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Performance and Emission Characteristics of Blending Diethyl Ether in Cotton Seed Oil Methyl Ester using a Direct Injection Diesel Engine

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Abstract — Most countries of the world faces crises of energy demand, rising petroleum prices and depletion of fossil fuels forces the researcher to find the alternate fuel for diesel engines. A lot of research work point out that biodiesel and its blends with diesel is employed as alternate fuel for diesel engine without any modifications in the existing diesel engine. Very few works have been done with the combination off two different biodiesel blends with the neat diesel fuel and leads to lot of scope in this area. This paper presents experimental results on dual fuel operation of a single cylinder diesel engine with diesel, cottonseed oil and mixture of cottonseed oil and diethyl ether (DEE) as primary fuels. Results on brake thermal efficiency, fuel consumptions and emissions, namely, un-burnt hydrocarbon (HC), carbon monoxide (CO) and NOx are presented here.The paper also includes vital information regarding performances of the engine at a wide range of load conditions with different blended fuel substitutions.

Keywords — Diethyl Ether (DEE); Biodiesel; Cottonseed oil; Trans-esterification; Diesel

I. INTRODUCTION

The effect of vegetable oil methyl ester on the DI diesel engine performance characteristics and emissions. The have conducted the experiments using Soybean oil, peanut oil, corn oil, sunflower oil, rapeseed oil, palm oil, palm kernel oil, and waste fried oil (vegetable oil basis)[1]. The bio diesel was production from Mahua (Madhuca Indica) oil through esterification followed by transesterification. The results show that 4% H_2SO_4, 0.33% v/v alcohol/oil ratio, 1 hr reaction time and 65^0C temperature are the optimum conditions for esterification [2]. The suitability of transesterified mahua oil as a fuel in C.I. engine. The experiments 7B.H.P single cylinder four stroke and vertical, water cooled Kirloskar diesel engine at rated speed of 1500rpm.The increase in brake thermal efficiency and decrease in specific fuel consumption was observed in the case of esterified mahua oil (at 75% mahua oil blends) compared to that of diesel fuel [3]. The effect of mahua oil methyl ester, ethyl and butyl esters of a four stroke, direct injection, constant speed, compression ignition diesel engine, on performance and emissions were analyzed .The CO, HC and NO_x is low for alkali esters were compared to neat diesel fuel. The ethyl ester showed lower NO_x emission compared to other esters [4]. The mahua oil methyl ester was in a single cylinder, four stroke, direct injection, constant speed, compression ignition diesel engine on the performance and emissions. The emissions of CO, HC were too low for mahua oil methyl ester and Oxides of nitrogen were slightly lower compared with diesel [5].

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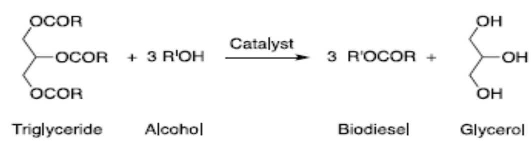

Fig.1 transesterfication chemical reaction

Table 1.Physical properties of raw cotton seed and cotton seed bio diesel.

PROPERTIES	RAW COTTON SEED OIL	COTTON SEED OIL BIO-DIESEL
Density (kg/m^3)	945	872
Kinematic viscosity (centi stokes)	25	4.0
Calorific value (KJ/Kg)	35000	41000
Flash point (degree Celsius)	226	204
Fire point (degree Celsius)	250	230

II. MATERIAL & METHODS

In the present work engine tests were conducted with cotton seed Bio Diesel blended with Diesel to evaluate performance and emission characteristics. Cottonseed oil is extracted from cottonseeds. Cotton has long been known as nature's unique food and fiber plant. It produces both food for man and feed for animals in addition to a highly versatile fiber for clothing, home furnishings and industrial uses. Cottonseed oil has a ratio of 2: 1 of poly n saturated to saturated fatty acids and generally consists of 65-70% unsaturated fatty acids including 18-24% monounsaturated and 42-52% polyunsaturated (linoleic) and 26-35% saturated (palmitic and stearic)6. The various properties of the above bio diesels are presented in table 1.

Table 2.Physical properties of diesel & additive used.

PROPERTIES	DIESEL	DIETHYL ETHER
Density (kg/m^3)	850	713.4
Kinematic viscosity (centi stokes)	3.05	0.2230
Calorific value (KJ/Kg)	42800	33892
Flash point (degree ^{0}C)	85	5
Latent heat of vaporization (KJ/Kg)	250	376
Molecular weight	170	74.12

A. *Blend Preparations:*

The two biodiesel blends were prepared in different proportions as:

i. Blend A- Cottonseed oil + DEE 25%
ii. Blend B- Cottonseed oil + DEE 20%
iii. Blend C- Cottonseed oil + DEE 15%
iv. Blend D- Cottonseed oil + DEE 10%
v. Blend E- Cottonseed oil + DEE 5%

III. EXPERIMENTAL SETUP

A. *Test Engine*

The present work is carried out to study the performance, combustion and emission characteristics of a single cylinder, four stroke, water cooled, and DI diesel engine using dual biodiesel as a fuel. An electric dynamometer is connected with this engine to determine the engine performance with constant engine speed. Exhaust gas analyzer and smoke meter are used with this diesel engine to determine the emission characteristics of the engine. The schematic diagram of the experimental setup as shown in Fig 2.

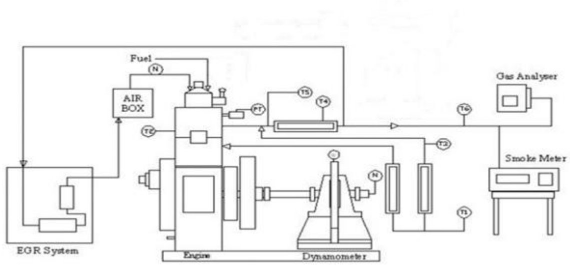

Fig 2.Experimental Setup

Table 3 Engine Specification:

Type	Vertical, Water cooled, Four stroke
Type	Water Cooled, 4-stroke DI CI engine
Number of cylinder	1
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Maximum power	5.2 kW
Speed	1500 rev/min
Dynamometer	Eddy current

B. *Testing Procedure*

Engine was started and warmed up at low idle, long enough to establish the recommended oil pressure, and was checked for any fuel and oil leaks. The engine was run on no-load condition and speed was adjusted to 1800 rpm by adjusting fuel injection pump. Engine was run to gain uniform speed, after which it was gradually loaded. Experiments were conducted at different load levels. The engine was run for 10 minutes and data's were collected during last 4 minutes (3 times). The performance and emission tests were carried out at different antioxidant mixture concentrations. The exhaust gas is sampled from exhaust pipe line and passed through an exhaust gas analyzer for measurement of CO, HC, and NOx present in exhaust gases.

IV. RESULTS AND DISCUSSIONS:

A. *Brake thermal efficiency*

The brake thermal efficiency of Blend A operation has been found to be 27.73% as compared to 26.01% of pure diesel operation respectively. The increase in the thermal efficiency can be attributed to the addition of the oxygenated additive, thereby enhancing the combustion of the fuel to a greater extent.

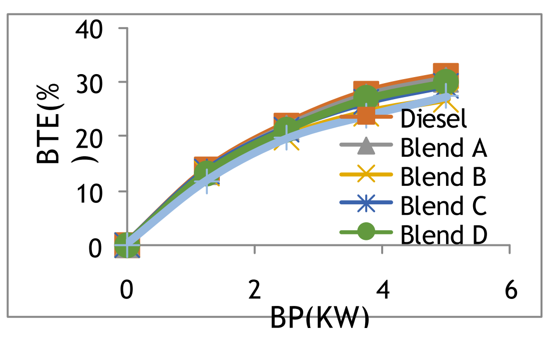

Fig 3 BP vs BTE

B. Brake Specific Fuel Consumption

The fuel consumption of Blend A increased from 5% to 25% .It is observed that at higher engine loads, the fuel consumption for the blends is higher than the fuel consumption for pure diesel. This is attributed to the lower calorific value of the blends when compared to pure diesel.

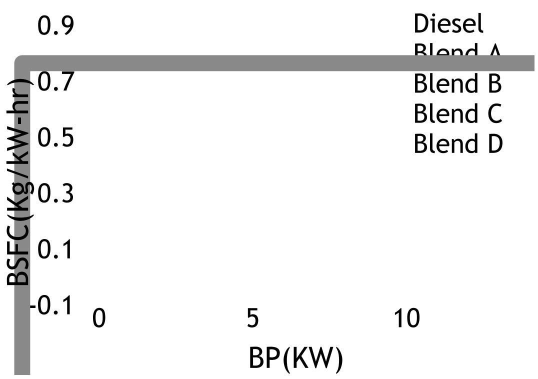

Fig 4 BP vs BSFC

C. HC Emissions

The total volume of unburnt hydrocarbons in the exhaust expressed in ppm by volume for pure diesel,Cottonseed oil and its blends. It is observed that the overall HC emissions for the blends are higher than those for pure diesel. At lower engine loads, the higher than pure diesel but the gap narrows down. The HC emissions of Blend A with Cottonseed oil operation has been found to be 27 ppm as compared to 29 ppm of pure diesel operation respectively.

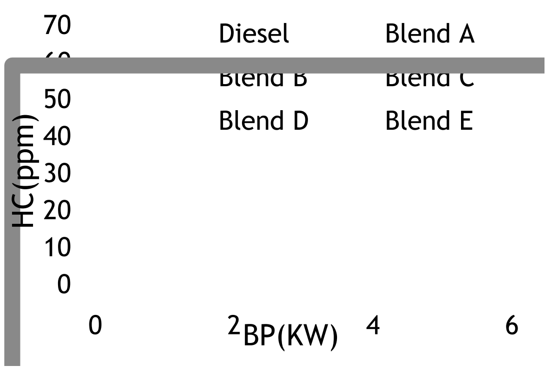

Fig 5 BP vs HC

D. NOx Emissions

The nitrous oxides emissions at various engine loads for neat diesel, Cottonseed oil and its blends up to 25% with diethyl ether.One of the important factors that decide the nitrous oxide formation is the peak combustion temperature in the engine cylinder and availability of O_2 in the combustion chamber. The NOx of Blend A with Cottonseed oil operation has been found to be 265 ppm as compared to 488 ppm of pure diesel operation respectively.

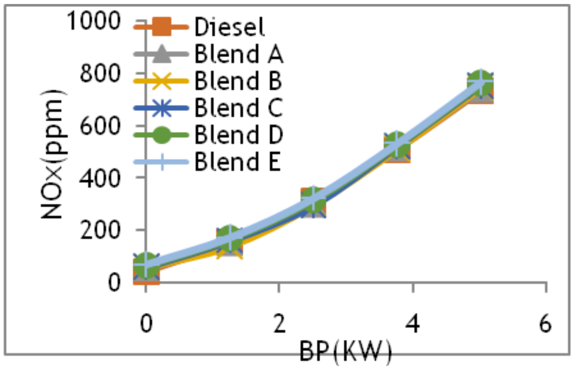

Fig 6 BP vs NOx

V. CONCLUSION

- The brake thermal efficiency of Blend A with Cottonseed oil operation has been found to be 27.73% as compared to 26.01% of pure diesel operation respectively.
- The CO emissions of Blend A with Cottonseed oil operation have been found to be 0.035ppm as compared 0.135 ppm of pure diesel operation respectively.
- The NOx of Blend A with Cottonseed oil operation has been found to be 265 ppm as compared to 488 ppm of pure diesel operation respectively.
- The HC emissions of Blend A with Cottonseed oil operation has been found to be 27 ppm as compared to 29 ppm of pure diesel operation respectively.

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