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Extraction and Experimental Investigation on Bamboo based Biodiesel as an Alternative Fuel

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ABSTRACT
In this study, the investigation were organized on engine performance and exhaust emission characteristics of a single cylinder four stroke diesel engine use ethanol blended in different ratios with diesel fuel. Ethanol produced by the fermentation of Bamboo was used as an alternative fuel in this study. The test was performed by two different blends of ethanol E0-neat diesel, E10 and E20. It is exposed from the observations that the test fuel blends are physically and thermally stable up to 21 days at room temperature the phase separation occurs. To avoid the phase separation, 2% of Ethyl acetate has been added to ethanol diesel blend.The performance results show that E20 fuel blend has maximum brake thermal efficiency and minimum Brake Specific Fuel Consumption at higher loads and exhaust emissions smoke number, CO, NO_x, HC were measured.Smoke emissions decreased with ethanol–diesel blended fuel, especially with E20 and E20 with additive.CO and NO_x emissions reduced for ethanol -diesel blends, but HC increased extensively when compare to neat diesel fuel.
Keywords **-** Bamboo, Emission Parameters, Engine Performance, Ethanol, Fermentation.

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I. INTRODUCTION

Diesel engines have been generally used as Engineering machinery, Automobile and shipping power equipment due to their perfect drivability and economy.At the same time, diesel engines are most important contributors of various types of air pollutants such as carbon monoxide (CO), oxides of nitrogen (NO_x), particulate matter (PM), and other hazardous compounds. With the increasing concern of the environment and more stringent government regulation on exhaust emissions, the reduction in engine emissions is a major research objective in engine development.It is difficult to reduce PM and NO_x at the same time owing to the trade-off between NO_x and PM [1].Ethanol is a renewable energy, Ethanol has a less carbon and sulphur content, and more oxygen than conventional fossil fuels.It is renewable in nature, and can be obtained from simple sugar, such as sugar cane, sugar beet, molasses or from other carbohydrates that can be converted to sugar, such as starch and cellulose.The starchy feed stocks are corn, maize, potatoes, etc.[2], and the cellulosic resources are wood, forest residue, agricultural residue, crop residue, etc. considered for ethanol production in this investigation was bamboo[3,4], Bamboo is a term used to explain a group of large woody grasses that normally grow in warm and humid condition.Bamboos are distributed mostly in the tropic, but they can naturally live in subtropical and temperate regions except for Europe.

Ethanol has higher miscibility in diesel than methanol[5**]**.Using the ethanol-diesel blend has disadvantages like lower miscibility at lower temperature,Phase separation and lower heating value, cetane number and viscosity. In addition, they reported that ethanol-containing diesel fuel exhausted greater formaldehyde, formic acid, and acetaldehyde emissions than did normal diesel [6]. are used to improve phase stability, improve cetane number,reduce ignition delay and cycle irregularities Dissimilar additives perform their own single action on its addition to the blend of fuel. The applications of ethanol fuel to direct injection diesel engine can produces some customer qualities such as full load performance improvement injector deposits suppression on the other hand HC emission extremely increased under higher load [7].Ethanol has fossil based fuel many properties which makes it useful as a fuel for internal combustion engine it has a higher octane number.Its higher latent heat most significant by the issues of low flash point and tank vapour flammability, it is a clean-burning fuel and it is also much less injurious to the environment [8]. The additive of ethanol to diesel fuel simultaneously decrease in cetane number high heating value.

Aromatics fractions and kinematic viscosity of ethanol blended diesel fuel change dilution temperature.

In this publication, the effect of high ethanol blends. Possibility for improving the homogeneity and prevent phase separation has been added to ethanol diesel blend, this blends were selected to be tested in a without any modification of diesel engine, and their performance, combustion and emissions were compared to those of a reference diesel fuel.

II. EXPERIMENTAL METHODS

2.1 Feed stock

The different production methods and factors which affect the Ethanol production from Bamboo were documented by some researchers [5, 6].Fig1 illustrate the schematic diagram of the ethanol production process.For the present study, the fresh bamboo was collected from the village,cleaned properly to remove the bamboo leaves.

The yeast (Saccharomyces Cerevisiae) [9] and the Bamboo were pre-treated for the extraction of sugars.The 1 lit of boiled water added to 250g of Bamboo for the Fermentation process, and also added 50g of yeast.The Bamboo extract taken in a 2000 ml bottle, and fermentation was carried out in a batch on the laboratory bench at a temperature of 30 ^{0}C ± 2 ^{0}C for 15 days [10].After the fermentation process, the first distillation was carried out to get the crude extract and further step is the fractional distillation was done for the removal of water.The quality of Ethanol was checked by the flame test.

2.2 Fuel Properties

The properties of diesel, ethanol is shown in Table1.Diesel and ethanol were mixed into a homogenous blend in a glass beaker by stirring it. The blend was kept in glass beaker is studied the solubility and phase stability. E10 and E20 are easily miscible and found to be stable as much as 15 to 21 days [11,12] but higher concentration of ethanol with diesel is not steady for longer period of time. Phase separation was takes place presently after stirring.To overcome this problem with adding the additive with equal proportions of ethanol.The volume percentages E20 are added with equal amount of diesel (2% additive).The suitability of blends selected was justified by measuring different physical-chemical properties as depicted in table 2.

2.3 Experimental setup and procedure

The experimental set up consists of a single-cylinder,four stroke,vertical water cooled natural aspirated diesel engine connected to water brake dynamometer for loading of the engine. The engine operated at speed 1500 rpm with compression ratio 17.5:1. Fuel consumption of time was measured with the help of burette and stop watch.Thermocouple is used to measure the exhaust gas temperature. Exhaust gas analyzer is used to measure exhaust gases like CO, HC, and NOx.This experiment conducted with pure diesel, diesel blend of ethanol for E10, E20. The effects are plotted against load (%). The experimental set up as shown in fig2. Initially the engine was started on neat diesel fuel and warmed up. The warm up period ended when the liquid cooling water temperature was stabilized. Then the fuel consumption and exhaust emissions of CO, HC, NOx and smoke were measured and recorded for different loads. Similar procedures were repeated for the bamboo ethanol fuel.

The experiments were carried out by using neat diesel as the base line fuel i.e. it was denoted by E0, 10% ethanol+90% diesel (E10),20% ethanol+80% diesel (E20) at different engine loads from 0% to 100% rated engine load in approximate steps of 25%. Before running the engine to a new fuel, it was allowed to run for sufficient time to consume the remaining fuel from the previous experiment or remove the oil from that engine. To measuring the performance parameters, important operating parameters such as power output, fuel consumption, exhaust emissions and cylinder pressure wave measured. Engine performance parameters such as Specific fuel consumption and brake thermal efficiency for biodiesel and its blends were measured.

III. FIGURES AND TABLES

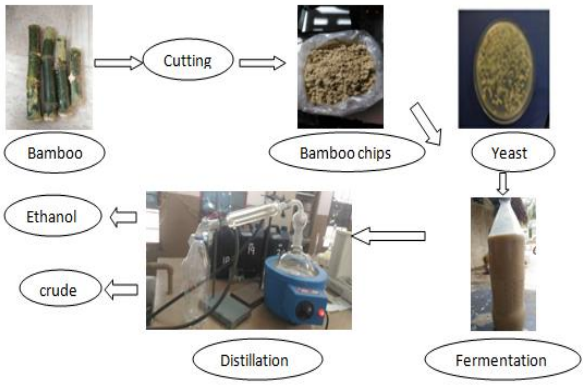

Fig.1 Production process of ethanol from bamboo

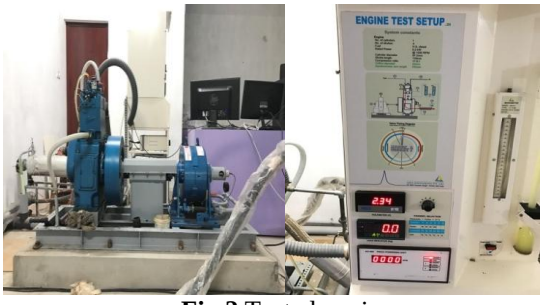

Fig.2 Tested engine

S.NO	Particulars	Description
1	Engine type	Four stroke, single cylinder, vertical water cooled ,diesel engine
2	Bore diameter	87.50 mm
3	Stroke length	110.00 mm
4	Compression ratio	17.5:1
5	Rated power	5.20 KW
6	Speed	1500 rpm
7	Dynamometer	Eddy current type

Table 1: Test Engine Specifications

Fuel property	Diesel	Ethanol	E10	E20	E20+ 2%EA
Kinematic viscosity @40^{0}C in CSt	2.48	1.86	2.18	2.47	2.54
Flash point (^{0}C)	50	13.8	16.5	14.9	14.9
Calorific value(KJ/kg)	42800	26400	39556	37904	36404
Density @15^{0}C in kg/m^3	843	794.85	837	833	838

Table 2: physical-chemical properties

IV. RESULTS AND DISCUSSION

4.1 Performance Characteristics

Brake thermal efficiency:

From the fig3 the graph shows that the variation in brake thermal efficiency E20 with additive shows clearly that BTE increases than other test blends and Diesel.Due to the complete combustion in E20 with additive.

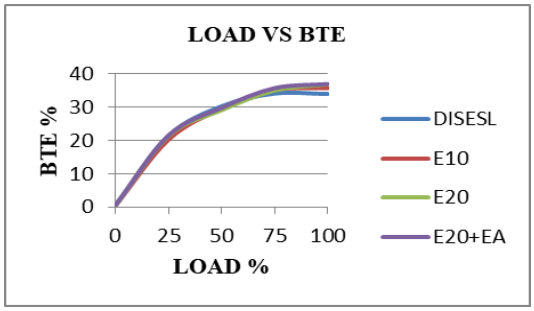

Fig.3 Brake thermal efficiency vs. Load

Specific fuel consumption:

Fig 4 shows that Graph between SFC and Load**.** From the above graph observed that E20 with additive shows that highest SFC compared to diesel and other test fuels. This may due to improved combustion, low viscosity, and high volatility of the test fuels using additives.

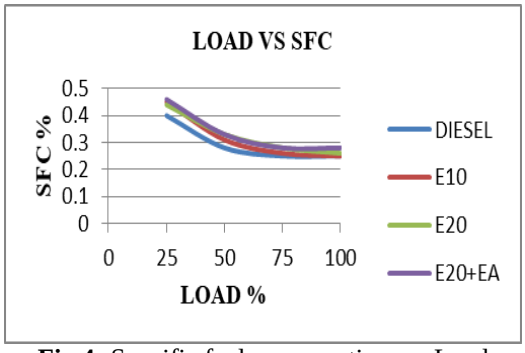

Fig 4: Specific fuel consumption vs. Load

4.2 Emission Characteristics

CO Emissions:

From the Fig.5. It shows variation between CO Emissions and Load explains that E20 with additive gives less emission than other blends and Diesel. Because of ethanol, the lowest CO emissions formed with E20+Additive fuel which is compared with the diesel and other blends.

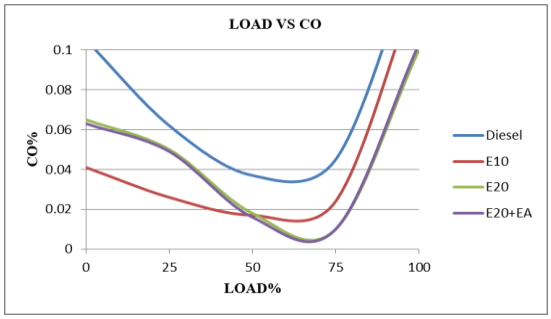

Fig 5: CO Emission vs. Load

HC Emission:

From Fig.6 shows that variation between HC emissions and Load. HC Emissions increase with increase in loads. During medium and high loads HC emissions increased E20 with additive. Due to high carbon nature in Ethyl Acetate causes high HC than Diesel.

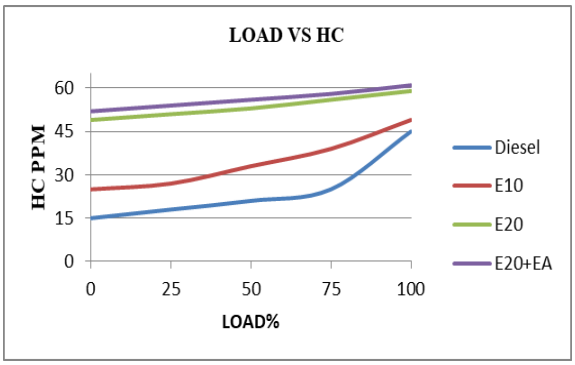

Fig 6: HC emission vs. Load

Smoke opacity:

From the Fig.7 graph represents variation between Smoke opacity and Load. The smoke opacity for the E20 with additive at higher load range, the smoke opacity of fuel blend is 72% less than that of pure diesel.

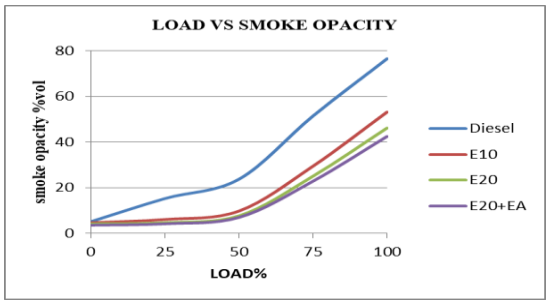

Fig 7: Smoke emission vs. load

NO_x emissions:

From Fig.8 shows that variation between NOx emissions and Load.E20 with additive reduces the NOx emission of is 70% for diesel fuel.Due to low temperature in E20 with additive.

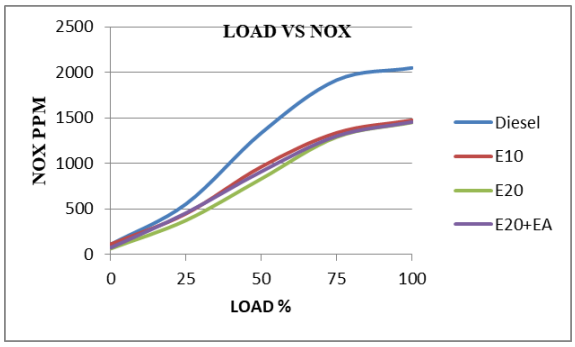

Fig 8: NO_x emission vs. load

CO_2 emissions:

From Fig.9 shows that variation between CO_2 emissions and Load. E20 with additive reduces the CO_2 emissions due to better combustion than other blends and Diesel.

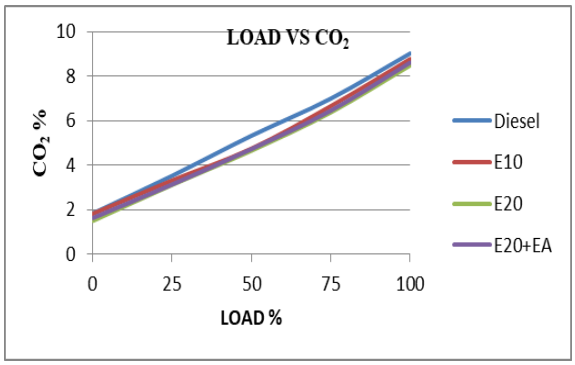

Fig 9: CO_2 emission vs. load

IV. CONCLUSION

An experimental investigation was conducted on the solubility and physical properties of Bamboo Ethanol with diesel and the effects of the application of these blends on the engine performance parameters and emissions. The tested blends are E10, E20 and E20+2% Ethyl Acetate.

- E10, E20 shows better efficiency and Specific fuel consumption compare to Diesel. Emissions like CO, NO_X, CO_2 and Smoke opacity are reduced and high in HC Emissions compare to Diesel.
- We use Ethyl Acetate as Additive to avoid phase separation of Ethanol and Diesel. It shows better result compare to non-Additive blends.

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