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Performance And Emissions characteristics Of Jatropha Curcus Oil In CI Engine as an Alternate Fuel

Dr.C.Krishnaraj[1]
Professor, Department of Mechanical Engineering,
Karpagam College of Engineering, Coimbatore, India[1]

Abstract: As a result of present work it is apparent that the non-edible oil obtained from biofuels crops called 'JATROPHA CURCUS' may behave like diesel fuel. It has the potential to act as an alternate to diesel and form a renewable source of energy. The oil can be used in two ways. First, Pure Jatropha oil blended with diesel up to 20% can be used without any problem. Secondly, by converting the plant oil into biodiesel which is nothing but glycerin free oil in order to reduce viscosity can be used in the engine without any blending with diesel. Both cases offers almost the same performance and engine durability as with use of petroleum diesel fuel, which are non-flammable, non-toxic, and reducing tailpipe emissions, visible smoke, Noxious fumes and odors without any engine modification. It is found that, esterified jatropha oil called biodiesel, is best suited as the exhaust pollution is very much reduced and also the efficiency is near to the efficiency of diesel fuel. But the cost required for converting into biodiesel has to be taken into account. This paper critically reviews different aspects of pure jatropha oil blended with diesel an alternate fuel for diesel engine. The various issues under consideration for fuel properties, comparison with diesel, performance of engine using various blends and emission characteristics of diesel engine using pure jatropha oil.

Keywords: Jatropha Curcus, Esterified jatropha oil, Viscosity, Emission characteristics, Biodiesel

I. INTRODUCTION

Pure jatropha oil is completely natural, renewable fuel applicable in almost any situation where conventional petroleum diesel is used. There is no petroleum or other fossil fuel in biodiesel. It is 100% vegetable oil based. It operates well in a conventional diesel engine with very few or no engine modification and can also be used in a blend with conventional diesel, while still achieving substantial reductions in emission.

II. ABOUT THE PLANT JATROPHA CURCUS

It is a monocious shrub or small tree grow up to 6 meter height in low rainfall regions and are not browsed by animals. The plant reaches a height of 3m within 3 years. This promising biofuel crop can be successfully cultivated on waste lands. The plant produces small seeds which contain25% to 35% of viscous oil by weight. The plants grow luxuriantly even in marginal, stony and sandy tracts. It cn be grown in hedges at a spacing of 15-20 cm by 15-25cm in single or double rows for conserving soil. For commercial plantation the spacing goes like 2m by 1.5m. Dry climate improves the oil yield. Jatropha absorbs carbon from the atmosphere and helps in preventing soil erosion. It is a source of clean fuel with no emissions and has a potential to transform the rural employment scenario. In Tamil Nadu Jatropha grown over 0.4 hectares can produce 1.10 million liters of biodiesel.

III. PREPARATION OF BIODIESEL

Biodiesel is formed by removing the glycerin molecule from the raw jatropha seed oil. Once the glycerin is removed from the oil, the remaining molecules are called as biodiesel.

The process involves,

One mole of pure Jatropha oil and 3 mole of ethanol are taken into the flask. The mixture is stirred vigorously at about 70'c for one hour since jatropha oil are immiscible liquids. Now, the mixture is cooled to 50'c. Then sodium hydroxide and little amount of ethanol are added. Here NaOH acts as a catalyst. Again the mixture is heated to about 70'c for one hour and stirred vigorously. Reaction takes place and three moles of fatty acids

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and one mole glycerol are produced. Glycerol is a valuable byproduct. Now the solution is cooled to 50'c and some amount of concentrated hydrochloric acid and cold water are added. Then it is allowed to cool overnight at room temperature and without stirring. Two layers are formed. The bottom layer consists of glycerol and top layer consists of esters also known as biodiesel. It is separated from glycerol and then used as fuel.

IV. ADVANTAGES OF BIODIESEL

- It is non-toxic, biodegradable and renewable source of energy.
- Handling and storage are safer than conventional petroleum diesel fuel.
- The cost compares well when pricing against other alternative fuels.
- Biodiesel itself acts as a lubricant, which actually improves the engine life, the thus chance of wearing out gets substantially reduced.
- Biodiesel exhaust has a less harmful impact on human health than diesel fuel.

V. PROPERTIES OF JATROPHA OIL IN COMPARISON WITH DIESEL

Parameter	Diesel	Jatropha oil
Energy content MJ/kg	42.6 – 45.2	39.6- 41.8
Specific Weight at 15 °C	0.84	0.91
Solidifying Point °C	-14	2
Flash point °C	80	110- 240
Cetane number	47.8	51
Sulphur %	1	.13

VI. EXPERIMENT SET UP AND TEST RESULT

Number of cylinder	:1
Bore	:80mm
Stoke	:95mm
Number of stokes	:4
Orifice diameter	:24mm
Cooling media	:water
Dynamometer	:Rope type
Rated power output	:5hp
No. of revolutions	:1500rpm
Coefficient of discharge	:0.64

Exhaust gas temperature, engine temperature etc. are measured using dial thermometer, fuel consumption is measured by calibrated burette attached with 3-way cocks and intake pressure is noted with the help of U-tube manometer. An Eddy current dynamometer was coupled to the test engine for torque and speed measurement. Jatropha oil as a diesel fuel is effective up to 20% blend in diesel. All testing are carried out at constant speed i.e. 1500rpm. Testing is carried out using various blends as:

100% Diesel

5%J	95%J
10%J	90%J
15%J	85%J
20%J	80%J

The Work was carried out on a single cylinder four stoke, direct injection and water cooled diesel engine. The test setup consists of engine, rope brake dynamometer and measuring instrument like dial thermometer tube manometer. The coolant inlet and outlet temperature of water, exhaust has temperature were measured using thermometer. Speed of the shaft can be measured by tachometer. Fuel flow is controlled by 3-way valve.

VII. PERFORMANCE GRAPHS

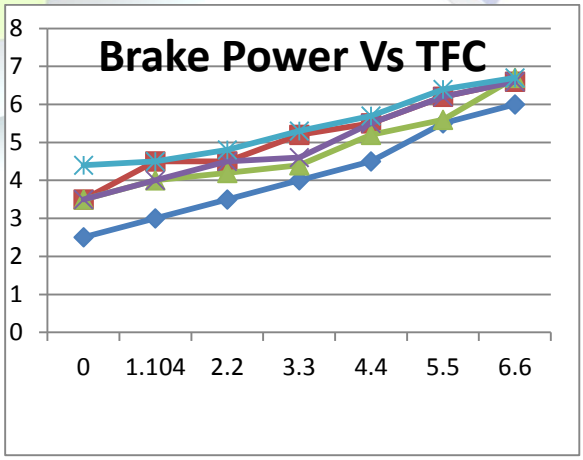

Figure 1. **Brake Power Vs TFC**

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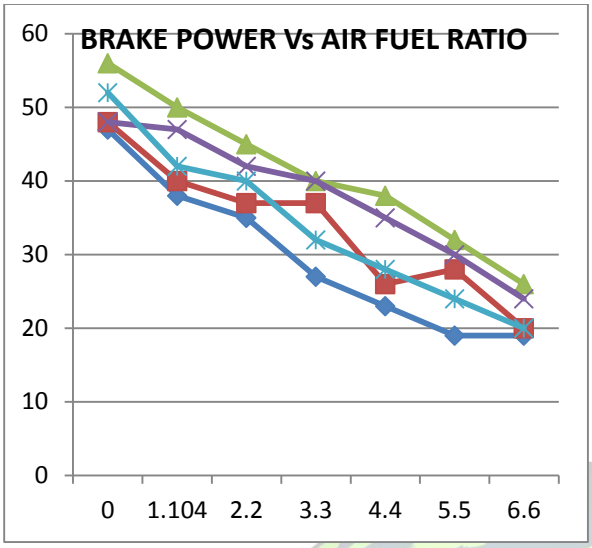

Figure 2. Brake Power Vs Air Fuel Ratio

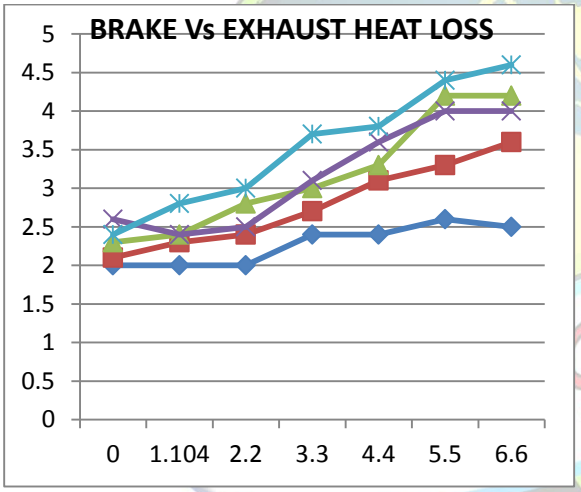

Figure 3. **BRAKE Vs EXHAUST HEAT LOSS**

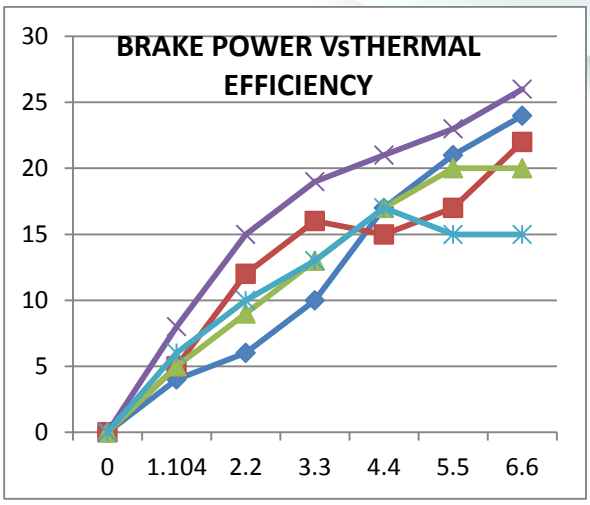

Figure 4 **BRAKE POWER Vs THERMAL EFFICIENCY**

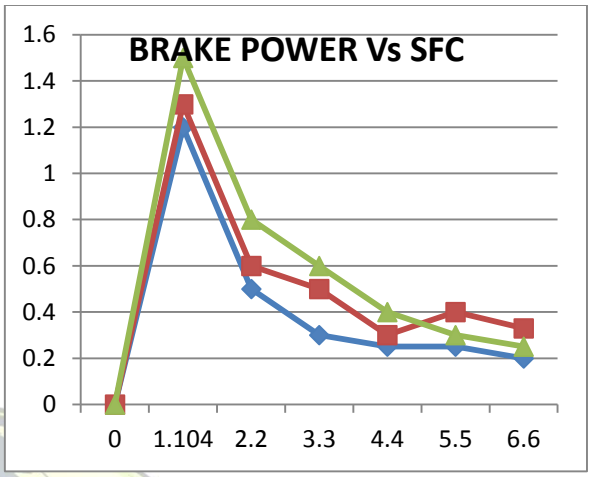

Figure 5 BRAKE POWER Vs SFC

VIII. DISCUSSIONS OF PERFORMANCE GRAPHS

Brake power Vs SFC

Specific fuel consumption is very important factor in selection of the fuel. The graph clearly indicates that as load increases SFC decreases. Among the various blends 80:20 blend decreases the SFC to a minimal value compared to other blends as shown in Figure 5.

Brake Power Vs TFC

Total fuel consumption increases with an increase in load. Among the blends analyzed 80:20 blends consumption is less compared to other blends as shown in Figure 1.

Brake Power Vs Exhaust Temperture

Exhaust temperature at the stack is being reduced when jatropha blend is used in multi cylinder diesel engine. When the exhaust temperature is reduced this will have positive effect on the environment. Exhaust temperature is minimal for 80:20 blends which recommend its use.

Brake Power Vs Air-fuel ratio

The graph indicates that air fuel ratio decreases with increase in brake power. The air fuel ration for 80:20 blends is maximum at no load condition and minimum at maximum load. The above results may be due to the presence of high oxygen content in the Jatropha oil as shown in Figure 2.

Brake power Vs Exhaust Heat loss

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Exhaust temperature is reduced to a great extent when diesel is blended with Jatrophacurcus. Exhaust heat loss is also reduced due to the above fact. Usage of 80:20 result in reduction of heat lost through exhaust gases by 50% as shown in Figure 3.

Brake Power Vs Brake Thermal Efficiency:

Brake thermal efficiency increases as load increases. As proportion of the oil in the blended fuel increases the brake thermal efficiency also increases. Hence among the tested blend 80:20 blends has the highest brake thermal efficiency as shown in Figure 4.

IX. EMISSION GRAPHS

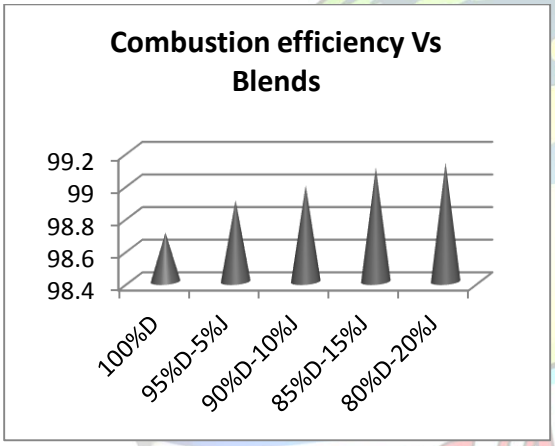

Figure 6 combustion efficiency Vs Blends

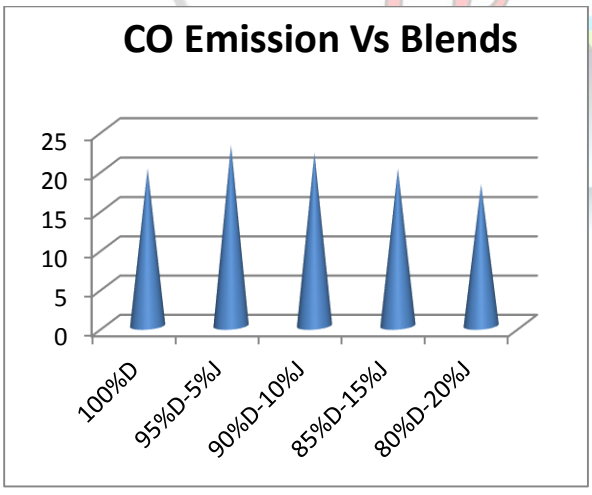

Figure 7 CO Emission Vs Blends

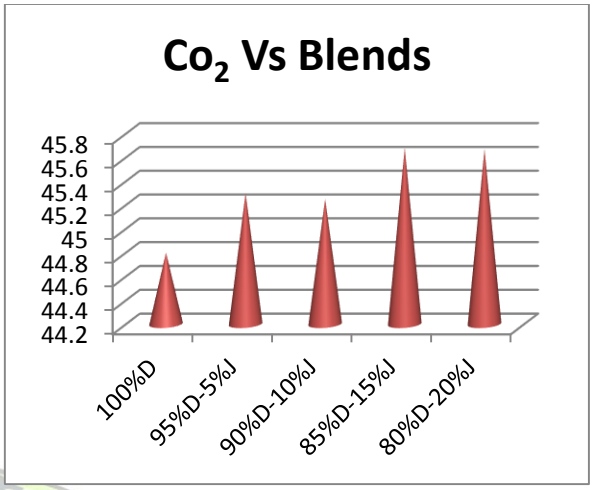

Figure 8 Co2 Vs Blends

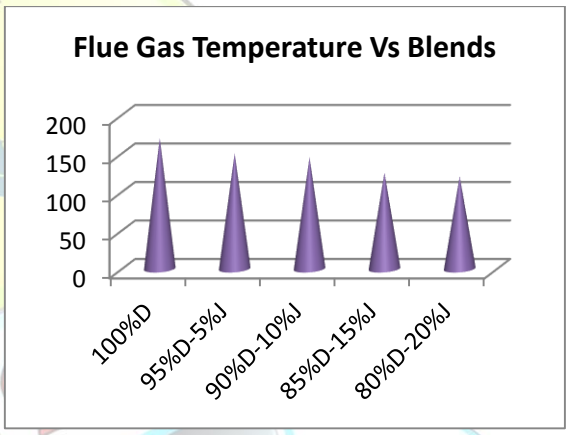

Figure 9 Flue Gas Temperature Vs Blends

X. DISCUSSIONS OF EMISSION GRAPHS

CARBON DIOXIDE EMISSION

Carbon dioxide is the only recyclable emission from the I.C engine. Increase in proportion of Jatropha oil in the diesel blend increases the carbon dioxide emission. as shown in Figure 8.

Jatrophacurcas plant is a very good absorber of atmospheric carbon dioxide and it can absorb the complete carbon dioxide emitted and recycle it. A slight increase in the carbon dioxide emission does not have adverse effect on the environment.

SULPHUR EMISSION

The exhaust emissions of sulphur oxides and Sulphates from blend were essentially

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eliminated compared to Sulphur oxides and sulphtes from diesel.

PARTICULATE MATTER

The exhaust emissions of particulate matter from biodiesel are about 47 percent lower than overall particulate matter emissions from diesel.

COMBUSTION EFFICIENCY

A fuel with high oxygen content increases the combustion efficiency substantially, Again as proportion of Jatropha oil in the blend increases the combustion efficiency also increases. Hence 80:20 blend has good combustion efficiency as shown in Figure 6.

NITROGEN OXIDES

NOx emissions increase or decrease depending on the engine family and testing procedures. NOxemission(a contributing factor in the localized formation of smog and ozone) from bio diesel increase on average by 10%. However blend's lack of sulphur allows the use of NOx control technologies. So NOx emissions can be effectively managed and eliminated as a concern of fuel.

FLUE GAS TEMPERATURE

As shown in Figure 9 the particulate matters has reduced as proportion of Jatropha oil in the blend increases the combustion efficiency also increases. Hence 80:20 blend has reduced flue gas temperature.

XI. PRESENT STATUS OF BIODIESEL IN INDIA

It is reported that the Railways, one of the largest consumers of diesel has leased 500 acres of land to Indian Oil Corporation, Lucknow for the plantation of Jatropha which is expected to yield 500-800 metric tones of biodiesel in two or three years. The price of this biodiesel is projected at Rs. 11-12per liter.

If biodiesel is used, as per plans, to the extent of 10 percent mixture with the conventional diesel, the Railways would be able to not only save on its rising fuel bill of Rs.3,400 crores for using diesel could be reduced by nearly Rs.300 crores to 400 crores per annum by using biodiesel. Ultimately, the percentage of biodiesel would go up to 15 per cent as per the accepted global norms.

XII. CONCLUSION

Study on pure jatropha oil and biodiesel reveals that it is a good alternative for diesel fuel and it is also ecofriendly fuel and its exhaust emission characteristics are also better than that of diesel emissions. The properties of biodiesel also indicate that it is close to that of petroleum diesel and hence can be used easily in the existing diesel engines. Thus biodiesel can become a suitable alternative fuel for diesel in the future.

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