Investigations on the Performance Characteristics of DI Diesel Engine Fuelled with Datura Biodiesel

K.Muni Raja[1], Dr.S.Sunil Kumar Reddy[2], B.Siddeswara Rao[3]

[1]PG Scholar, [2]Professor & Head, [3]Associate Professor, Department of Mechanical Engineering
Siddharth Institute of Engineering & Technology, Puttur, A.P, India -517583

Abstract: **The consumption and demand of petroleum products are increasing day by day with the increase of vehicles and urbanization. By using the petroleum products the emissions are also enormously increased .So to decrease the consumption and emissions of petroleum products, the researchers are in search of alternative fuels. Various types of biodiesel are reviewed and among them Datura biodiesel will plays a vital role in replacement of diesel, because the Datura plant will grow in any environmental conditions and also with minor changes in engine one can easily use Datura as a fuel in diesel engine. As India is an agricultural country, if the cultivation of Datura plants are made by our farmers it will be very useful to the farmers and also to our Indian economy .Many researches had tried on Datura as a replacement for diesel and confirmed that with minor changes in engine, the efficiency of diesel engine can be improved marginally. But due to the higher viscosity of Datura, the flow capacity of Datura is less which is the major drawback for increasing the efficiency of engine. To overcome this flow problem, in the present work it is planned to work with blending of diesel and biodiesel in different proportions. Among them B20(20% Datura seed oil + 80% diesel) shows a better performance compare to other blends of biodiesel, but the performance is not desirable compare to diesel. The performance is investigated on DI Diesel engine. The observations are recorded and they are represented in the form of graphs for comparison with diesel.**

Keywords: Datura Biodiesel blend, Emissions and Performance.

I-INTRODUCTION

Compression ignition engines are employed particularly in the field of heavy transportation and agriculture applications on account of their higher thermal efficiency and durability. However, diesel engines are the major contributors of oxides of nitrogen, carbon and particulate emissions. Hence stringent norms are forced on exhaust emissions. With the global energy crisis and the increasingly stringent emission norms, the search for alternative renewable fuels has intensified. The consumption and demand of petroleum products are increasing day by day with the increase of vehicles and urbanization. By using the petroleum products the emissions are also enormously increased, which is a major aspect for global warming in the world. So to decrease the global warming, the consumption of petroleum products must be decreased. Hence the researchers are in search of alternative fuels, which must have the following characteristics. Low cost, Easy availability, Transportation is easy, High calorific Value, Produced less emissions & Renewable. Various types of biodiesel are reviewed and among them Datura biodiesel plays a vital role in the replacement of diesel with its characteristics, and also the major important advantage of Datura oil is it can easily available, because the Datura plant will grow in any environmental conditions and also with minor changes in the engine, one can easily use Datura biodiesel as a fuel in diesel engine. Wide range of research is going on for finding the optimum methods for cultivation of Datura plants and also extraction methods of biodiesel from Datura seeds.

II-LITRATURE REVIEW

Considerable amount of research work has been done on various types of biodiesels on diesel engine. Some of them are presented below.

Ali Keskin et al,[1] investigated the effect of Mg and Mo based fuel additives on diesel engine performance fuelled with tall oil biodiesel. A single cylinder DI diesel engine is used for their investigation and found that the engine performance values do not change significantly in Mg and Mo based fuel blends, but the engine emissions like HC,CO and NOx are reduced significantly in Mg and Mo based fuel blends compare to tall oil biodiesel.

M.Shahabuddin et al,[2] studied the effect of IRGANOR NPA fuel additive on diesel engine performance fuelled with POME biodiesel with blending proportion of B20+1% (20% biodiesel +80% diesel + 1% additive). A single cylinder Turbocharged (IDI) diesel engine is used for their investigation and found that the engine shows the best performance values at B20+1% compare with POME biodiesel and also the engine CO emissions are reduced by 0.141% at B20+1% blending proportions not only that the HC and NOx emissions are reduced significantly compare with POME biodiesel.

S.SivaLakshmi et al,[3]. A single cylinder DI diesel engine is used for their investigation and found that the engine performance values increases significantly in diethyl ether and ethanol blends compare with Neem oil methyl ester biodiesel and also the brake specific energy consumption is low in both fuel additives at BD-1 and BD-2 blending proportions, and also the engine emissions HC,CO and NOx are reduced significantly in diethyl ether and ethanol blends.

Gvidonas Labeckas et al,[4] investigated the effect of Marisol FT (Sweden) and SO-2E (Estonia) as a fuel additives on diesel engine performance fueled with shale oil biodiesel. A single cylinder DI diesel engine is used for their investigation and found that the engine performance values increases significantly in Sweden and Estonia fuel blends compare with shale oil biodiesel and also the brake specific energy consumption declines by 18.3-11.0% in both fuel additives blends compare to shale oil biodiesel and also the NOx emissions from engine are reduced by 41.6% at Sweden fuel blends and also the HC and CO emissions are reduced significantly compare with POME biodiesel.

Y. V. Hanumantha Rao et al,[5] investigated the effect of DM-32 and methyl-ester as a fuel additives on diesel engine performance fuelled with Jatropha biodiesel. A single cylinder DI diesel engine is used for their Experimental study and found that the engine performance values increases significantly with DM-32 and methyl-ester fuel blends compare with jathropha biodiesel and also the brake specific energy consumption is lower in both fuel additives blends compare with Jatropha biodiesel .Engine emissions like HC, CO and NOx are reduced significantly in both DM-32 and methyl-ester fuel blends compare with jathropha biodiesel.

G.R.Kannan et al,[6] had investigated the effect of metallic based fuel additive(ferric chloride) on diesel engine performance with waste cooking palm oil biodiesel as a fuel. A single cylinder DI diesel engine is used for their investigation and found that the engine brake thermal efficiency was increased by 6.3% with ferric chloride fuel blends compare with waste cooking palm oil biodiesel and also the brake specific energy consumption declines by 8.6% compare to waste cooking palm oil biodiesel. The ferric chloride a metallic based fuel additives was added at dosage of 20 ppm with waste cooking palm oil biodiesel and also found that the engine CO emissions are reduced by 1.9% not only that the HC and NOx emissions are reduced compare with waste cooking palm oil biodiesel. The smoke emissions are reduced by 6.9% compare to waste cooking palm oil biodiesel.

S.Manibharathi et al,[7] studied the effect of Rhodium oxide as a fuel additive on diesel engine performance fueled with Pongamia pinnata biodiesels. A single cylinder DI diesel engine is used for their investigation and found that the engine brake thermal efficiency was marginally increased with Rhodium oxide fuel blends and BSFC decreased by 3% compare with Pongamia pinnata biodiesel and found that the engine HC,CO and NOx emissions are reduced up to 45% ,20% and 37% with Rhodium oxide fuel additive blends compare with Pongamia biodiesel respectively.

M. Mohan Rao et al,[8] had investigated the effect of Zinc oxide as a fuel additive on diesel engine performance fuelled with Palmolion Stearin Wax biodiesel with proportion of B20(20% biodiesel + 80% diesel) , B20 + 150 ppm (20% biodiesel + 80% diesel + 150 ppm of additive) and B20 + 200 ppm (20% biodiesel + 80% diesel + 200 ppm of additive) . A single cylinder DI diesel engine is used for their investigation and found that the engine mechanical efficiency was increased by 5.57% at blending proportion of B20 + 150 ppm compare to other blends of biodiesel and the brake specific energy consumption was declines by 12.77% for B20 + 200 ppm and 5.15% for B20 + 150 ppm compare with the other blends of biodiesel and also found that the engine CO emissions are reduced at B20 + 150 ppm compare to other blends of biodiesel not only that the HC emissions are reduced up to 16.5% at B20 + 200 ppm compare to other blends of biodiesel.

B.Sachuthananthan et al,[9] investigated the effect of diethyl ether as a fuel additive on diesel engine performance fuelled with Water- biodiesel emulsion with proportion of BD-1(5% diethyl ether + 95% biodiesel) and BD-2(10% diethyl ether + 90% biodiesel). A single cylinder DI diesel engine is used for their investigation and found that the engine brake thermal efficiency was increased by 0.7% at BD-1 compare to other blending proportion of biodiesel and also the brake specific energy consumption is low at BD-1 and BD-2 blending proportions compare with the other blending proportion of biodiesel and also represent that the engine emissions like HC,CO, NOx and smoke are reduced at BD-1 and BD-2 blending proportions.

III-EXPERIMENTAL WORK

For the present work the experiment is conducted on a constant speed, single cylinder, four stroke, vertical, water cooled, high speed diesel engine equipped with AVL five gas analyzer system is used. The photographic view of Experiment set up is as shown in figure.1

Figure 1. Photographic view of Experimental setup

Various blends of Datura biodiesel is used as a fuel, the performance and emission characteristics was recorded for various loads at constant speed of 1520 rpm at a constant injection timing of 23.4° bTDC (before Top Dead Centre).The engine has a belt brake dynamometer to measure its output. A constant load test is conducted and the results were recorded under steady state conditions. The properties of petroleum diesel, Datura and B20 (20% Datura oil and 80% diesel) are measured with standard equipment. The specifications of the engine and properties of fuels are mentioned in the following tables.

Table 1. Technical Specifications of the Engine

Make	Kirloskar
Type	4-stroke,1-cylinder diesel engine (water cooled)
Rated power output, RPM	5HP,1520 RPM
Bore & Stroke	80mm x 110mm
Compression Ratio	16.5:1
Dynamometer	Belt brake
Emissions	AVL Gas analyzer

Table 2. Properties of Petroleum Diesel and Datura biodiesel

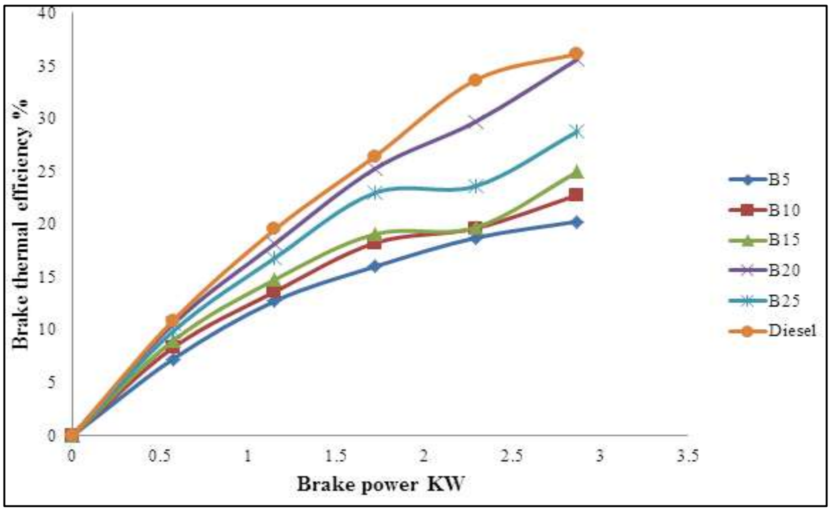
S.No	Properties	Petroleum Diesel	Datura	B20
1	Density (Kg/m^3)	850	880	856
2	Viscosity (Mm^2/s)	2.6	4.80	3.04
3	Flash Point (°C)	60	127	73.4
4	Fire Point (°C)	64	131	77.4
5	Calorific Value (MJ/Kg)	43	39.23	41.44

The performance and emission parameters of B20 blended are compared with diesel and other blend of biodiesel. The Datura biodiesel was supplied by Jatropha oil seed development & Research Hyderabad, Telangana, India. The petroleum Diesel was purchased from The Bharat Petroleum pump outlet, Tirupati, A.P, India. The Datura oil is blended with diesel in a Magnetic stirrer. The Photographic view of Magnetic stirrer with biodiesel blend is as shown in figure 2.

Figure 2. Photographic view of Magnetic stirrer with biodiesel blend

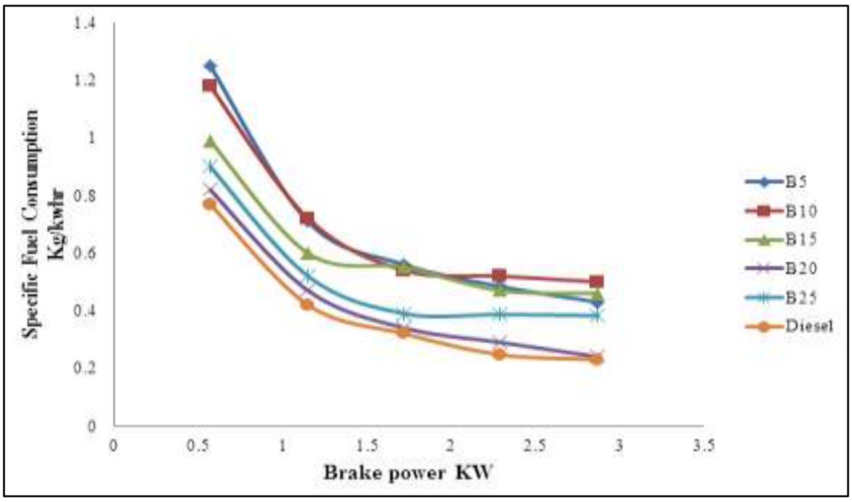
IV-RESULTS AND DISCUSSIONS

The following results are obtained after testing the various blends at rated load. Graph 1 shows the variation in brake thermal efficiency with brake power for diesel, B5, B10, B15, B20 and B25



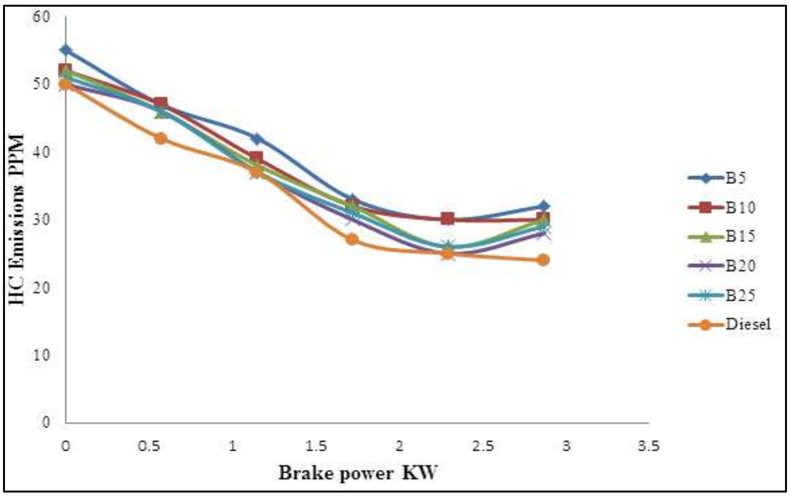
Graph.1. Variation of Brake thermal efficiency with B.P

Brake thermal efficiency (BTE) is the ratio between the power output and the energy introduced through fuel injection the latter being the product of the injected fuel mass flow rate and the lower heating value. The break thermal efficiency versus brake power graph Graph.1shows a variation of break thermal efficiency of diesel and also various blends of biodiesel. Even a small quantity of diesel in the blend improves the performance of the engine. The brake thermal efficiency of the B20 blend is better than other blends, which is very closer to diesel. This is due to reduction in viscosity which leads to improved atomization, vaporization and combustion.



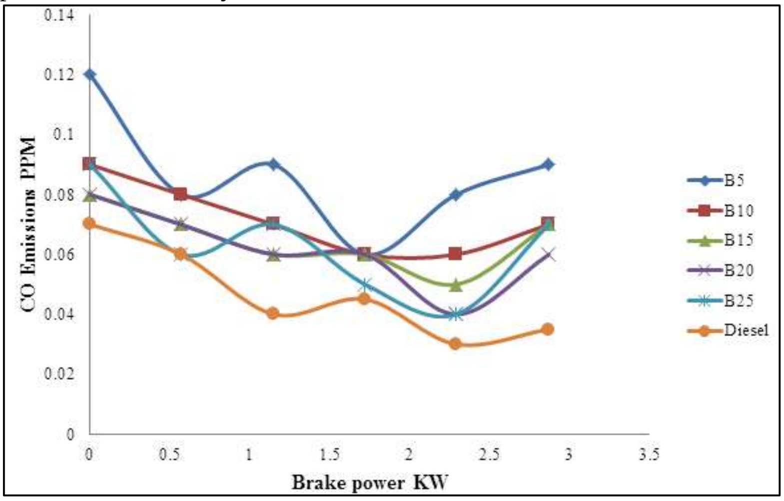
Graph.2. Variation of Specific fuel consumption with B.P

The SFC is an ideal parameter for comparing the engine performance of fuel having different calorific values and specific gravities. SFC is the ratio between the mass flow rate of the tested fuel and effective power. Graph.2 is SFC variation of the biodiesel and its blends with respect to brake power of the engine. The SFC of the engine with B5 is higher when compare to other blends. This may be due to lower heating value, higher viscosity and density of B5 Datura seed biodiesel. The primary reason in increase of SFC with increase in fuel blends is the additional consumption of biodiesel fuel by the test engine in order to maintain constant power output.B20 blend SFC is less compared to B5.



Graph.3. Variation of HC Emissions with B.P

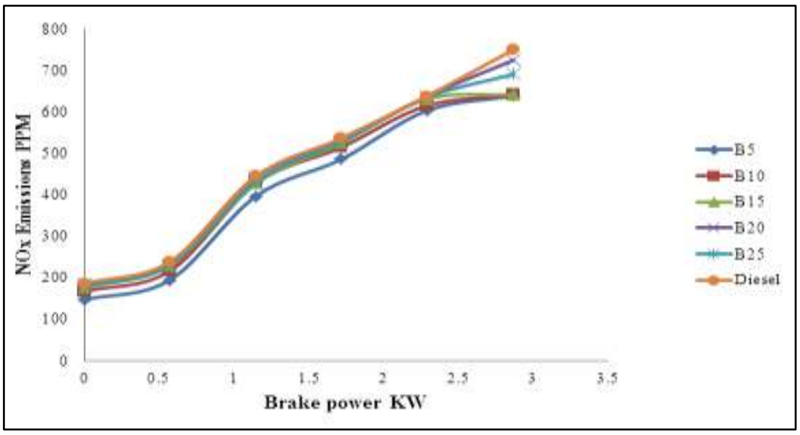
The HC emissions are formed due to improper combustion. The HC emissions are decreased by 6% for Diesel and increased by 2.3% for B25 blend of biodiesel compared to B20 blend respectively. At Diesel the complete combustion takes place due to sufficient oxygen present in combustion chamber. So the hydrocarbon emissions are decreased. But at B20 due to incomplete combustion in chamber compared to Diesel the hydrocarbon emissions are increased



Graph.4. Variation of CO Emissions with B.P

The formation of CO emissions is due to lack of oxygen for combustion in the chamber. In the present work the CO emissions are decreased by 0.01% for Diesel compared to B20 and it is increased by 0.4% for B25 blend of biodiesel. At Diesel the air fuel mixture is equal to the stoichiometry air fuel ratio the complete combustion takes place in the combustion chamber. So the CO emissions are increased compared to diesel

Graph 5 shows the variation of the NOx emissions with brake power for diesel and with different blends of biodiesel . The NOx are formed due to higher temperatures in chamber, at lower temperature the NOx are inactive. In present work the NOx emissions are increased by 1.5% for Diesel compared to B20 and it is decreased by 1% for B25 blend of biodiesel. For Diesel maximum brake thermal efficiency is obtained. So the temperature in the combustion chamber is also maximum. The NOx are depending upon the temperature in combustion chamber. So for the Diesel the NOx are increased compared to B20 and other blends of biodiesel.



Graph.5. Variation of NO_x Emissions with B.P

V-CONCLUSION

The experiments were conducted on a single cylinder four stroke diesel engine fuelled with Datura seed biodiesel blends . Following conclusions are derived after analysing the results and graphs.
Performance characteristics were analysed when engine fuelled with B5,B10,B15, B20 & B25 blends and diesel. Engine brake thermal efficiency was high fuelled with B20 blend when compared to other two blends and low in comparison with diesel.
The blend B20 showed a better performance compared to other blends of biodiesel
1).The Brake thermal efficiency of Datura seed bio-diesel blend B20 decreases by 4.2% when compared to diesel .due to its low calorific value of mango seed bio-diesel.
2).The Specific fuel consumption is increased by 3 %at B20 compared to diesel
3).The HC emission was decreased by 9.09% of diesel when compared to B20.
4).The CO emission was decreased by 5.55% of Diesel when compared to B20.
5)The NOx emission was increased by 20.12% of Diesel when compared to B20.

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