STUDY ON EMISSION CHARACTERISTICS OF ETHANOL DRIVED FROM FOOD WASTE AS A FUEL IN DIESEL ENGINE

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Abstract — Significant quantities of food are being wasted by people in day to day life which cause real environmental problems. These food wastes can be used as a potential feedstock for ethanol production and this could also be an alternate for disposal of the polluting residues, which is the primary aim of the project. Secondly, diesel fuel and ethanol were blended for this investigation and injection was done through continuous manifold injection. It reduces exhaust emissions and shows better lube oil quality as compared together tested fuels. This is mainly due to the effect of fuel additive in the blended fuel. The specific objective of this investigation is to develop the performance of fuel by using as in-house-formulated fuel additive. Rice ranks first among the most significant food followed by corn, banana and Mango and milk. It is a stable food among south India. The rice is more prone to wastage at place like marriage halls, hostels, restaurants. To determine the performance, combustion and emission analysis are performed on the single cylinder diesel engine, diesel, ethanol 10, ethanol 20 and ethanol 30.

Index Terms :- Ethanol, emission, transesterification alternative fuel, bio-diesel

1. INTRODUCTION

Biofuel is a type of fuel whose energy is derived from biological carbon fixation. Biofuels include fuels derived from biomass conversion, as well as solid biomass, liquid fuels and various biogases. Although fossile fuels have their origin in ancient carbon fixation, they are not considered biofuels by the generally accepted definition because they contain carbon that has been "out" of the carbon cycle for a very long time. Biofuels are gaining increased public and scientific attention, driven by factors such as oil price hikes, the need for increased energy security, concern over greenhouse gas emission from fossil fuels, and support from government subsidies.

From the standpoint of preserving the global environment and to sustain from the large imports of crude petroleum and petroleum from gulf Countries, alternate diesel fuels is the need of the hour. The recent upward trend in oil prices due to uncertainties in supply of petroleum products scarcity and ultimately depletion has a great impact on Indian economy and the nation has to look for alternative to sustain the growth rate. Diesel fuel (B0), 20% Ethanol diesel was selected for this investigation. It reduced exhaust emissions and shows better lube oil quality as compared together tested fuels. This is mainly due to the investigation is to develop the performance of B20. The specific objective of this investigation is to develop the performance of B20 fuel by using an in-house-formulated fuel additive.

Biodiesel is made from vegetable oils and animal fats. Biodiesel can be used as a fuel for vehicles in its pure form, buy it is usually used as a diesel additive to reduce levels of particulates, carbon monoxides, and hydrocarbons from diesel-powered vehicles. Biodiesel is produced from oils or fats using trans-esterification and is the most common biofuel.

2. EXPERIMENTAL SETUP AND PROCEDURES

The stability of ethanol-diesel-isoproponal additive blends of different proportions are investigated. The fuel blends are prepared and monitored carefully for the stability of 10 minutes interval. It is observes that the stability of the blend is achieved without phase separation for a period of more than six months. Experiments are conducted in the laboratory to determine the fuel properties of diesel ethanol blends. The stable fuel blends E10 contain 87% Diesel + 10% Ethanol.

ENGINE:

Type : Four stroke, Single Cylinder Vertical Air Cooled diesel engine

Rated Power - 4.4 KW
Rated Speed - 1500rpm
Bore Dia (D) - 87.5 mm

Stoke (L) - 110 mm
Compression ratio - 17.5:1
Orifice Diameter- 13.6mm
Coefficient of Discharge (Cd) - 0.6

FUEL:
Fuel used: Diesel and Ethanol E10, E20 E30.

Calorific Value of Diesel - 44514.6 KJ/Kg
Calorific Value of E10 - 43192.5 KJ/Kg
Calorific Value of E20 - 41874.5 KJ/Kg
Calorific Value of E30 - 40577.4 KJ/Kg
Density of Diesel - 860 Kg/m³
Density of E10 - 833 Kg/m³
Density of E20 - 829 Kg/m³
Density of E30 - 826 Kg/m³

LOADING DEVICE
TYPE: Electrical swinging field dynamometer supply

VOLTAGE: 240±10% AC 50 Hz 1Ø

The procedures followed are: The engine is started under no load condition by hand cranking using decompression lever. The engine is run under no load condition for few minutes so that the speed stabilizes at rated value. Note the time taken for 10cc of fuel consumption using stop watch. Insert the exhaust gas analyzer sensor in the provided slot in exhaust line and note down exhaust gas composition. Save the required data and characteristic curves in the computer using AVL software(V2.5). Now load the engine gradually to obtain required brake power. Repeat above procedure for different brake power.

Figure 1: Diesel Engine

3. MATHEMATIC MODELING

Brake Power (BP) = (V * I * Ø) / (η * 1000) kw
(1)
Indicated Power (IP) = [(IMEP) *LAN/2] / (60000) kw
(2)
Total Fuel Consumption (TFC) = (Volume of fuel consumed * Density of fuel) / (t) kg/h
(3)
Specific fuel Consumption = TFC / BP Kg / Kwh
(4)
Mechanical Efficiency (η m) =(BP/ IP) * 100
(5)
Brake Thermal Efficiency (η BT) = [BP/ (TFC* CV)] * 100
(6)
Indicated Thermal Efficiency (ηIT) = [IP/ (TFC*CV)] * 100
(7)

4 Results and Discussions

The CO_2 emission variation with respect to Load when tested with different blends in constant speed of 1500 rpm at all loading conditions are shown in figure 2. As the load increase the CO2 percentage for diesel and Biodiesel increase, the CO2 level is same at all initial Loads. The CO2 emission of Diesel is greater than blended fuel (E10, E20, E30), at 80 – 100% Load. The CO2 Emission decreases with increase in percentage of ethanol.

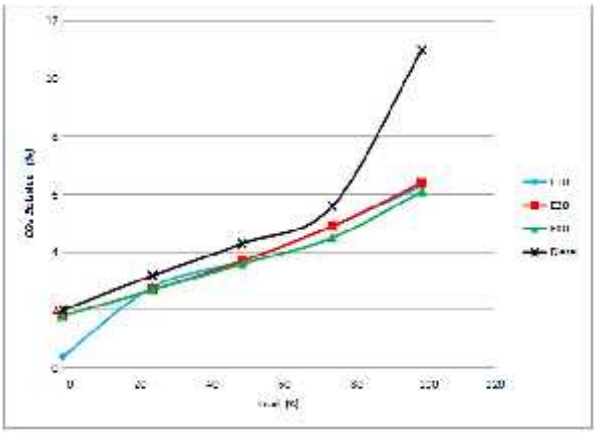

Figure: 2: CO_2 emission vs Load

The CO emission variation with respect to Load when tested with different blends in constant speed of 1500 rpm at all loading conditions are shown in figure 3. As the load increase the CO percentage of biodiesel decrease, the CO level is same at all initial loads. As the load increases CO percentage of diesel is low 75% load and then suddenly increase at full load condition. As a load at 75-100% CO percentage of biodiesel

remains same. The blended fuel (E30), emission of CO percentage decrease at 0-80% load, after that it remains constant.

The Variation of NOx emission with respect to load when tested with different blends in constant speed of 1500 rpm at all loading conditions is shown in figure 4. As the load increase the NOx amount of diesel increase tremendously when compared to that of E10, E20, and E30. Oxides of nitrogen which occur in the engine exhaust are a combination of nitric oxide (NO) and nitrogen di oxide (NO2). Nitrogen and oxygen react relatively at high temperature. Therefore high temperature and availability of oxygen are the two main reasons for the formation of NOx. The Maximum NOx is formed air ratios between 14:1 and 16:1. At lean and rich air fuel ratios the NOx concentration is comparatively low.

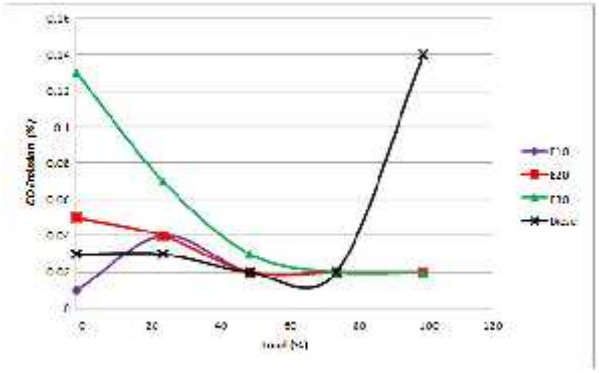

Figure 3: CO emission vs Load

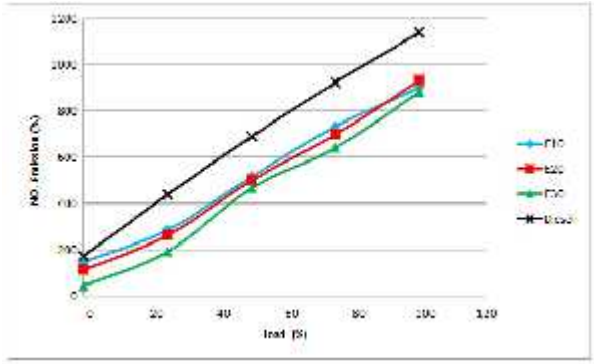

Figure 4: NO_x emission vs Load

The O_2 emission with respect to Load when tested with different blends in constant speed of 1500 rpm at all loading conditions are shown in figure 5. As the load increases, O2 emission of diesel decreases than blended fuel (E10, E20, andE30). As an O2 analysis, emission of O2 level is almost same at all initial loads. As the load increases blended fuel (E10, E20, and E30) tends better O2 emission than diesel. The emission of O2 level in diesel suddenly decrease at an load of 75-100%.

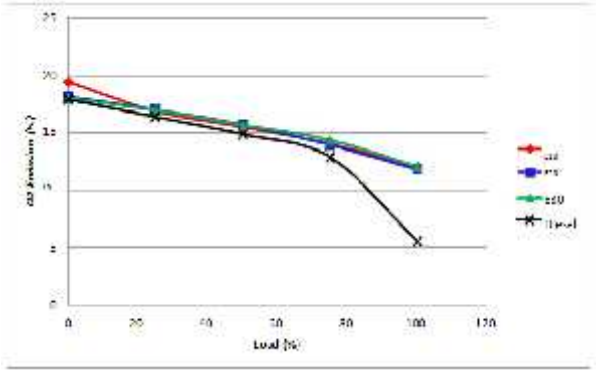

Figure 5: O_2 emission vs Load

The Hydrocarbon emission(HC) with respect to Load when tested with different blends in constant speed of 1500 rpm at all loading conditions are shown in figure 6. As a load increases, HC emission of diesel is low at 25 – 75% load and then it is suddenly increase at full load. The HC emission of blended fuel (E10, E20, and E30) is greater than diesel, the emission of HC level different at initial loads conditions. The HC increase with increase in the ethanol content on biodiesel.

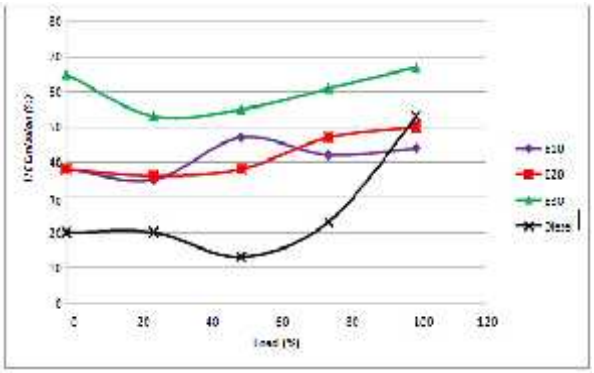

Figure 6: HC emission vs load

The Filter smoke number (FSN) with respect to Load when tested with different blends in constant speed of 1500 rpm at all loading conditions are shown in figure 7. As the load increases filter smoke number (FSN) of diesel tends to increase, the emission of FSN in diesel suddenly raise at an load of 75-100%. The emission of FSN is initially almost same at all loads; the emission of FSN in blended fuel (E10, E20, and E30) is lower than diesel. The FSN value decrease with increase in the ethanol content in biodiesel.

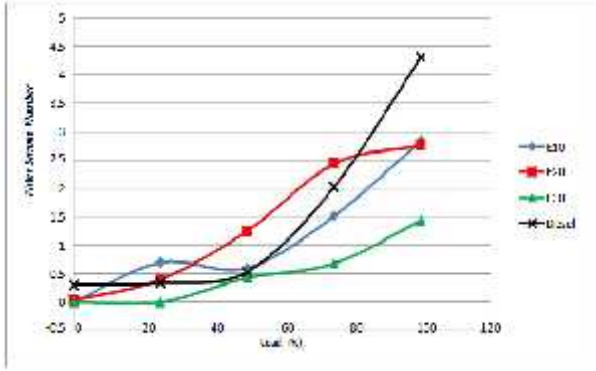

Figure 7: FSN vs Load

5 CONCLUSIONS

Hence the emission analysis are performed on the single cylinder diesel engine with diesel, ethanol 10, ethanol 20 and ethanol 30. From the performance curve it was found that From the obtained emission readings emissions curve were drawn. It was found that CO2, NOx and FSN amount was decreased with increase in the percentage of ethanol in the fuel. ie ethanol 30 shows a good combustion range for these parameters while in comparison with ethanol 10 and ethanol 20. CO percentage is initially different level at biodiesel and then 50-100 % it was almost low and same value. O2, HC value is increased with increased in the ethanol content in the fuel. ie ethanol 10 shows a good combustion range for these parameters while in comparison with ethanol 20 and ethanol 30. So an intermediate range of ethanol will show a good combustion performance in diesel engine.

References

[1]. Stephen, Chinwendu, Uhibueze, Daniel, Ekekwe N(2013). Ethanol fuel from food waste, Ripe plantain peels and corn cobs.

[2]. Gulten Izmirliogu, Ali Demirci (2012). Ethanol production from waste potato mash by using saccharomyces cervisae. www.mdpi.com/journal

[3]. Piyapong Thongdumyu, Nugul intrasungkha and Sompong O-Thong (2014). Optimization of ethanol production from food waste hydrolysate by co-culture of zymomonas mobilis and candida shehatae under non-sterline condition. www.academicjournal.org

[4]. Churairat Moukamnerd, Hidehisa Kawahara, Yoshio Katakura (2013). Feasibility study of Ethanol production from food wastes by consolidated continuous solid-state fermentation.

[5]. A.I. Bamgboye and A.C. Hansen, "Prediction of cetane number of biodiesel fuel from the fatty acid methyl ester (FAME) composition", International Agrophysics, 2008, 22, 21 -2.

[6]. Shaik Himam Sahib, "Performance test on diesel engine using alternative fuels like b5 and b10", International Journal of Mechanical Engineering and Robotics Research, VOL3, NO.1, January 2015 ISSN 2278-0149