Performance, Combustion and Emission Characteristics of Corn oil blended with Diesel

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***Abstract*— Petroleum based fuels is a finite resource that is rapidly depleting. Consequently, petroleum reserves are not sufficient enough to last many years. Biodiesel is one of the alternative fuel made from vegetable oil, friendly for environment and has no effect on health and can reduce the emission compared with diesel fuel. In this paper will be examined the use of diesel-corn oil mixtures in diesel four-stroke engine. For those mixtures the brake thermal efficiency, brake specific fuel consumption and combustion characteristics. The gas emissions of carbon dioxide (CO_2), hydrocarbons (HC), are being measured.**

***Keywords*— Bio fuels, corn oil, engine performance, combustion and emissions**

I. INTRODUCTION

Diesel engines have been use since the last 18th century. The first diesel engine was developed to run on a peanut oil. Once the technology becomes widely known in the 1900's, the abundance and low cost of fossil fuels, caused a paradigm shift away from vegetable based fuels [1]. At the turn of current century, the same paradigm was beginning to shift back, due to rising fuel cost, the environmental impact and an abundance of waste feedstock available. Thus there is a demand to find alternative fuels for diesel engines. It is thus very essential to make all possible efforts to search for alternate fuel oils [2]. To ever increasing number of auto mobiles has lead to increase in demand of fossil fuels (petroleum). The increasing cost of petroleum is another concern for developing countries as it will increase their import bill. Fossil fuels have limited life and the ever increasing cost of these fuels has led to the search of alternative renewable fuels for ensuring energy security and environmental protection [3].

In this paper, to study the performance, combustion and emission characteristics, the experimental setup consists of a single cylinder four stroke diesel engine, coupled with electrical dynamometer. The mixtures used are the following: diesel-15%cornoil, diesel-30%cornoil, diesel-45%corn oil, diesel-60%corn oil.

LITERATURE SURVEY

- S.Ganesan, Dr.A.Elango [4] is conducted test on blends castor oil and ethanol using C.I engine. The experimental investigation has been carried out on single cylinder CI Engine and the results has been recorded.they observed lower HC and NO emissions. Brake thermal efficiency and exhaust gas temperature are less compared to diesel.
- C.Solaimuthu, D.Senthil kumar [5] studied the diesel engine performance, combustion and emission characteristics mahua bio diesel (mahua oil methyl ester) and its blends in different volumetric proportions with diesel. They found that the brake thermal efficiency is almost same and less fuel consumption and also show that reduced NOX and HC emissions.
- Ahmet necati ozsen, Mustafa canacki [6] investigated experimentally on canola oil methyl ester (COME) and waste (frying) palm oil methyl ester (WPOME). They found that the brake power reduced by 4–5%, while the brake specific fuel consumption increased by 9–10%. On the other hand, methyl esters caused reductions in carbon monoxide (CO) by 59–67%, in unburned hydrocarbon (HC) by 17–26%, in carbon dioxide (CO) by 5–8%, and smoke opacity by 56–63%.
- M.G. Bannikov [7] has studied on Mustard methyl esters (further biodiesel) and regular diesel fuel were tested in direct injection diesel engine. Analysis of experimental data was supported by an analysis of fuel injection and combustion characteristics. Engine fuelled with biodiesel had increased brake specific fuel consumption, reduced nitrogen oxides emission and smoke opacity, moderate increase in carbon monoxide emission with essentially unchanged unburned hydrocarbons emission.

II. BIO DIESEL PRODUCTION PROCESS

The chemical process commonly used make bio-oils less viscous, turning them into "biodiesel" is called "Transesterification" [8].

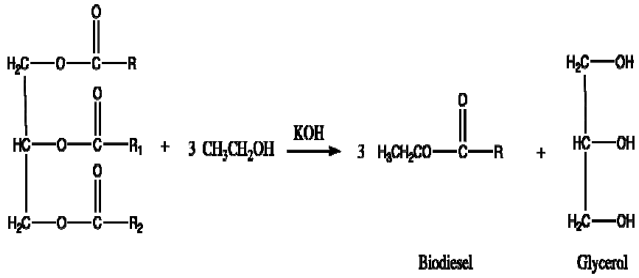
A. Transesterification Process

Corn oil was used as the raw oil to be transesterified with methanol in a reacting tank. The temperature values are below

the boiling point of methanol (63^0C), to prevent the methanol in the reactant mixture from evaporating [9].

The potassium hydroxide was stirred with methanol for 10 minutes using an electric-magnetic stirrer to form potassium methoxide, which was then poured into the reacting tank and mixed with the corn oil [10]. The total reaction time was 60 minutes. Almost total conversion to corn oil bio diesel was achieved quickly after a few minutes from the start of the reaction, depending on the ambient conditions.

The chemical formula for biodiesel Transesterification is:



B. Properties of biodiesel comparison with diesel

Properties	Corn oil	Pure diesel
Density at15^0c (gm/cc)	0.8944	0.82
Viscosity at 40^0c (Centi stokes)	6.71	5
Cloud point (^{0}C)	18	-6
Pour point (^{0}C)	-8	3
Carbon Residue (%)	0.42	0.1
Calorific value (KJ/kg)	36204	42,500

III. Experimental Investigation

In order to evaluate and compare the performances, combustions and emission characteristics of the fuel, the experiments were conducted using a diesel engine in thermal laboratory. This section deals with description of the experimental set up, various instruments and software used for testing.

A. Description of test rig

The diesel engine is a high speed, four stroke, vertical, air cooled type. The loading is by means of an electrical dynamometer. The fuel tank is connected to graduated burette to measure the quantity of fuel consumed in unit time.

An orifice meter with U-tube manometer is provided along with an air tank on the suction line for measuring air consumption. An AVL415 smoke meter is provided for measuring FSN for exhaust gases. The test rig is installed with AVL software for obtaining various curves and results during operation. A five gas analyser is used to obtain the exhaust gas composition.

B. Test engine specifications

Type: four stroke single cylinder vertical air cooled diesel engine.

TABLE I

Rated power	4.4 KW
Rated speed	1500 rpm
Bore Dia (D)	87.5 mm
Stroke(L)	110 mm
Compression ratio	17.5:1
Orifice diameter	13.6 mm
Coefficient of discharge(C_d)	0.6

C. Test methodology

The present set of experiments were conducted on a four stroke single cylinder vertical air cooled diesel engine equipped with eddy current dynamometer. First the maximum torque of the engine is calculated and the engine is started under no load condition by hand cranking using de-compression lever. The engine is run under no load condition for a few minutes so that the speed stabilizes at rated value. The engine is run under constant speed and fuel consumption time indicator is arranged with 10cc of fuel quantity. Using eddy current dynamometer the experiment conducted for variable loads. The engine test were performed using bio diesel and the results were recorded. The above procedure is repeated at the same operating conditions for all the blends. The four types of

blends (B15, B30, B45, B60) were used in this experiment. The different parameters required for evaluation of fuel was noted.

D. Results and discussions

1. Performance characteristics:

The brake thermal efficiency variation with brake power for the corn oil and diesel are shown in figure1. It can be seen that in the beginning with increasing brake power of the engine the brake thermal efficiency of various concentration of blends and pure diesel were increased. The maximum brake thermal efficiency of the engine was 28.07 for corn oil B15 at brake power 3.32 where it is 25.46 for diesel. This is due to improved atomization fuel vaporization, better spray characteristics and improved combustion through mixture.

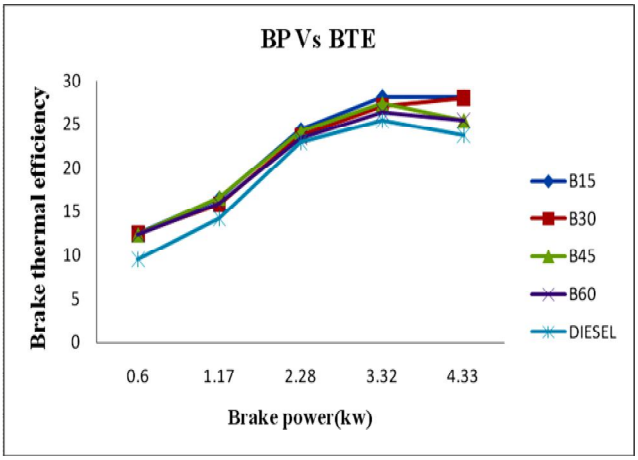


Fig. *1 Brake Thermal Efficiency against Brake power*

Fig. 2 shows Brake specific fuel consumption variation brake power for the corn oil and pure diesel. It is observed that the brake specific fuel consumption is found to decrease with increase in load. Among the blends B15 concentration shows the minimum specific fuel consumption than other blends and pure diesel. The minimum BSFC is observed as 0.31 for B15 blend where as for pure diesel it was 0.33 at initial load of the engine. This may due to better combustion and an increase in the energy content of the blend. This is also due to lower calorific value of the blended fuel as compared with diesel.

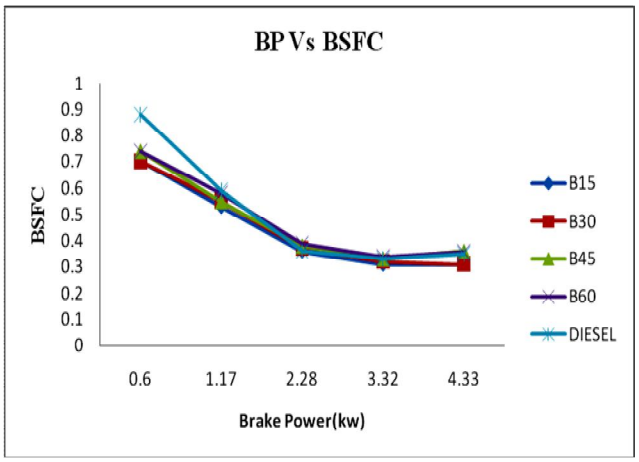


Fig. 2 Brake specific fuel consumption against brake power

2. Combustion Characteristics

The variation of cylinder pressure with crank angle is shown in figure-3.is is found that B60 concentrations provide high cylinder pressure compared to that of pure diesel and other blended fuels. The maximum cylinder pressure observed as 69bar for B60 blends, at maximum brake power of the engine.

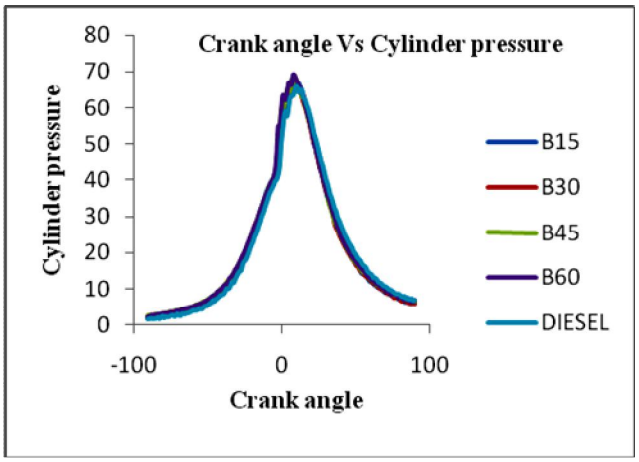


Fig. 3 Cylinder pressure against crank angle

Figure 4 shows variation of heat release rate with crank angle for pure diesel and blended fuel at full load. The heat release rates are higher for B30 blend than pure diesel and other blends. The higher heat release rate is observed as 105kj/m^3deg at maximum brake power of the engine. This is due to better combustion.

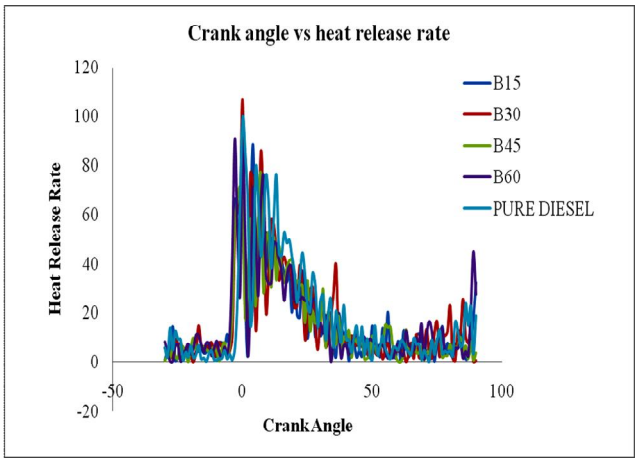


Fig. 4 Heat release rate against Crank angle

3. *Emission Characteristics*

The variation of carbon dioxide with brake power of the engine is shown in figure-5. It is observed that carbon dioxide emission increase with increase of brake power. The Minimum carbon dioxide value for the corn oil was 1.4 at B45&B60 and at the initial brake power 0.06 at it was 2.4 for diesel. This is a result of low availability of oxygen during combustion.

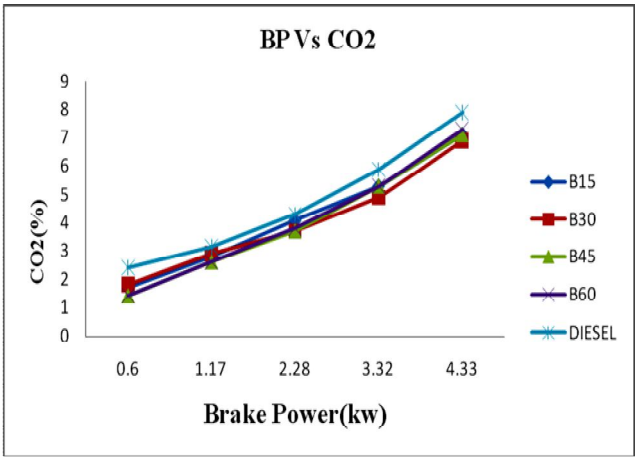


Fig. 5 Carbon dioxide against Brake power

The hydro carbons variation with brake power for the corn oil and diesel are shown figure-6.The hydro carbons are lower for all the blends for the corn oil compared with diesel. The lowest value of HC was 18 at brake power 0.06 and it was 25 for diesel. This result depends on oxygen quantity and fuel viscosity, in turn atomization.

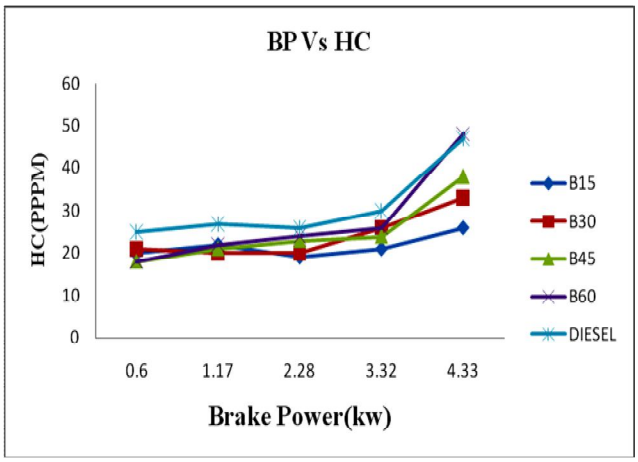


Fig. 6 Hydro carbons against Brake power

IV. Conclusions

The performance, combustion and emission characteristics of diesel and bio diesel were investigated on four stroke single cylinder vertical air cooled diesel engine. The conclusions of this investigating at are as follows.

- The maximum brake thermal efficiency 28.07% was observed with the blend B15 as compared to pure diesel and the other blend at the brake power 3.32kw of the engine.
- The specific fuel consumption of the 0.31kg/kw-hr was observed with the blend B15 the SFC is lower for above blend than that of other blends and pure diesel.
- In the combustion analysis, the maximum cylinder pressure observed as 69bar for B60 blends than all the other blends at maximum brake power of the engine.
- The heat release rate are also higher for B30 blend than pure diesel and all the other blends.
- The CO_2 percentage increased with increase of loads. The minimum value occurred at B45&B60.
- The hydro carbons are also lower for all the blends compared with diesel

References

[1] A.P Patil, M.V Patil: "maize oil blended with diesel as an eco friendly energy source" IOSR Technical paper. *ISSN: 2278-1684, PP: 46-50.*

[2] M.V.Nagarhalli,K.C.Mohite: Emission and performance characteristics of karanga bio diesel and its blendsin a CI engine and its economics.ARPN journal paper. ISSN 1819-6608. Feb, 2010.

[3] N. EI Boulifi, A. Bouiad, M. Martinez, J. Aracil: 'Process optimization for bio diesel production from corn oil and its oxidative stability'.IJOCE paper. Doi:10.1155/2010/518070.

[4] S.Ganesan, Dr.A.Elango: 'performance analysis of CI engine using blends of castor oil and ethanol'. IJMME paper. ISSN 2320-4060.2013.

[5] C.Soliamuthu, D. Senthil kumar 'an experimental investigation on performance, combustion and emission characteristics of mahua oil methyl ester on four stroke direct injection diesel engine'. IJEMS paper.vol.20,feb 2013pp.42-50

[6] Ahmet necati ozsezen, Mustafa canakci: 'determination of performance and combustion characteristics of diesel engine fuelled with canola and

waste palm oil methyl esters'. ELSEVIER paper. Energy conversion and management 52 (2011) 108-116

[7] M.G.Bannikov : 'combustion and emission characteristics of mustard biodiesel'. 6th internationaladvanced technologies symposium(IATS'11), 16-18 may2011 elazig turkey

[8] Mr.Jalpesh solanki, prof. ashish agarwal: 'to study of vegetable oils and their effects on diesel engine performance'. IJSR publications. Vol2, issue 10, Oct 2012

[9] Avinash kumar agarwal: 'bio fuels (alcohols and biodiesel) applications as fuels for internal combustion engines'. ELSEVIER paper. Energy and combustion science 33(2007)233-271

[10] Hsing-pang liu, shanon strank: 'combustion emission modeling and testing of neat bio diesel fuels'. ASME paper. May 2010