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Research Paper

PERFORMANCE AND EMISSION CHARACTERISTICS ON 4-STROKE SINGLE CYLINDER C. I. ENGINE USING COTTONSEED BIO FUELS

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ABSTRACT

The objective of this work is to conduct performance test on horizontal single cylinder variable speed Greaves engine with various blends of cottonseed oil (B5, B10, B15, B20, B40 & B100) and comparing the performance of cottonseed oil with diesel. Blending conventional Diesel Fuel (DF) with esters (usually methyl esters) of vegetable oils is presently the most common form of biodiesel. The most common ratio is 80% conventional diesel fuel and 20% vegetable oil ester, also termed “B20,” indicating the 20% level of biodiesel. The TFC and SFC of B20 remains very stable on various loading conditions and the blends B15 and B20 has a moderate NOx and CO emission. The overall comparison shows that B20 diesel with blend 20% yields the optimum value, with less fuel consumption and higher efficiencies than diesel and it is feasible us it in the diesel engine with no modification.

KEYWORDS Bio diesel, Cottonseed, Transesterification, Performance and Emissions.

I. INTRODUCTION

World over concern for environment, reduction of dependence on oil imports and energy security are the three driving forces which are shaping the pattern of technology development in transport industry which is the single largest consumer of fossil energy. Rapid depletion of conventional energy sources, along with increasing demand for energy is a matter of serious concern. It is essential that alternate fuels for engines should be derived from indigenous sources and preferable renewable energy sources. These requirements have generated a great deal of interest in vegetable oils as substitute or supplementary fuels for diesel engines. Among various vegetable oils, biodiesel from cottonseed oil has many distinguishing and desirable characteristics to suit the entire engines without any modifications. It was found that the performance and emission characteristics of the engine were improved. Also the behavior of diesel engine when operated with biodiesel and its blend with diesel is found satisfactory.

2. EXPERIMENTAL SETUP

A single cylinder horizontal air cooled Greaves engine was used in this investigation. The performance test were conducted in constant speed (2600rpm) air cooled, 4HP greaves engine. The test has been conducted for various blends (such as B5, B10, B15, B20, B40, and B100) at various loads. The specifications of this engine are summarized in Table 1. The engine was coupled to mechanical loading through a transmission shaft. The maximum load which the engine could take at 1200 rpm was found to be 70 N. This was taken as the 100 percent load for this investigation and the various loads were calculated as 0, 1, 3, 6, and 7 to represent the 0%, 10%, 30%, 60% and 70% of maximum load. Emission test was conducted by running the bio diesel in the greaves test engine and this was coupled with the exhausted gas analyzer. In this test the output result from exhaust gas analyzer was noted for each set of loads.

Table1. The Specifications of Greaves Engine

Particulars Details	
No. of cylinder	single
Power	4 H.P
Speed	2600 rpm
Bore	70mm
Stroke	75mm
Type of loading	Belt loaded brake drum

3. PROPERTIES OF BIO-DIESEL

The Biodiesel prepared from cottonseed oil and its blend is considered for this investigation. It is important to estimate its properties and compare it with that of ASTM standards so that we can confirm that we had obtained bio-diesel. The properties of the bio-diesel indicate its degree of purity. The properties of biodiesel are summarized in Table 2. It can seen from the table that the bio fuel blend B100 owning the properties closer to the Diesel compared with ASTM standard for biodiesel.

4. RESULTS AND DISCUSSION

4.1 Engine Performance

Each test has been conducted after it reaches the steady running condition by varying the loads at different levels. The time for 10cc consumption of fuels has been noted, which in turn SFC, BP, BTE and ITE were calculated. Based on the observations and calculations for various blends like B5, B10, B15, B20, B40, B100 the following graphs such as B.P. Vs SFC, η_{bth}, η_{ith} and η_{mech} were drawn. Also Emission test were conducted for various load with different blends.

4.2 Brake Specific Fuel Consumption

It can be seen from the fig. 1 for various increase in BP, the SFC becomes increased at remarkable level. For various blends it can be seen as a narrow band with each one closer to each other on which the SFC obtained using diesel fuel comparatively consumes larger fuel.

4.3 Effect of Blend

It can be seen from the fig 6.3 the mean Brake SFC of diesel and various blends B5, B10, B15, B20, B40 and B100 were found to be 0.863, 0.818, 0.843, 0.845, 0.842, 0.880 and 0.942 kg/kW-hr respectively.

It is observed from the above each 10% increase in blending of biodiesel the fuel consumption rate is decreased in the range of 3% to 7%. This may be due to the decrease in viscosity and density of the bio fuel. The SFC has comparatively closer value for all the bio fuel blends with the diesel fuel.

4.4 Brake Thermal Efficiency

The mean value of η_{bth} of diesel and various blends B5, B10, B15, B20, B40 and B100 were found to be 10.48, 11.11, 11.54, 10.95, 11.09, 10.55 and 10.20 respectively. It can be seen from the fig. 2 for various blends, by varying the brake power output, brake thermal efficiency was increased from 3% to 9% with various. Among the blends B10 and B20 yields the optimum efficiency compare with diesel by 5% to 9%.

4.5 Indicated Thermal Efficiency

The variation of Indicated thermal efficiency observed in this engine is shown in fig. 3 is a function of load and brake power. It can be seen the power developed inside the combustion chamber has been reduced by varying the loads. The mean value of η_{ith} of diesel and various blends B5, B10, B15, B20, B40 and B100 were found to be 26.96, 28.23, 27.76, 27.68, 28.75, 28.69 and 26.04 respectively. It is observed that for different blends ITE has been reduced by 2% to 10% for different loads and compare with diesel the blend B20 has the optimum ITE. This result may occur due to the calorific value of bio fuel par with diesel and its complete combustion.

4.6 Biodiesel Emissions Analysis

Table 3 indicates the Emissions after switching to biodiesel. The exhaust gas analysis by 5 gas analyzer reveals that there is a considerable reduction in the amount of Co emission. Since the oils have oxygen in their structure, the constituent of O_2 in the exhaust gas is increased. This has further guided the complete combustion, thereby increase in CO_2 emission and reducing CO. The fuel has no sulphur content in their origin, so the sulphur oxide emissions are completely eliminated. The carbon particulate emission and unburned hydrocarbons are reduced because of the sufficient availability of oxygen resulting in complete combustion. This can be justified from a clean, white smoke observed during biodiesel operation than the blackish smoke obtained in Diesel operation. It is observed that the NOx emission has more in diesel than the blends of Biodiesel and the B10 and B20 produce less NOx than with the diesel fuel.

Fuel property	Diesel	Bio diesel						Diesel	Biodiesel
		B5	B10	B15	B20	B40	B100	ASTM D975	ASTM PS 121
Kinematic viscosity at 40°c (centistroke)	2.5	2.4214	2.5851	2.6814	2.7775	3.2106	4.8219	1.3.-4.1	1.9-6.0
Density at 15°c (gm/c.c)	0.8321	0.8274	0.8292	0.8326	0.8358	0.8470	0.8828	--	---
Absolute Viscosity (centipoise)	2.08	2.0034	2.1435	22333	2.3214	2.7193	4.2567	--	--
Specific gravity	0.85	0.8286	0.8300	0.8333	0.3366	0.8478	0.8836	0.85	0.88
Pour point (°C)	15	3	0	0	-3	-3	-3	-35 to -15	-15 to10
Cetane number	51	48	49	49	50	51	53	40-55	48-65
Flash point (°C)	66	122	130	137	141	148	156	60-80	100-170

Table 3 Reductions in Emissions After Switching to Bio-Diesel

Pollutants	CO_2	SO_2	SOOT	CO	HC	PAH	Aldehydes	No_x
% Reduction of pollutants	100	100	60	50	50	75	13	10

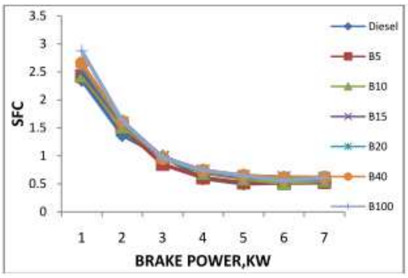

Fig-1 Effect of Brake Power on SFC for Diesel and Various Other Blends of Cottonseed Biodiesel

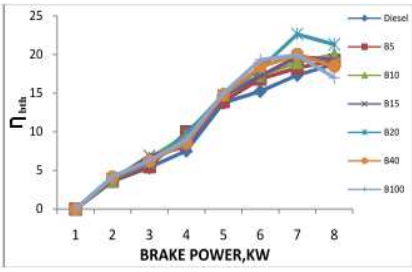

Fig-2 Effect of brake power on η_{bth} for diesel and various other blends of Cottonseed biodiesel

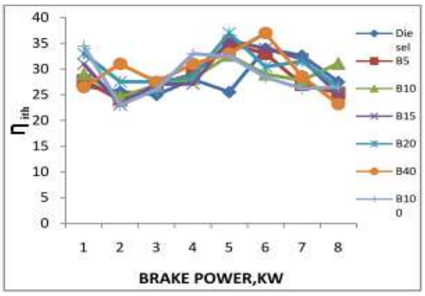

Fig-3 Effect of brake power on η_{ith} for diesel and various other blends of Cottonseed biodiesel

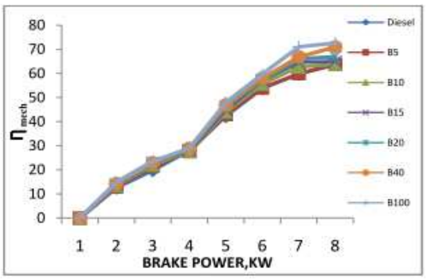

Fig-4 Effect of brake power on η_{mech} for diesel and various other blends of Cottonseed biodiesel

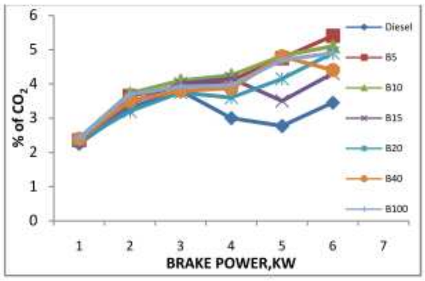

Fig-5 Effect of load on CO_2 emission for diesel and various other blends of Cottonseed biodiesel

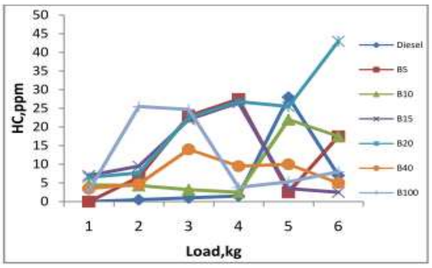

Fig-6 Effect of load on HC emission for diesel and various other blends of Cottonseed biodiesel

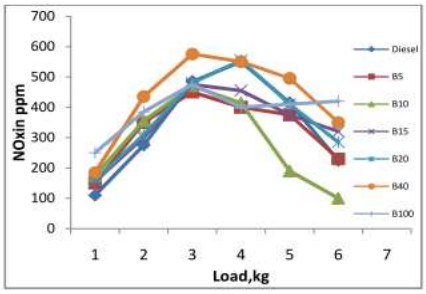

Fig-7: Effect of load on O_2 emission for diesel and various other blends of Cottonseed biodiesel

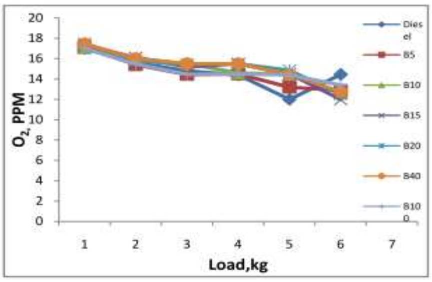

Fig-8: Effect of load on NO_x emission for diesel and various other blends of Cottonseed biodiesel

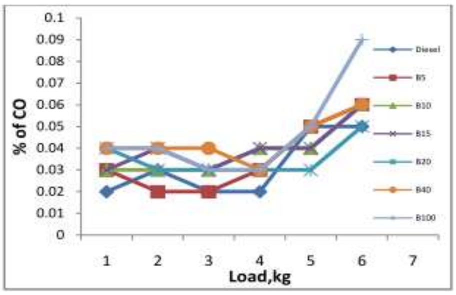

Fig.9 Effect of load on CO emission for diesel and various other blends of Cottonseed biodiesel

5.CONCLUSIONS

Based on the observations of this experiment, it can be concluded that TFC and SFC were found to be the function of load and brake power. The performance test done on various blends of bio-diesel shows that its characteristics follow the same trend as that of the bio-diesel. The emission test conducted shows that emission levels for biodiesel are lower than diesel. On comparing the performance test graphs of B5, B10, B15, B20, B40 and B100 with diesel we come to know that TFC and SFC of B100 and B40 is very high compared to that of diesel . So the usage of these blends will be uneconomic but the TFC and SFC of B20 remains very stable on various loading conditions .Thus the usage of B20 blend will be more optimum compared to diesel. On comparing the efficiency graphs of various blends with diesel we determine that efficiency of B100 and B40 blends are low, but the efficiency of B10, B15 and B20 remains stable for various loading conditions.

It can be seen from the fig. 5 to fig.9 exhaust gas emissions of various blends and diesel is compared. The NOx and CO emission is very high than any blends .Among the blends B15 and B20 has a moderate NOx and CO emission. Thus the overall comparison shows that B20 diesel with blend 20% yields the optimum value, with less fuel consumption and higher efficiencies than diesel and it is feasible us it in the diesel engine with no modification.

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