Performance Analysis of CI Engine using blends of Castor Oil and Ethanol

S.Ganesan¹, Dr.A.Elango²

Abstract—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 States 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 emissions 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 poses reasonable cetane no. due to which it causes less knocking tendency. It also has less sulphur content and is eco-friendly.

Thus using the two combination of viable renewable fuel a Performance analysis has been forwarded using STAR-CD. A computational domain of the model geometry has been taken to analyse the combustion characteristics using this blends in diesel. The experimental investigation has been carried out on single cylinder CI Engine (Kirolskar high speed four stroke diesel engine with 4.4 KW, 1500rpm. TAF Vertical air cooled engine) and the results has been recorded.

Keywords—Blends, Castor oil, Ethanol, Performance Analysis

I. INTRODUCTION

From the standpoint of preserving the global environment and to sustain from the large imports of crude petroleum and petroleum products 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 alternatives to sustain the growth rate.

Since the dawn of oil age man has burnt about 800 million barrels of petroleum. About 71 barrels are burnt everyday throughout the world. And this consumption rate goes on increasing by 2% every year. The 2% doubles the quantity every 34 years. Somewhere between 1000 to 1600 billion barrels of fuel consumption are assumed to be in formation where economic recovery is possible. By current year the world would have consumed about one-half of the total amounts that is technically and economically feasible to extract. And at the current rate of consumption 1600 billion barrels would be depleted in 60 years. It is high time to think about the alternative fuels.

One hundred years ago, Rudolf Diesel first tested vegetable oil as fuel for his engine. With the advent of cheap petroleum, appropriate crude oil fractions were refined to serve as fuel and diesel fuels and diesel engines started evolving together. Later in the 1940’s, vegetable oils were used again as fuel in emergency situations, during the period of World War II. Because of the increase in crude oil prices, limited resources of fossil fuels and the environmental concern, there has been renewed focus on vegetable oils and animal fats for the production of bio-diesel fuel. Bio-diesel has the potential to reduce the level of pollution and the level of global warming.

In this project we are focusing on combination of diesel, castor oil and ethanol.

II. LITERATURE REVIEW

M.A. Kalam, H.H.Masjuki [1] Department of Mechanical Engineering, University of Malaya has conducted testing in palm bio diesel and diesel blends to control NOx and CO while improving efficiency in diesel engines, 50603 Kuala Lumpur, Malaysia. This paper presents experimental test results of a diesel engine using additive-added palm bio diesel (it is also known as palm diesel) obtained from palm oil. The test results obtained are brake power, specific fuel consumption (SFC), exhaust emissions and anti-wear characteristics of fuel’s contaminated lubricants. A computer-controlled dynamometer-engine test bed was used to measure engine brake power and SFC at half throttle condition with a speed range of 1000–4000 rpm. The emission test was done with a dynamometer fixed load of 50Nm and constant engine speed of 2250rpm. A total of three fuels, such as 100% diesel fuel (B0), 20%palm diesel and 80% B0 (B20), were 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

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effect of fuel additive in the blended fuel of B20. The specific objective of this investigation is to develop the performance of B20 fuel by using an in-house-formulated fuel additive.

G. Amba Prasad Rao, & P Rama Mohan [2] conducted Performance test in Evaluation of DI and IDI Engines with Jatropha Oil based Bio diesel”, Transesterified vegetable oil, also called biodiesel, is becoming increasingly important as a fuel for diesel engines due to several reasons. Biodiesel is a renewable, inexhaustible and a clean burning fuel. This paper deals with the experimental investigations carried out on direct injection (DI) and indirect injection (IDI) type engines at recommended injection pressure of respective engines with methyl esters of Jatropha oil. Supercharging was also done on DI engine in order to obtain the performance close to the engine performance with diesel-fuel operation. Both engines were evaluated in terms of parameters such as brake specific fuel consumption and smoke density. Bio diesel operation under naturally aspirated condition yielded the best result in case of IDI engine, with an specific fuel consumption of 0.354 kg/kWh and exhaust smoke density.

Abdul Rahim Ismail and et al [3], conducted test on computer modeling, for 4-Stroke Direct Injection Diesel Engine study on computational modeling of 4-stroke single cylinder direct injection diesel engine is presented. The engine with known specification is being modeled using one dimension CFD GT-Power software. The operational parameters of the engine such as power, torque, specific fuel consumption and mean effective pressure which are dependent to engine speed are being discussed. The results from the simulation study are compared with the theoretical results to get the true trend of the results.

N.Stalin and H. J. Prabhu [4] department of Chemical Engineering, National Institute of Technology, Trichy, Tamil Nadu, India Performance test of internal combustion engine using karanja biodiesel conducted test on this paper presents a review of the alternative technological methods that could be used to produce this fuel Performance of IC engine using karanja biodiesel blending with diesel and with various blending ratios has been evaluated. The engine performance studies were conducted with a proxy brake-diesel engine set up. Parameters like speed of engine, fuel consumption and torque were measured at different loads for pure diesel and various combinations of dual fuel. Brake power, brake specific fuel consumption and brake thermal efficiency were calculated. The test results indicate that the dual fuel combination of B40 can be used in the diesel engines without making any engine modifications. Also the cost of dual fuel (B40) can be considerably reduced than pure diesel

A.P.Sathiyagnanam, et al [5], conducted test on Hexanol-Ethanol Diesel Blends on DI-Diesel Engine to Study the Combustion and Emission, Hexanol was added in ethanol – diesel fuel to prevent separation of ethanol from diesel in this study. The ethanol blend proportion can be increased upto 45% in volume by adding the Hexanol. Engine performance characteristics of the fuel blends were investigated on a diesel engine and compared with diesel fuel. Experimental results show smoke emission decreases significantly with the increase of oxygen content in the fuel. When blended fuels are used, nitrogen oxides (NOx) emission is almost the same as or slightly higher than the NOx emission when diesel fuel is used. Cylinder pressure and Heat release are slightly increased when the engine was fueled with ethanol – Hexanol – diesel blends. Hexanol – ethanol diesel blended fuel slightly improves the performance of the engine.

Roberto G. et al [6]. is conducted test on Characterization and effect of using blends of diesel and soya bean biodiesel as fuel in a stationary engine The present work describes an experimental investigation concerning the electric energy generation using blends of diesel and soya bean biodiesel. The soybean biodiesel was produced by a transesterification process of the soybean oil using methanol in the presence of a catalyst. The properties (density, flash point, viscosity, pour point, cetane index, Conradson carbon residue and distillation) of the diesel and soybean biodiesel were determined. The exhaust emissions (CO, CO2, O2, NO, NOx and SO2) were, also, studied. The results show that the use of diesel-soybean biodiesel as fuel blends in stationary engine is an alternative for the sustainable development.

Semin et all [7], Automotive Focus Group, Faculty of Mechanical Engineering Ismail has conducted test on Computational Visualization and Simulation of Diesel Engines valve Lift Performance Using CFD. The paper visualized and simulated the intake and exhaust valve lift in the single-cylinder four-stroke direct injection diesel engine. The visualization and simulation computational development were using the commercial Computational Fluid Dynamics of STAR-CD 3.15A software and GTSUITE 6.2 software. The one dimensional of valve lift modeling was developed using GT-POWER software and the visualization the model using STAR-CD. The model simulation covers the full engine cycle consisting of intake, compression, power and exhaust. The visualization and simulation shown the diesel engine intake and exhaust valve lifting and moving based on the crank angle degree parameters. The result of this visualization and simulation had shown the intake and exhaust valve lift moving and air fluid flow of the diesel engine model.

III. CASTOR OIL

Castor oil is a vegetable oil obtained from the castor bean (technically castor seed as the castor plant, Ricinus communis, is not a member of the bean family). Castor oil (CAS number 8001-79-4) is a colorless to very pale yellow liquid with mild or no odor or taste. Its boiling point is 313 °C (595 °F) and its density is 961 kg/m³. It is a triglyceride in which approximately ninety percent of fatty acid chains are ricinoleic acid. Oleic and linoleic acids are the other significant components.
Castor oil is non-volatile fatty oil taken from beans of the plants. It ranges in color from colorless to greenish. It has two derivates such as blown castor and hydrogenated oil. Castor oil used in textiles, paints, varnishes, plastics, cosmetics, fibers, hair oils and drying oils. It is also used for Traditional and medical treatment purposes.

Fig 1 Castor oil

IV. CHARACTERIZATION OF ETHANOL

There are two types of ethanol produced in the United States – fermentation ethanol and synthetic ethanol. Fermentation ethanol (or bioethanol) is produced from corn or other biomass feedstocks and is by far the most common type of ethanol produced, accounting for more than 90% of all ethanol production. Fermentation ethanol is mainly produced for fuel, though a small share is used by the beverage industry and the industrial industry. Synthetic ethanol is produced from ethylene, a petroleum by-product, and is used mainly in industrial applications. A small amount of synthetic ethanol is exported to other countries.

Ethanol is used to increase octane and improve the emissions 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. All automobile manufacturers that do business in the United States approve the use of E10 in gasoline engines; however, only flex fuel vehicles (FFVs) are designed to use E85. October 2010, the Environmental Protection Agency granted a partial waiver to allow E15 to be sold in the U.S., subject to several conditions. Pure ethanol or E100 is used in Brazil but is not currently compatible with vehicles manufactured for the U.S. market. Manufacturer approval of ethanol blends is found in vehicle owners' manuals under references to refueling or gasoline.

V. EXPERIMENTAL SETUP AND PROCEDURE

Commercial diesel fuel used in India which was obtained locally is used as a base line fuel for this study. Ethanol used in this study is anhydrous ethanol (99.7%) purity. It was mixed with Castor Oil after esterification in order to decrease the viscosity of the oil. Fuel and its blends density and heating value were measured in a laboratory with hydrometer and bomb-calorimeter.

VI. RESULTS AND DISCUSSION

A. Performance characteristics

The Table 1.1, 1.2 and 1.3 shows the reading and results taken at 1500 rpm (constant speed)

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<th>Sl.No</th>
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<th>Brake Thermal Efficiency</th>
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### B. Fuel Consumption

In Fig 6.1 influence of fuel consumption on brake power for various blends of fuel is represented as above. It is observed that the fuel consumption for sample 2 is lesser at no load condition and almost same at other brake power with comparing to pure diesel.

### C. Brake thermal efficiency

In fig 6.2 the effect of brake thermal efficiency is represented in fig 6.2. It is observed that the brake thermal efficiency of sample 2 and sample 3 are almost same to pure diesel and higher at 6.3 Brake power.

### D. Exhaust Gas Temperature

In fig 6.3 the effect of Exhaust gas temperature for sample 2 and sample 3 was observed less at all load condition and slightly more than pure diesel at no load condition.

### VII. CONCLUSION

The Sample 3 have lower value of NO, Unburnt hydrocarbon than diesel. This is due to better combustion of fuel inside the cylinder than diesel.

The Exhaust gas temp and Brake thermal efficiency for sample 3 is less comparing to sample 2 and pure diesel.

As the above graphs shows that sample 3 with 90% diesel, 10% castor oil and 20% methanol gives us optimum values of performance and emission characteristics comparing to sample 3 and pure diesel.

The results between the cfd at compression stroke and experimental data ensure the accuracy of numerical prediction collected with this work. The peak value of cylinder pressure and rate of pressure rise are shown good accuracy between computational fluid dynamics and measured data during compression stroke.

### REFERENCES

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