IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8528

Extraction, Physico-Chemical characteristic study and Emission analysis of dual bio fuels

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Abstract: In this current study, Collection of Seeds ,Extraction of Oil and Transesterification of Biodiesel ,Physical–Chemical properties and Emission properties, with mixed dual fuel of jatropha curcas , pongamia pinnata biodiesels mixture - diesel blend in equal proportions with conventional mineral diesel in the proportions of B5,B10,B15,B20 with ratios of (50:50),(60:40),(70:30) and the results were compared with diesel. FTIR test , Fatty Acid Profile, Physico chemical properties such as Density, Kinematic viscosity, Calorific value, flash and fire points and Emission properties such as CO , CO_2 , HC , No_x smoke percentage ,Exhaust gas temperature, were determined by using the standard test methods and compared with conventional diesel fuel.

Keywords: Dual Bio-fuel, Physical Chemical Properties, Emission, Blending, Transesterification

I. INTRODUCTION

The growth on energy consumption, environmental concern of the global warming, climate change and increasing petroleum price in worldwide has significantly increased the interest of searching for new fuels as an alternative source to diesel fuel. [1]Methyl ester (Biodiesel) is one of the alternative transportation fuel available. It received attention all over the world as an alternative automotive fuel because they are renewable and eco-friendly biodegradable, nontoxic and can considerably decrease exhaust emissions and overall life cycle.Bio diesel is an high - energy bio fuel from oils,fats.[2-6] Several studies focused on single biodiesels as well as their blends with diesel. The researchers have left a space open for the use of dual biodiesels (mixtures of two different biodiesel).The majority of the literature proposed that jatropha oil and pongamia pinnata oil are ideal diesel substitutes.[7-11] Two biodiesels,jatropha oil and pongamia pinnata oil, were blended with diesel fuel in this study. The main physical and chemical properties of jatropha biodiesel–pongamia pinnata biodiesel–diesel fuel without engine alteration in a four-stroke compression ignition engine The obtained findings were also related to the pollution results of mineral diesel fuel.

II. METHODS

A. Oil Extraction

Collection of Seeds

The seeds are collected from different parts of Coimbatore. And for Oil extraction Large quantity of seeds is required so, seeds is also been purchased.

Drying of seeds

The Collected seeds were washed and dried under the sun for 15 consecutive days to remove the moisture content from the seeds and to acquire accurate results.

Coldpress Extraction

We planned to extract oil using cold pressed method such it is environmentally friendly use with no use of solvents.

B. Transesterification

In single step base transesterification process methanol is used as reagent and NaOH as a catalyst. The conversion of pongamia pinnata and jatropha curcas by transestrification reaction into bio diesel is conducted in a

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reactor having a condensor assembly. The whole process is done in a well furnished and equipped laboratory. The mixture of 200 ml of methanol and 6.5 grams of 97% pure NaOH (Sodium Hydroxide) is prepared and is added into the reactor at 60℃ and stirred at 600 rpm for two hours, Solution turns into brown silky colour and the reaction is ended. The solution is now turned into Bio diesel (methyl ester) and glycerin untreated Bio diesel. The Bio diesel (methyl ester) is separated from glycerin by using the separation funnel. Then the methyl ester is been bubble washed twice with distilled water to remove the methanol content in it. Then it is been set to dry in a oven at 100℃ for about 15 minutes to remove the moisture content present in it, we then finally get pure methyl ester. Then the Bio diesel of pongamia pinnata and jatropha curcas is mixed and blended with mineral diesel in different ratios for testing.

C. Blending Percentage and Ratio

As the Blend is Mixed in the format of (Eg: In an 100 ml blend named as D95JP5 (70:30) which means Diesel 95% (95ml) + Biodiesel 5% (5ml) in which the Biodiesel of 5% contains 70% (3.5ml) Jatropha and 30%(1.5ml) Pongamia Methyl ester).

Blend Name	Blend Percentage
B5 (D95JP5)	Diesel 95% + Biodiesel 5%
B10 (D90JP10)	Diesel 90% + Biodiesel 10%
B15 (D85JP15)	Diesel 85% + Biodiesel 15%
B20 (D80JP20)	Diesel 80% + Biodiesel 20%

Blend	Blend Ratio
50:50	50% Jatropha + 50% Pongamia
60:40	60% Jatropha + 40% Pongamia
70:30	70% Jatropha + 30% Pongamia

III. EXPERIMENTATION

Kirloskar Four stroke single cylinder, speed is kept as constant with no load and exhaust gas analyzer was used to measure the carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbon emission (HC) and nitrogen oxides (NO_x). The smoke percentage, Exhaust gas temperature was measured and the results were compared with diesel fuel.

Make	Kirloskar oil engine India
Details	Single cylinder DI, Air cooled
Cubic Capacity(Ltr)	0.948ltr
Rated Power	7.4 Kw/hr (25249.9 btu)
Rated Speed	1500 rpm (157.1 rad/sec)
Bhp	10

IV. RESULTS AND DISCUSSION

A. FTIR Test

For the quantification of fatty acid methyl ester content in the manufactured biodiesel, Fourier transform infrared spectroscopy was used as a quick and accurate analytical technique. Fourier-transform infrared spectroscopy for Jatropha Methyl ester and Pongamia Methyl ester were analysed. For easy understanding the values from the FTIR graph is tabulated.

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Wave number	Type of vibration	Functional group	Compound class
3609-47	Stretching	O-H	Alcohols, phenols
3006.49	Stretching	C-H	Alkanes
2921.77	Stretching	C-H	Alkanes
2852.85	Stretching	C-H	Alkanes
1742.61	Stretching	C=O	Esters, saturated
1460.9	Bending	C-H	Alkanes
1374-79	Rock	C-H	Alkanes
1235-71	Wag, Stretch	C-H/C-N	Alkyl halide, Aliphatic amines
1160.14	Wag, Stretch	C-H/C-N	Alkyl halide, Aliphatic amines
1114-92	Wag, Stretch	C-H/C-N	Alkyl halide, Aliphatic amines
721.55	Rock	C-H	Alkanes
592.7	Stretching	C-Br	Alkyl halides

Table -1: FTIR for Jatropha Methyl Ester

Wave number	Type of vibration	Functional group	Compound class
2922.12	Stretching	C-H	Alkane
2852.72	Stretching	C-H	Alkane
1741.73	Stretching	C=O	Esters
1647.21	Stretching	C=C	Alkene
1460.11	Bending	C-H	Alkane
1436.97	Bending	O-H	carboxylic acid
1359.82	Bending	O-H	Alcohol
1246.02	Stretching	C-N	Amine
1195.87	Stretching	C-O	tertiary alcohol
1168.86	Stretching	C-O	Ester
721.38	Bending	C-C	Alkene

Table -2: FTIR for Pongamia Methyl Ester

Frequency range (cm-l)	Bond type	Family
3000-2850	C-H stretching	Alkanes
1470-1450	C-H bending	Alkanes
1370-1350	C-H rock	Alkanes
725-720	C—H rock	Alkanes
1000-650	═C—H bend	Alkenes

Table -3: FTIR for Diesel

The FTIR spectrums of Diesel, Jatropha Methyl ester (B100) and Pongamia Methyl Ester (B100) had been recorded after scanning. Typically a sharp intensity absorption area ranging between 1750-2000 cm-1 was absorbed as simple carbonyl compounds such as ketones, aldehydes, esters, or carboxyl.The peak value at 1742 cm-1 indicated the presence of C=O functional group esters.A specific peak at 2921.77 cm-1 revealed the presence of alkanes functional group (C-H).In addition, the presence of peak between the wave number 1000-1250 confirmed the existence of aliphatic compounds specifically Aliphatic amines (C-N) at 1158.2 cm-1.A narrow band was observed between 3500-4000 with the peak value at 3609.47 cm-1 which revealed the presence of oxygen related group, such as alcohols (O-H).

FTIR results of Jatropha and pongamia samples have shown the presence of four different functional groups like esters,alkanes,aliphatic amines and alcohol which is essential to prove the characteristic properties of biodiesel.

B. **Fatty Acid Profile**

Fatty acid testing is done on vegetable oil to calculate the exact amount acidic components present in it. It mainly determines the properties and uses of the oil. High content of oleic acid and low saturated fatty acid level is currently suitable for considering for Biodiesel application. Since it has good oxidative stability and combustion characteristics.

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FATTY ACID	STRUCTURE	JATROPHA BIODIESEL	PONGAMIA BIODIESEL	JATROPHA PONGAMIA BIODIESEL
Myristic acid	C14.0	0.10	0.18	0.12
Palmitic acid	C16:0	14.9	19.25	18.35
Palmitoleic acid	C16:1	1.74	0.175	0.997
Stearic acid	C18:0	7.32	6.75	7.01
Oleic acid	C18:1	43.70	50.95	49.32
Linoleic acid	C18:2	32.64	28.48	31.574
Linolenic acid	C18:3	1.38	3.96	2.84
Arachidic acid	C20.0	0.21	0.98	0.91
Saturated Fatty acids		23.73	15.39	18.99

Table -3: Fatty acid Profile

C. **Physical Chemical Properties**

Fuel properties can be derived and divided into physical properties of the liquid such as calorific value, Kinematic viscosity, density, flash point and cetane index. This mainly refers to the quality of the fuel.

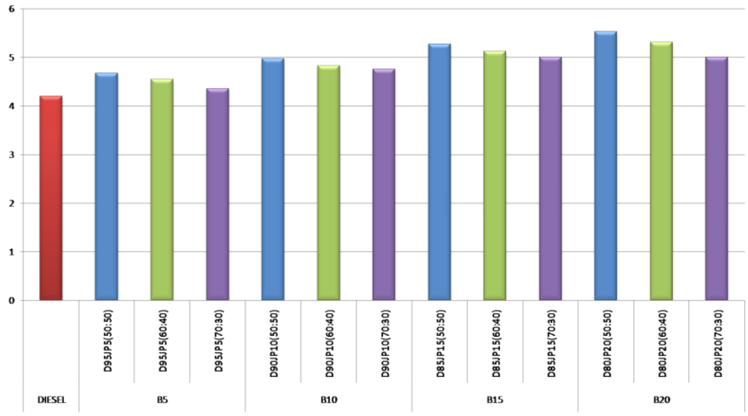

Fig -1: Kinematic Viscosity vs Blend

Viscosity of fuel determines flow characteristics when a liquid fuel flows through injector nozzle, flow line.The maximum Viscosity is 5.53 cSt measured for D10JP20 (50:50) biodiesel sample, and the minimum is 4.35 cSt measured for D95JP5 (70:30) biodiesel sample. The European standard Viscosity values of biodiesel are 3.5 to 5 cSt, and the American standard Viscosity values are 1.9 to 6 cSt.. The relationship between Viscosity and percentages of biodiesel in the samples is shown in Fig.1. B5 samples have the lower viscosity of all other blended samples.

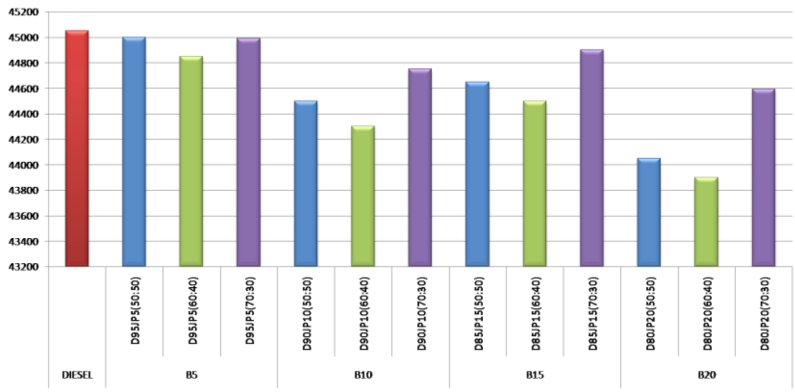

Fig -2: Calorific Value vs Blend

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ISSN (Print) 2394-1588

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The maximum calorific value is 45000 kJ/kg measured for B5 [(D95JP5(50:50))] biodiesel sample, and the minimum is 43900 kJ/kg measured for B20 [(D80JP20(60:40))] biodiesel sample. The standard calorific value range of diesel is 42000 kJ/kg to 44000 kJ/kg and the biodiesel of our blend shows the range of results within the comfortable limits of standards. The relationship between calorific value and percentages of biodiesel in the samples is shown in Fig.2

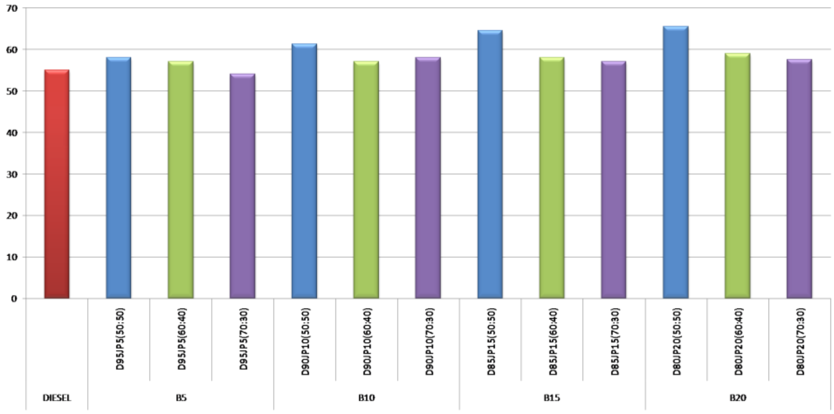

Fig -3: Flash Point vs Blend

The maximum flash point is 65.5 0C measured for B20 [(D80JP20(50:50))] biodiesel sample, and the minimum is 54 ^{0}C measured for B5 [(D95JP5(70:30))] biodiesel sample. The standard flash point range of diesel is 38 ^{0}C to 95 ^{0}C @ 15^{0}C and the biodiesel of our blend shows the range of results within the permissible limits of standards. The relationship between flash point and percentages of biodiesel in the samples is shown in Fig.3

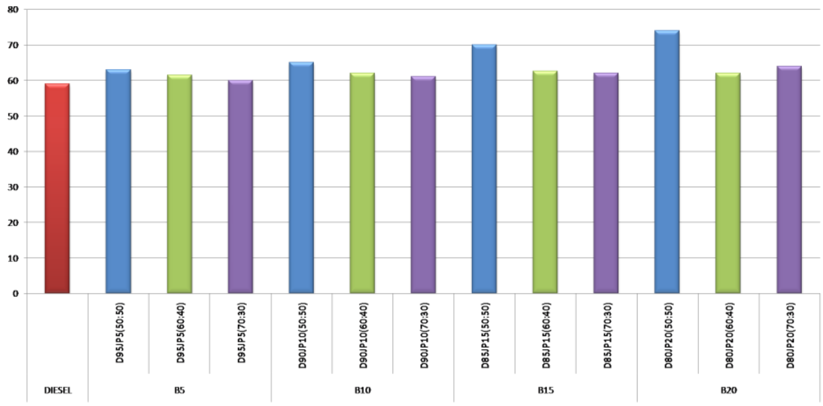

Fig -4: Fire Point vs Blend

The maximum fire point is 74 0C measured for B20 [(D80JP20(50:50))] biodiesel sample, and the minimum is 60 0C measured for B5 [(D95JP5(70:30))] biodiesel sample. which is well above the flash point of the respective blends and within the ranges of the standards. The relationship between fire point and percentages of biodiesel in the samples is shown in Fig.4

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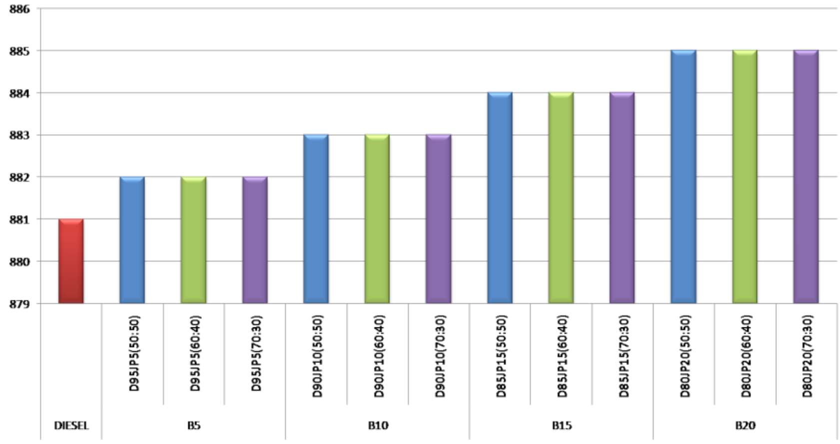

Fig -5: Density vs Blend

The maximum density is 885 kg/m3 measured for B20 [(D80JP20(50:50))], B20 [(D80JP20(60:40))],[(D80JP20(70:30))] biodiesel sample, and the minimum is 882 kg/m3 measured for B5 [(D95JP5(50:50))] , B5 [(D95JP5(60:40))] , B5 [(D95JP5(70:30))] biodiesel sample. The standard density values of diesel 875 kg/m3@ 150C and the biodiesel of our blend shows the range of result 882 kg/m3 to 885 kg/m3 @ room temperature which resides inside the permissible limits of standards. The relationship between density and percentages of biodiesel in the samples is shown in Fig.5

D. **Emission Properties**

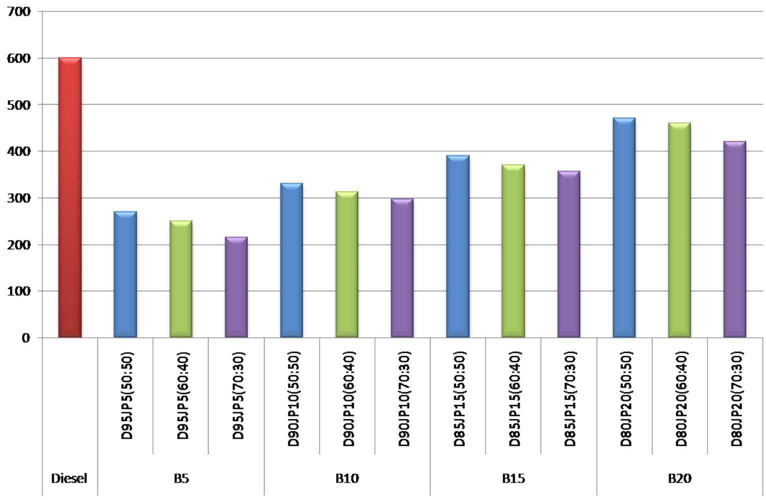

Fig -6: Carbon Monoxide vs Blend

As from results D90JP10(70:30), With higher the blends of bio fuel with diesel lowers the co value in the emission compared to diesel, because of the more oxygen content present in the vegetable oil. Which intend cause easy burning at higher temperature and complete combustion inside the engine and reduces the HC and CO emission.

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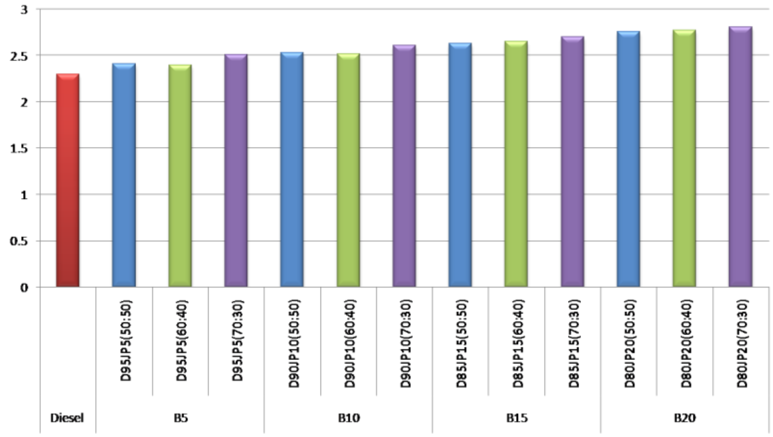

Fig -7: Carbon dioxide vs Blend

As from results D90JP10(70:30),Carbon dioxide gradually increases when the blends of oil content get increased. Usually carbon dioxide emission is higher in bio diesel compared to the fossil diesel as it comes from vegetable oil and with higher oxygen content produces complete combustion and increase in CO2. Such in case the carbon dioxide emission produces from the bio diesel is been reabsorbed by the same number of plants where they are derived.

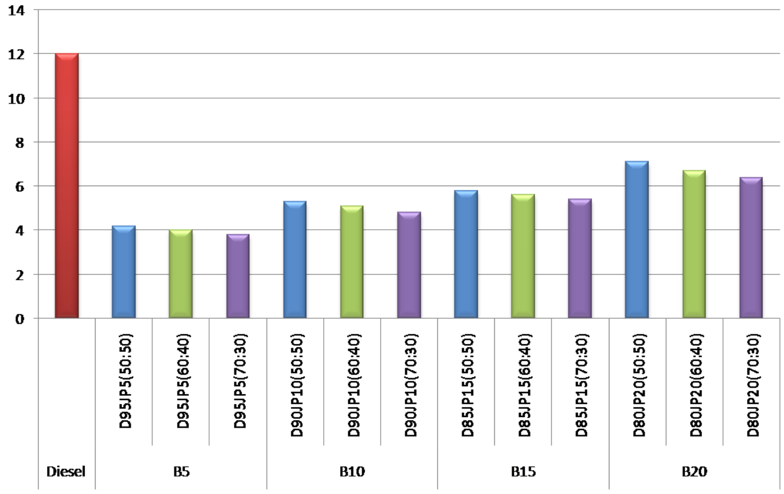

Fig -8: Hydrocarbon vs Blend

Hydrocarbon gradually increases when the blends of oil content get increased. As from results D90JP10(70:30) produces less HC compared to other blends and 60% lower HC than diesel in constant rpm. Thus due to high viscosity and density present in higher blends of the bio diesel reduces the complete combustion and as result increases the HC.

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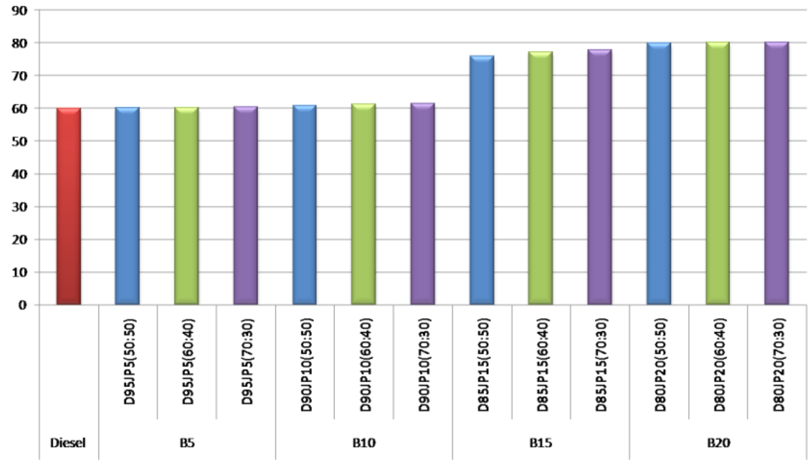

Fig -9: Nitrogen Oxide vs Blend

The NOX emission values from bio diesel is generally higher than the fossil diesel. The increase in NOX emission is because of the more oxygen content present in oil and high temperature caused by complete combustion. As from results D90JP10(70:30), the NOX emission from the blend is more or less compared to be same as the emission of the fossil diesel. And also it can be regulated by the exhaust gas recirculation (EGR).

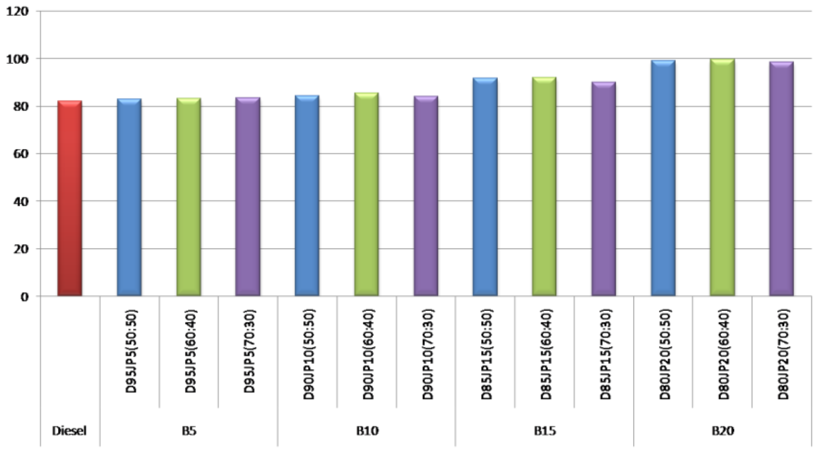

Fig -10: Exhaust Temperature vs Blend

Exhaust temperature gradually increases when the blends of oil content get increased. The cetane number of diesel is 47.14 and the cetane number of mixed bio diesel is (48-50). The cetane number has a direct effect on exhaust temperature. As there is increase of blends gradually the exhaust temperature gets increased, this means slightly the energy is being wasted. As from results D90JP10(70:30) only about 1% of the loss is increased from the fossil diesel so that can be manageable.

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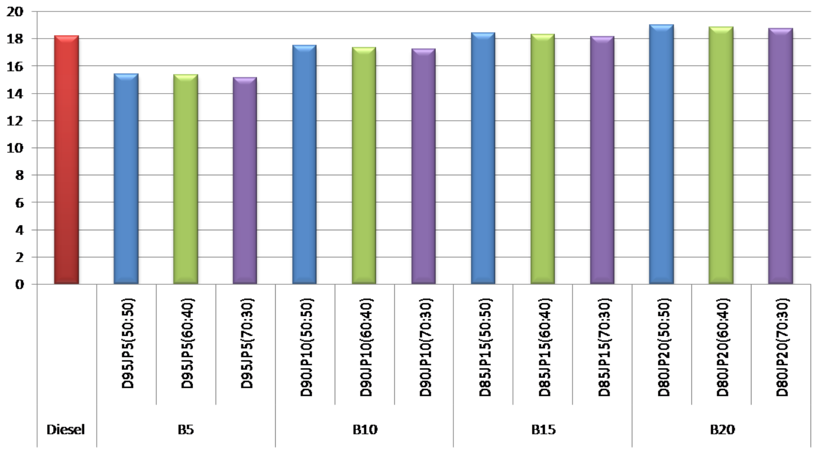

Fig -11: Smoke Percentage vs Blend

As from results D90JP10(70:30), The smoke emission of the mixed bio diesel for all blends are lower than diesel expect B20. Its due the rich oxygen content present in the oil, which helps in complete combustion and less emission of smoke.

V. Conclusion

So far, only a small amount of research has been conducted in the mixed bio diesel blended fuels analysis. This research was carried out to investigate the different blends of bio diesel with different ratios from 50:50, 60:40, 70:30 of blends in fuel like B05,B10, and B20for emission characteristics. For Physico-chemical properties, the following conclusions can be done: The properties of the Jatropha and Pongamia mixture were similar to those of diesel after two stages of transesterification into methyl ester.When the JPME was mixed with oil, the properties were much more similar to those of diesel.JPME can be mixed with diesel because some of the main fuel properties, such as viscosity, heat of combustion, and density, seem to be similar in the blends.For Emission analysis, the following conclusions can be inferred

1.As from the study and various experiments conducted.This blend of B10 D90JP10(70:30) (90% mineral fossil diesel+ 7% of jatropha bio diesel + 3% of pongamia bio diesel) has significant results compared to other blends been tested.

2.This D90JP10(70:30) bio diesel shows a promising result in reduction in Carbon monoxide about 50% and reduction in hydrocarbons about 60%. However the emission of the nitrous oxides and exhaust temperature is slightly higher than the mineral fossil diesel. It can be controlled by the exhaust gas recirculation system (EGR).

3.This D90JP10(70:30) bio diesel can be used in agricultural purpose engines and stationary generators without any modification of the engines.

4.Further investigation can be carried out in future to evaluate the engine performance parameters of a diesel engine operating on the same samples of mixed bio diesel fuel.

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