Performance Characteristics of Ethanol Derived From Food Waste As A Fuel in Diesel Engine

Franklin Merlin. R
Assistant professor
Department of Mechanical Engineering
RIT Chennai (Mechanical)

Martin Jose
Assistant professor
Department of Mechanical Engineering
RIT Chennai (Mechanical)

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.
Keywords: Ethanol, food waste, SFC, alternative fuel, bio-diesel

I. INTRODUCTION

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.

Ethanol is the most widely used biofuel today. In 2009, more than 7.3 billion gasoline – equivalent gallons were added to gasoline in the united state to meet biofuel requirements and reduce air pollution. Ethanol is currently produced using a process similar to brewing beer where starch crops are converted into sugars, the sugars are fermented into ethanol, and the ethanol is then distilled into its final form. Ethanol is used to increase octane and improve the emission quality of gasoline. In many areas of the United States today, ethanol is blended with gasoline to form an E10 blend (10% ethanol and 90% gasoline), but it can be used in higher concentrations, such as E85, or in its pure form E100. Besides Ethanol, Castor oil turns to be another sources of renewable fuel which can be domestically produced at a very less cost comparatively. It is biodegradable, non-toxic can be used as a promising fuel at low temperature conditions. Castor oil also posses reasonable cetane no. due to which it causes less knocking tendency. It also has less sulphur content and is eco-friendly.

II. 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% Ethano l.

A. Engine:

Type : Four stroke, Single Cylinder Vertical Air Cooled diesel engine 1
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

B. 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

C. 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.

Fig. 1: Diesel Engine

III. 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)

IV. RESULTS AND DISCUSSIONS

A. Performance Characteristics:

The TFC 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. In this graph the diesel under various inlet conditions are compared for the parameter TFC. As the load increase Ethanol 30 takes the maximum value followed by Ethanol 20, Ethanol 10 and diesel respectively. TFC of diesel starts form 0.468(Kg/h) gradually increase to 1.407 (Kg/h). Compared with diesel E10, E20, and E20 takes more fuel.

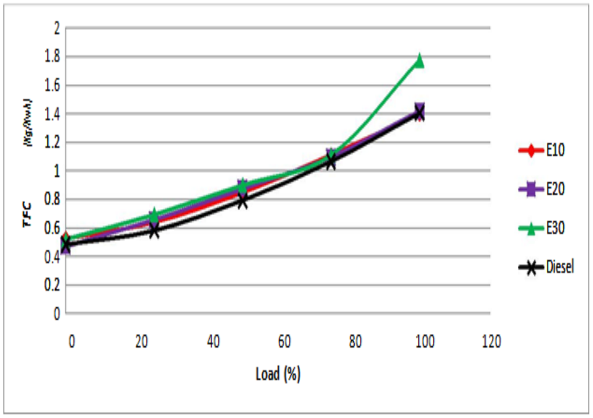

Fig. 2: Total fuel consumptions vs Load

The SFC 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. In this graph the diesel under various inlet conditions are compared for the parameter SFC. As the load increase Ethanol 30 takes the maximum value followed by E30, E20, E10, and Diesel. As the load increase, SFC various form 0.507(Kg/Kwh) to 0.330(Kg/Kwh) for pure diesel. As the load increase, SFC varies from 0.587(Kg/Kwh) to 0.333(Kg/Kwh) for Ethanol 10.

Similarly, as the load increase, SFC varies from 0.61(Kg/Kwh) to 0.327(Kg/Kwh) for Ethanol 20. Similarly, as the load increase, SFC varies from 0.652(Kg/Kwh) to 0.342(Kg/Kwh) for Ethanol 30.

The Variation of Mechanical Efficiency with respect to Brake power 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 diesel has the maximum mechanical efficiency when compared to Ethanol 10, Ethanol 20 and Ethanol 30. As the Load Increase mechanical efficiency various from 43(%) to 72.38(%) for diesel. As the Load Increase mechanical efficiency various from 41.41(%) to 70.71(%) for Ethanol 10. As the Load Increase mechanical efficiency various from 47.42(%) to 70.3(%) for Ethanol 20. As the Load Increase mechanical efficiency various from 40.95(%) to 69.9(%) for Ethanol 30.

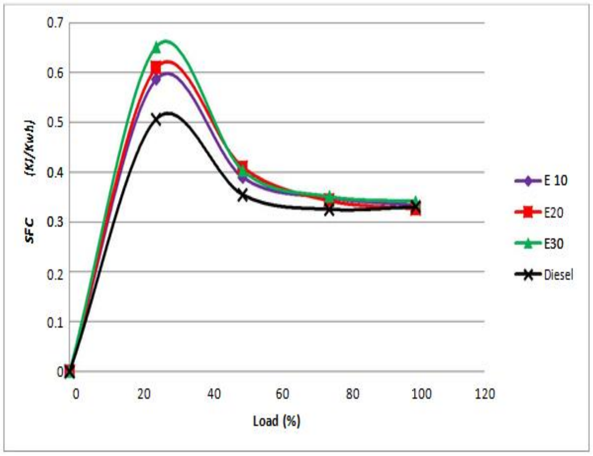

Fig. 3: Specific fuel consumption vs Load

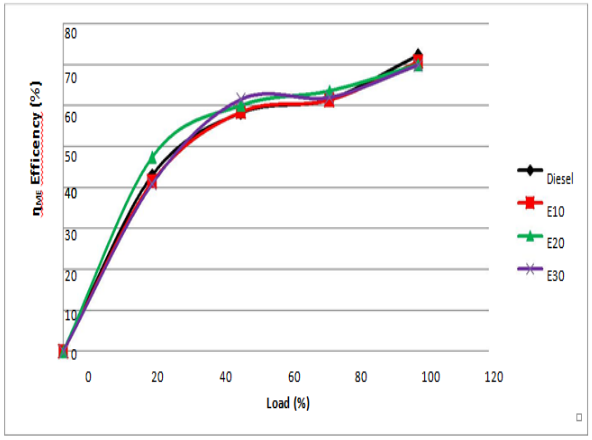

Fig. 4: Mechanical Efficiency Vs Load

The indicated Thermal Efficiency 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 increase, diesel under all three conditions vary randomly and nearly coverage at a point at 100% load. As the load increase upto 50%, the indicated thermal efficiency varies from 38.86% and then decrease to 33.50 for diesel. As the load increase upto 75%, the indicated thermal efficiency varies from 33.97% and then decrease to 35.30% for Ethanol 10. As the load increase upto 75%, the indicated thermal efficiency varies from 39.18% and then decrease to 35.42%.

The indicated Thermal Efficiency 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 the Load increase the diesel has the maximum Break thermal efficiency when compared to Ethanol 30. The Break Thermal Efficiency of Ethanol 30 has the lower value when compared to E20, E30.

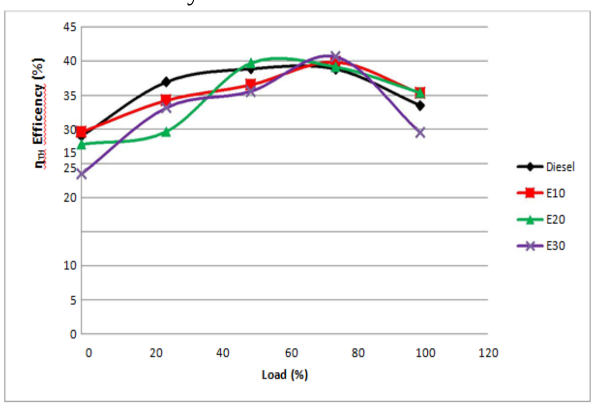

Fig. 5: Indicated Thermal Efficiency Vs Load

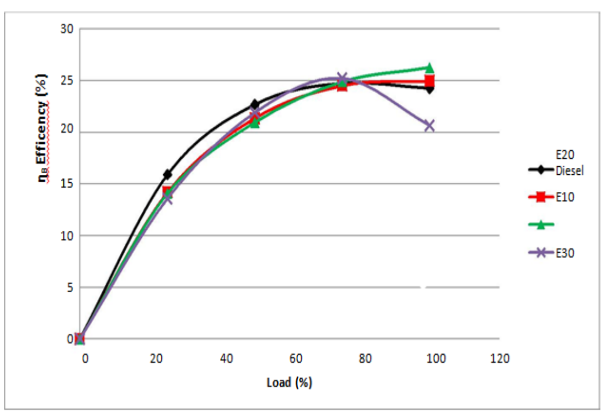

Fig. 6: Brake Thermal Efficiency Vs Load

V. CONCLUSIONS

Hence the performance 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 Total Fuel Consumption and Specific Fuel Consumption are related to each other and increase with increased in the ethanol percentage in the biodiesel. Ethanol 30 will be showing the highest ranges in all the three cases of ethanol ranges in comparison with diesel. Where the efficiency parameters such as Mechanical efficiency and Brake Thermal Efficiency is decreased with increased in ethanol percentage in biodiesel. The efficiency parameter will be good for ethanol 10. So it can be inferred that an intermediate range of ethanol will be good for the proper performance in a diesel engine.

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