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# STUDY OF PERFORMANCE AND EXHAUST EMISSIONS OF A 4-STROKE 4-CYLINDER DIESEL ENGINE USING ESTERIFIED JATROPHA, MUSTARD OIL AND PALM OIL

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**ABSTRACT:** This paper studies the possibility and comparison of biodiesel made from jatopha oil, mustard oil and palm oil to be used as an alternate fuel for four stroke four cylinder direct injection diesel engine. The term "alternative fuel" is used for any fuels other than gasoline or diesel fuel used in vehicles. A four stroke four cylinder direct injection 10 H.P. diesel engine was used to test and compare different parameters of jatropha curcas biodiesel & its blends, esterified mustard oil & its blends and palm oil & its blends. In this experimental work different blends (B10, B20, & B100) of jatropha curcas, mustard oil and palm oil were prepared and tested for the performance and exhaust emission of four stroke four cylinder diesel engine. The engine performance parameter studied were power output, brake thermal efficiency, exhaust gas temperature, hydrocarbons (HC), carbon monoxide (CO) emission by using diesel fuel alone and above mentioned blends. Graphical representation of comparison of diesel and esterified jatropha, mustard oil & palm oil for performance and exhaust emission with different blends has been carried out.

## 1. INTRODUCTION

The term "alternative fuel" has been used to describe any fuels suggested for use in vehicles other than gasoline or diesel fuel. With the experimentation using alternative fuels rather than petroleum fuels, it has been proved that alternative fuels had inherent environmental advantages over petroleum fuels. The original impetus for development of alternative fuels to gasoline and diesel fuel was the realization that the petroleum oil – producing nations that held the majority of the world's reserves had the power to dictate the price and availability of what had become a truly international commodity.

## 2. EXPERIMENTAL SETUP

In tune of the scope and objectives of the project an experimental setup was prepared consisting of a four stroke, four cylinder diesel engine coupled to hydraulic dynamometer and arrangements for measurement of fuels consumption. Cooling water circulation was provided for the requirement of maintaining of controlled thermal condition of the engine. Specifications of the experimental setup are as stated below.

### 2.1 Engine specifications

The specifications of test engine are as follows:

| | | |
|---|---|---|
| Make | : | Hindustan Motors.(Altech Industries, Coimbatore) |
| Type of Engine | : | Compression ignition, 4-stroke, water cooled |
| No. of Cylinders | : | 04 (four) |
| Bore | : | 73 mm |
| Stroke | : | 90 mm |

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| | | |
|---|---|---|
| Cubic Capacity | : | 1500 cc |
| Rated Speed | : | 1500 RPM |
| Rate of Output | : | 10.0 HP @ 1500 RPM |
| Fuel Used | : | High Speed Diesel Oil |

## 3. Experimentation

Following readings are to be taken for each load applied on the engine:

(I) Speed of the engine (constant 1500 rpm).

(II) Time in seconds for 100 cc fuel consumption.

(III) DBT, WBT of ambient air.

(IV) Height difference between two limbs of U-tube water manometer (for measurement of air flow).

(V) Cooling water inlet & outlet temperature and mass flow rate.

(VI) Calorimeter inlet and outlet temperature.

(VII) Exhaust gas temperature.

(VIII) Exhaust emission by Exhaust Gas Analyzer for HC and CO.

### 3.1 Performance Evaluation with Diesel and Bio Diesel

In this phase of experimental work, the engine is operated on diesel fuel with different percentage of Bio Diesel. Methodology used must be identical with that of high-speed diesel operation with respect to change of loads, recording of fuel consumption, exhaust emission and various temperatures.

Experiments were conducted on different blends of Bio Diesel with diesel as below:

1. 100% Diesel
2. 90% Diesel and 10% Biodiesel (B10)
3. 80% Diesel and 20% Biodiesel (B20)
4. 100% Biodiesel (B100)

## 4. RESULTS AND DISCUSSION

A four stroke, four cylinder direct injection diesel engine of 10 HP output was used to test jatropha curcas, palm and mustard biodiesel and its blends, and compared with conventional diesel fuel for the different parameters. The fuel properties of jatropha, palm and mustard biodiesels were very much similar to the conventional diesel fuel.

The comparison of different observations between conventional diesel fuel and biodiesels are as follows.

### 4.1 Brake Thermal Efficiency

Comparing Brake Thermal Efficiency at 13.5 kg load :

*B10 :*

| | | |
|---|---|---|
| Diesel fuel | : | 20.06 % |
| Jatropha | : | 22.09 % |
| Palm | : | 23.69 % |
| Mustard | : | 22.60 % |

*B20 :*

| | | |
|---|---|---|
| Diesel fuel | : | 20.06 % |
| Jatropha | : | 21.72 % |
| Palm | : | 23.96 % |
| Mustard | : | 22.12 % |

*B100 :*

| | | |
|---|---|---|
| Diesel fuel | : | 20.06 % |
| Jatropha | : | 23.85 % |
| Palm | : | 24.03 % |
| Mustard | : | 23.98 % |

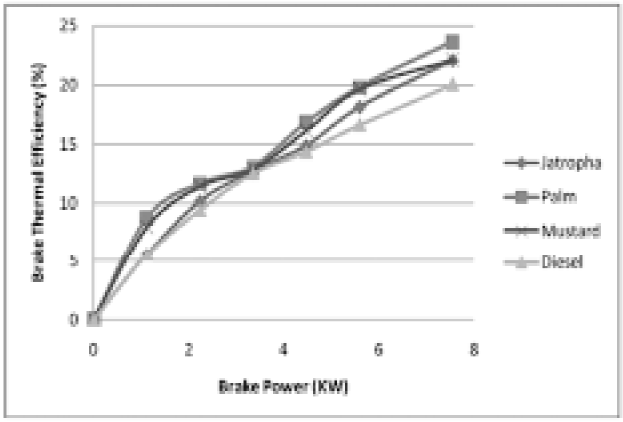


**Figure1. BP Vs. Brake Thermal Efficiency (B10)**

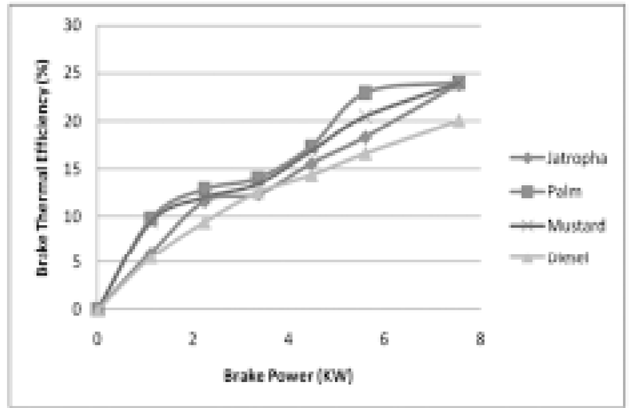


**Figure 2. BP Vs. Brake Thermal Efficiency (B20)**

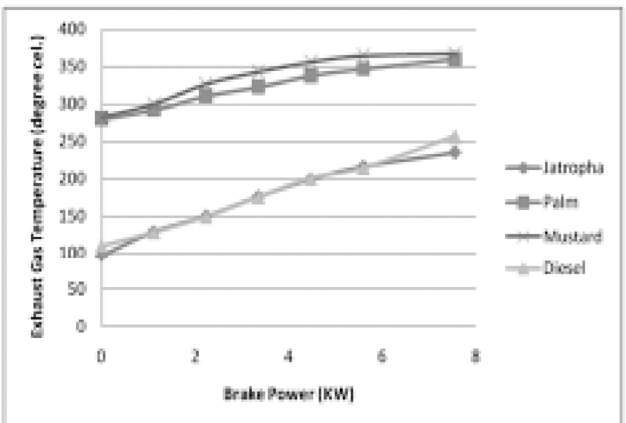


**Figure 3. Brake power Vs. Brake Thermal Efficiency for B100**

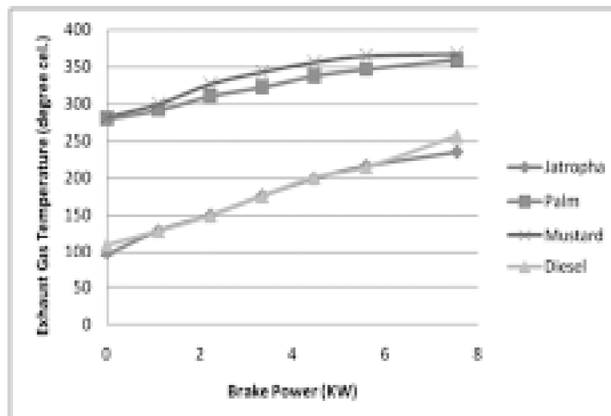


**Figure 4. Brake power Vs. Exhaust Gas Temperature for B10**

So, we can say that, the Brake Thermal Efficiency for jatropha, palm and mustard biodiesel and its blends was found to be slightly higher than that of diesel fuel at tested load conditions. The reason being that, the biodiesel contains approximately 10% higher oxygen than diesel fuel which may results in better combustion. (Refer Figures 1-3).

### 4.2 Exhaust Gas Temperature

*B10 :*

Diesel fuel : 257 °C
Jatropha : 236°C
Palm : 360 °C
Mustard : 367 °C

*B20 :*

Diesel fuel : 257 °C
Jatropha : 242 °C
Palm : 359 °C
Mustard : 360 °C

*B100 :*

Diesel fuel : 257 °C
Jatropha : 325 °C
Palm : 345 °C
Mustard : 315 °C

From the graphs shown, we can see that the exhaust gas temperature for palm biodiesel at higher load conditions is greater than exhaust gas temperature of remaining. (Figures 4-6).

### 4.3 Carbon Monoxide (Exhaust Emission)

*B10 :*

Diesel fuel : 0.28 %
Jatropha : 0.27 %
Palm : 0.27 %
Mustard : 0.28 %

*B20 :*

Diesel fuel : 0.28 %
Jatropha : 0.26 %
Palm : 0.25 %
Mustard : 0.26 %

*B100 :*

Diesel fuel : 0.28 %
Jatropha : 0.19 %
Palm : 0.21%
Mustard : 0.21 %

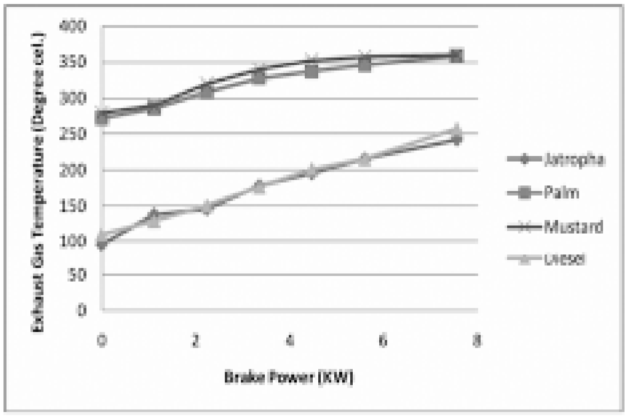


**Figure5. Brake power Vs. Exhaust Gas Temperature for B20**

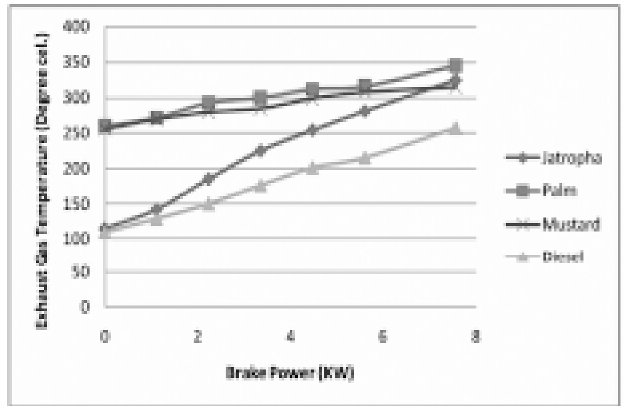


**Figure 6. Brake power Vs. Exhaust Gas Temperature for B100**

The comparison says that there is definitely improvisation in exhaust emission if jatropha, palm and mustard biodiesel is used instead of diesel fuel. The reason may be, the carbons which are not converted into carbon dioxide will be converted into carbon monoxide in the exhaust. So, it is very much clear that CO keeps on reducing by increasing the percentage of biodiesel in blends. (Refer Figures 7-9).

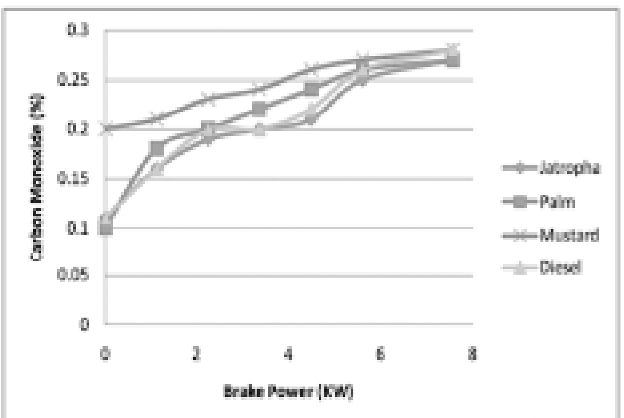


**Figure 7. Brake power Vs. CarbonMonoxide(B10)**

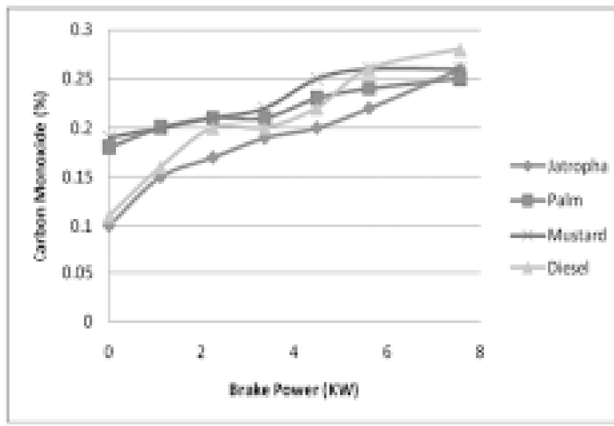


**Figure 8. Brake power Vs. CarbonMonoxide(B20)**

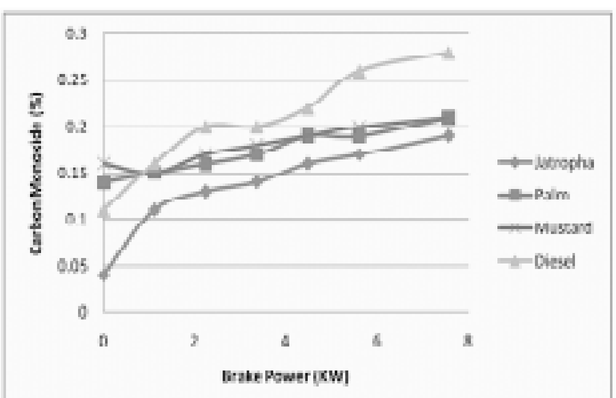


**Figure 9. Brake power V CarbonMonoxide(B100)**

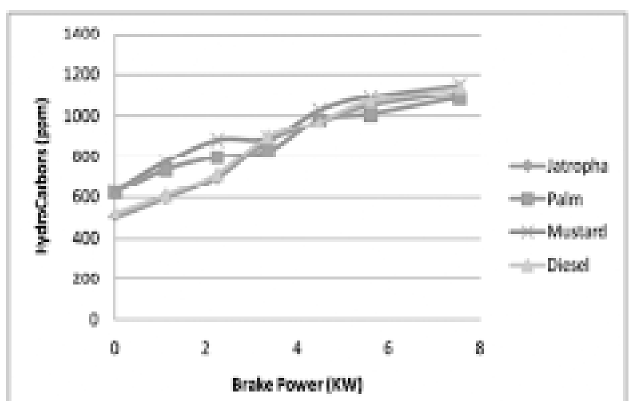


**Figure 10. Brake power Vs. Hydrocarbons (B10)**

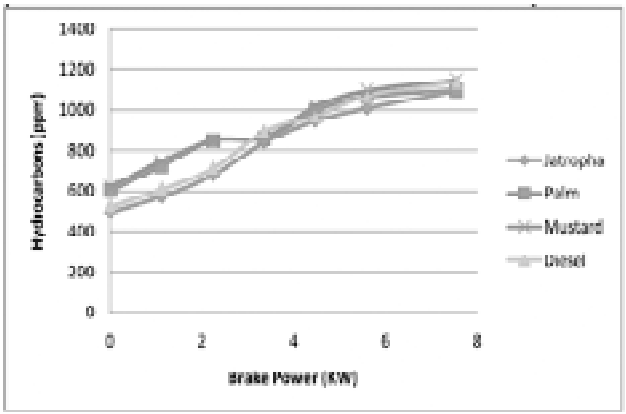


**Figure 11. Brake power Vs. Hydrocarbons (B20)**

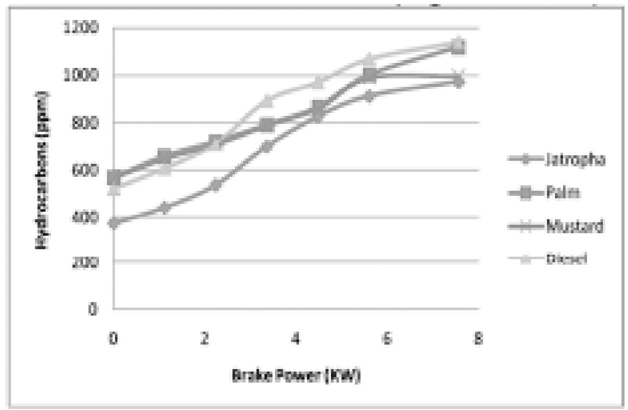


**Figure 12. Brake power Vs. Hydro carbons (B100)**

## 4.4 Hydro Carbons (Exhaust Emission)

| *B10 :* | | | *B20 :* | | | *B100 :* | | |
|---|---|---|---|---|---|---|---|---|
| Diesel fuel | : | 1140 ppm | Diesel fuel | : | 1140 ppm | Diesel fuel | : | 1140 ppm |
| Jatropha | : | 1110 ppm | Jatropha | : | 1098 ppm | Jatropha | : | 0973 ppm |
| Palm | : | 1087 ppm | Palm | : | 1100 ppm | Palm | : | 1120 ppm |
| Mustard | : | 1150 ppm | Mustard | : | 1152 ppm | Mustard | : | 0997 ppm |

The theory for emission is, in the presence of air, HC burns inside the cylinder of the engine. And the amount of hydro carbon which is not taking any part in the combustion process will be referred as unburned hydro carbons in the exhaust emission (Figures 10-12).

## 5. CONCLUSION

This paper studies the possibility and comparison of biodiesel made from jatopha, palm and mustard to be used as an alternate fuel for four stroke four cylinder direct injection diesel engine. The term “alternative fuel” is used for any fuels other than gasoline or diesel fuel used in vehicles. A four stroke four cylinder direct injection 10 H.P. diesel engine was used to test and compare different parameters of jatropha curcas, palm oil and mustard oil & its blends. In this experimental work different blends (B10,B20,& B100) of jatropha curcas, palm oil and mustard oil were prepared and tested for the performance and exhaust emission of four stroke four cylinder diesel engine. The engine performance parameter studied were power output, brake thermal efficiency, exhaust gas temperature, hydrocarbons (HC), carbon monoxide (CO) emission by using diesel fuel alone and above mentioned blends. The Brake Thermal Efficiency for jatropha and palm biodiesel and its blends was found to be slightly higher than that of diesel fuel at tested load conditions. There is definitely improvisation in exhaust emission (CO & HC) if jatropha, palm and mustard biodiesels are used instead of diesel fuel.

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