel

4. RESULTS & DISCUSSION

4.1 Graphical Analysis

4.1.1 Brake Power

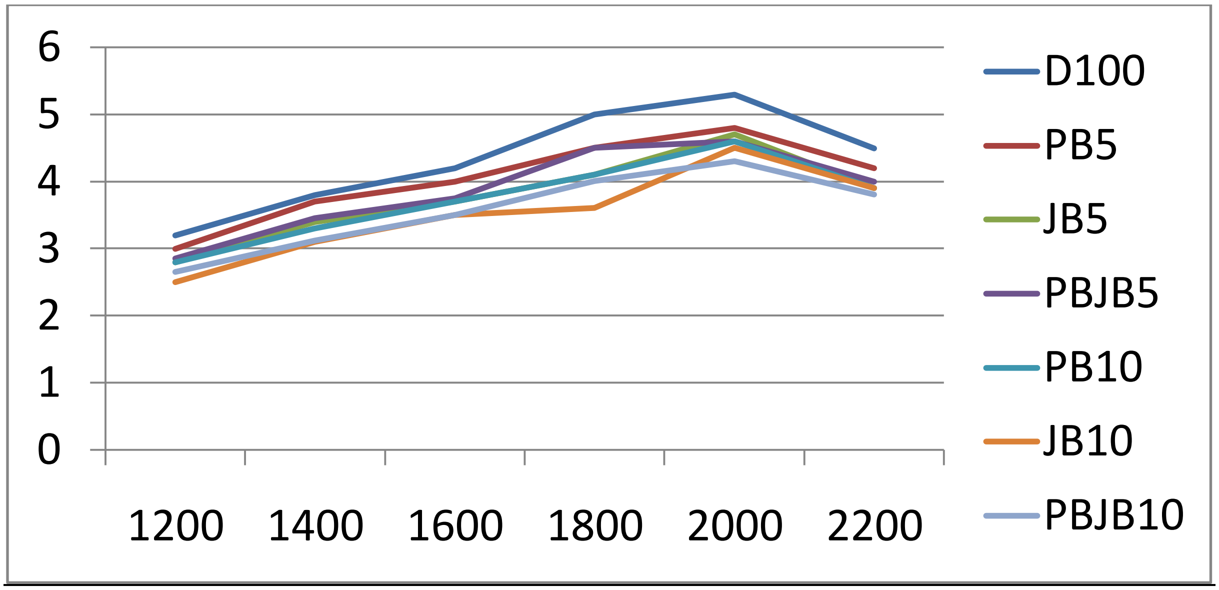

Figure 1: Engine Speed VS. Brake Power

The Graph plotted between Engine Speed and Brake Power clearly shows the variation of the tested fuels with engine speed. It was found that the trend of variation of the PBJB10 blend represent the lowest brake power which is exactly opposite to the trend shown in D100 blend. The blend PB5 produced brake power closest to D100 blend. Comparing palm and jatropha biodiesel , the brake power produced by palm biodiesel was higher than jatropha biodiesel. The combined blend PBJB5 produced a median brake power in all the blends.

4.1.2 Brake Specific Fuel Consumption

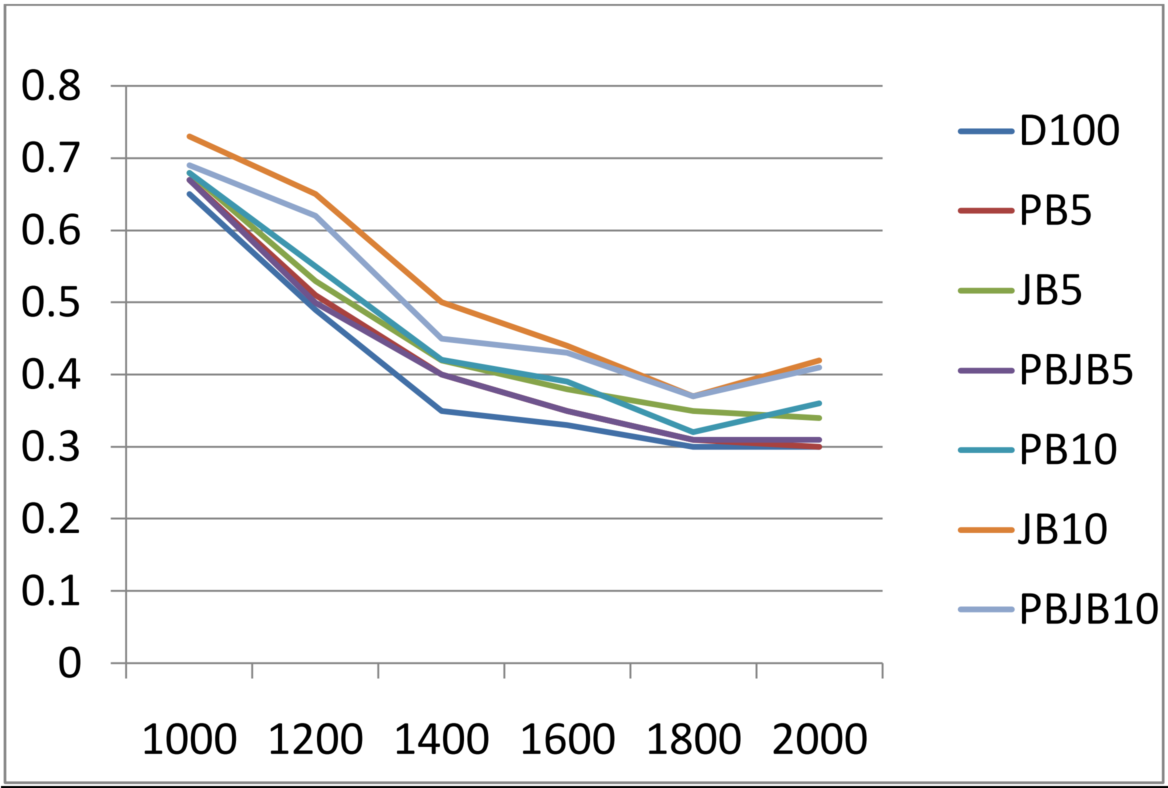

Figure 2: Engine Speed vs Brake Specific Fuel Consumption

The Graph plotted between Engine Speed and Brake Specific Fuel Consumption clearly shows the variation of the tested fuels with engine speed. It was found that the trend of variation of the JB10 blend represent the highest bsfc. The Bsfc was found to be lower for the tested blends of D100 and combined blend of PBJB5. Bsfc for PB10 is higher compared to PB5.The Bsfc for palm blends was found out to be much lower than jatropha blends due better atomization of palm based fuels. D100 and combined blend of PBJB5 has the least bsfc and hence most effective.

4.2 EMISSIONS

4.2.1 NOX

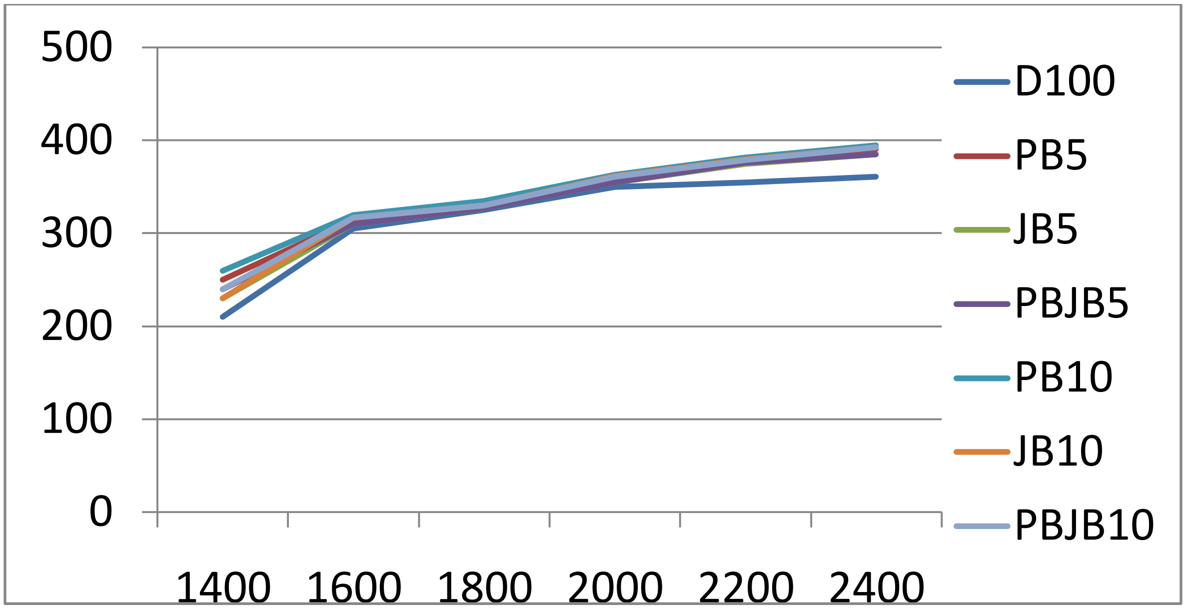

Figure 3 : Engine Speed vs NOx emissions

It was observed that all fuel blends had a pretty moderate value when it came to emission of nitrogen oxide compounds with respect to speed. However, the least NOx emissions were found in D100 blend. All the remaining blends had very similar values of NOx emissions with the combined blends of palm and jatropha producing less NOx than individual blends of these fuels with diesel.

4.2.2 Hydrocarbons

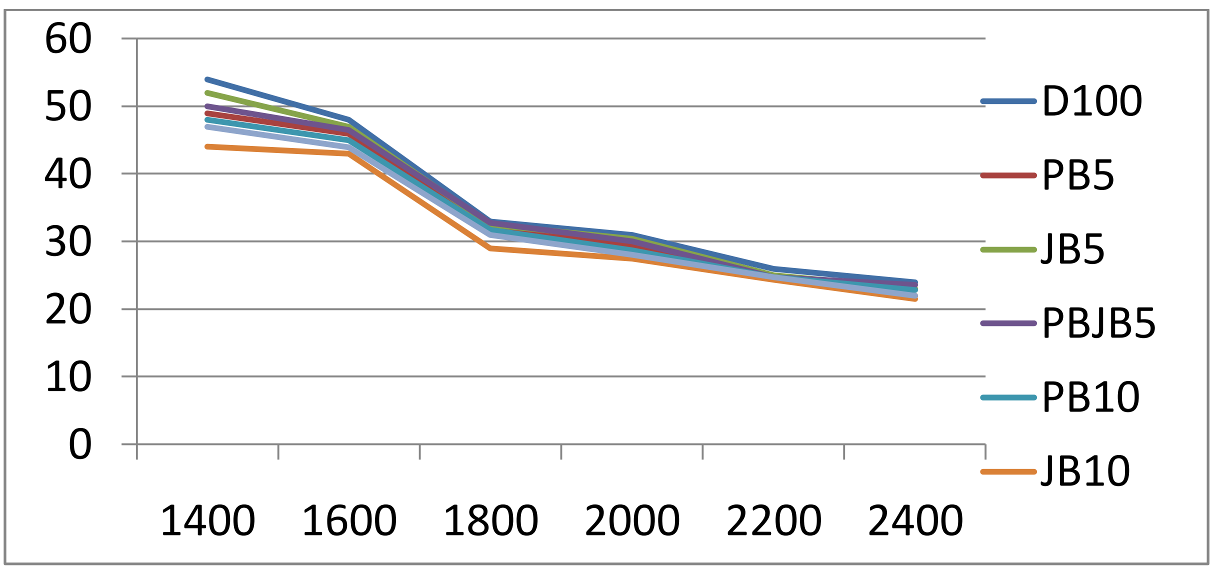

Figure 4: Engine Speed vs Hydrocarbon emission

It was observed that HC emissions of all the fuel blends with respect to speed were quite similar. However, Jatropha blends produced least hydrocarbon emissions when compared to other blends. JB10 blend had the least value of hydrocarbon emissions. D100 blend due to obvious reasons produced the highest hydrocarbon emissions due to unburnt diesel particles in the combustion chamber. Palm Blends produced more hydrocarbons than both jatropha and combined blends. Both combined blends, PBJB5 and PBJB10 produced median values of hydrocarbon emissions.

5. CONCLUSION

In our research, we have concluded that the combined blends of palm and jatropha oil with diesel can be used as substituents of diesel. Due to the shortage of petroleum and diesel used for transportation purposes, palm oil blends with diesel produce positive results. Some of the main points of this research are summarised asgiven below :

- NOx emission increased in all tested biofuel blends compared to D100. D100 blend showed the least NOx emissions.However, NOx emission of PBJB5 and PBJB10 were found slightly lower than PB10 and PB20 blends respectively and almost same for JB10 and JB20 blends. Therefore , the combined blends of palm and jatropha oil proved to be a better alternative than individual palm and jatropha blends with diesel.

- Hydrocarbon emission was observed to be least in jatropha oil blends with median values obtained for combined jatropha and palm blends. Also , Hydrocarbon emissions were maximum for diesel fuel.

- Brake Power values according to speed were mamximum for diesel. However, palm blends also showed considerably high values of brake power with increasing speed. Combined blends PBJB5 and PBJB10 also showed higher values of brake power when compared to JB5 and JB10.

- Brake specific fuel consumption with increasing speed was observed least for palm biofuel blends. The values of bsfc were nearest to D100 blend.

Therefore , it is observed that palm biofuel can serve as a good alternative for diesel as it shows the various performance and emission values similar to diesel. Also, combined blends of palm and jatropha oil can be used as it shows median values of all the parameters with increasing engine speed.

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