EFFECT OF USING BIODIESEL AS A FUEL IN COMPRESSION IGNITION FUEL

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Abstract
In this paper spotlight is shown on the effect of biodiesel a energy source for compression ignition engine. Feed stocks like vegetable oil, animal fats, used frying oil, waste cooking oil and edible oils such as soybean, sunflower, canola, palm and non-edible oils such as Jatropha curcas, Pongamia pinnata, can be used in Trans-esterified form. It is conventional wisdom that use of biodiesel leads to higher Output thermal efficiency, Outlet Gas temperature and Oxides of nitrogen emission. On the contrary lower CO and UbHC emissions were found.
Index Terms: Biodiesel, Compression ratio, Performance, Diesel Engine

I. INTRODUCTION

Energy is a major need for the development of country and the increase in population needs more energy for both economic and social development. The petroleum fossil fuels are a predominant source of energy in the current days. As the demand increases for such fuels steps up, the rate of inflation collaterally shoots. In fact in major developing countries the crude oil price controls the financial markets and budget of the nation. So in order to cater the current problem a search of alternate which meets the characteristics of the current fuel is in hunt. In the current paper the modified version of vegetable oils and oil of non edible sources is highlighted as 'Biodiesel'. Biodiesels are basically esteried oils which can blended with base diesel fuel for the compression ignition engine. Below is such an effort to mark the work carried so far.

II. LITERATURE SURVEY

Altun *et al.* [1] used a B50 blend of sesame oil as an alternative fuel in a DI-CI engine. Experiments were executed on a Lombardini 6 LD 400, one cylinder, four-stroke, air- cooled, direct injection diesel engine. They stated that the power created by the blend of the B50 was close to that of mineral diesel fuel. The specific fuel consumption was higher for blended fuel than that of the ordinary diesel fuel. It was seen that the blended fuel emitted low CO values and slightly low NO_x values when compared with an ordinary diesel fuel.

Yu et al. [2] have tested the use of waste cooking oil as alternative fuel for diesel engine. It has been further re-counted that the combustion characteristics were similar to that of diesel fuel. It has been described that the peak pressure was little higher and it occurred earlier by 1.1°-3.8° CA than diesel. It has also been stated that the engine performance deteriorates for long term use, because, heavy carbon deposition on the piston crown is higher than diesel. It has been concluded that the waste cooking oil developed similar engine performance but deteriorated after long use. [2]

Laxminarayana Rao et al [3] found the use of unrefined rice bran oil, coconut oil and neem oil on a direct injection diesel engine. It has been reported that the brake thermal efficiency was lower for vegetable oil than diesel, due to lower calorific value. It has also been reported that the carbon dioxide and hydrocarbon emissions were slightly higher than diesel, but NOx emissions were lower than diesel. It has been conducted that the sluggish combustion and increased fuel consumption are due to lower caloric value and atomization.

Yoshimoto et al.[4] conducted an experiment on single cylinder diesel engine to investigate the spray characteristics, engine performance, emissions and combustion characteristics of water emulsions of the blended fuel with equal amounts of rapeseed oil and diesel. The researcher found that the performance was improved with slightly increased emissions of CO and NO_X with knock free combustion [4]

Bajpai et al. [5] started an experimental study to assess the feasibility of blending Karanja vegetable oil with diesel oil and utilization in a DI diesel engine. Pre heating of oil and blending with diesel was found to reduce the viscosity and with higher flash point, it was safe to stock. Engine operation for short duration test studies were satisfactory requiring no major engine hardware modification and can suitably substitute petro-diesel. Performances were comparable and emissions were less for entire range of operations. Self lubricity and free oxygen content of the fuel recommended that, Karanja as an optimum test fuel with slight modification in injection timing and duration to offset its higher viscosity effect.[5]

Kandasamy and Thangavelu et al.[6] investigated on the performance of diesel engine using various bio fuels. In this study the bio fuels were blended with diesel and preheated before it was injected into the cylinder. The preheating ensures the enhancement of combustion efficiency and the overall performance of the engine. The investigators concluded that the highest engine efficiency was obtained for the B60 of Pongamia oil and also that the efficiency increased with increase in the temperature. For the rice bran oil, the difference in the engine efficiency was very minimum with change in temperature and the performance of the engine was found to be good for the B40 blend. However the overall performance of the engine was found to be good when the oil and diesel blend is provided to the cylinder after pre heating.[6]

Haldar et al. [7] conducted performance and emission test on diesel engine operated on Jatropha, Karanja, and Putranjiva oils at various injection timings. The blends of degummed non-edible oils and diesel were used in a variable compression engine. At 45° BTDC Jatropha and Putranjiva oils performed better than diesel. Higher cetane number and ignition temperature of oils compared to diesel were responsible for this trend. Smoke and particulates of all three oils were lower than diesel.

Mani and Nagarajan *et al*. [8] used waste plastic oil as fuel in diesel engine. The properties of waste plastic oil was compared with the petroleum products and found that it can also be used as fuel in compression ignition engines. They studied the influence of injection timing on the performance and emission characteristics of a single cylinder, four stroke, direct injection diesel engine using waste plastic oil as a fuel. Tests were performed at four injection timings (23^o,20^O,17^o and 14^o before top dead centre BTDC). When compared to the standard injection timing of 23° BTDC, the retarded injection timing of 14° BTDC resulted in decreased oxides of nitrogen, carbon monoxide and unburned hydrocarbon while the brake thermal efficiency, carbon dioxide and smoke increased under all the test conditions [8]

Shelke *et al*. [9] tested blends of diesel oil and esterified soyabean oil in a standard single cylinder diesel engine at two different compression ratios of 16 and 18. Brake specific fuel consumption increased in Soyabean - diesel oil blend and esterified Soyabean oil at different compression ratios .In compression ratio 16 and 18, Output specific fuel consumption are increased by 29 % and 37 % respectively compared to 100% diesel operation. For the same injection angle, brake thermal efficiency is decreased in Soyabean - diesel blends and esterified Soyabean oil compared to 100% diesel operation at different compression ratios. The reduction in BTE in compression ratio 16 is slightly lower than in 18. 3. Similarly, the exhaust gas temperature and smoke density are on better side in compression ratio 16 rather than in 18.

Ashish Karnwal *et al*. [10] has analyzed the transesterification process for production of Thumba oil methyl ester and the various process variables like temperature, catalyst concentration, amount of methanol and reaction time have been optimized with the objective to maximize yield. The optimum conditions for transesterification of Thumba oil with methanol and KOH as catalyst were found to be 60°C reaction temperature, 6:1 molar ratio of Thumba oil to methanol, 0.75% catalyst (w/w) and 1 hour reaction time

Venkanna *et al*. [11] studied the performance of a direct injection (DI) diesel engine operated on neat Diesel (ND) and neat honne oil (H100). Brake thermal efficiency of H100 was 25.01% compared to 29.20% with ND. EGT of H100 was 620ºC compared to 565ºC with ND. CO emission of H100 was 0.36% (by volume) compared to 0.15% (by volume) with ND. HC emission of H100 was 80 ppm (μL/L) compared to 62 ppm (μL/L) with ND. Smoke opacity of H100 is 95% compared to 84.8% with ND. NOx discharge of H100 is 550 ppm (μL/L) compared to 667 ppm (μL/L) with ND.

Ong *et al*. [12]have reviewed the production, performance and emission of palm oil, Jatropha curcas and Calophyllum inophyllum biodiesel. Palm oil is one of the most efficient oil bearing crops in terms of oil yield, land utilization, efficiency and productivity. However, competition between edible oil sources as food with fuel makes edible oil not an ideal feedstock for biodiesel production. Therefore, attention was shifted to non-edible oil like Jatropha curcas and Calophyllum inophyllum. Calophyllum inophyllum oil can be transesterified and being considered as a potential biodiesel fuel.[12]

Sathya Selvabala Vasanthakumar *et al*., [13] reported a two-step process developed to produce biodiesel from Calophyllum inophyllum oil. Pre-treatment with phosphoric acid modified b-zeolite in acid catalyzed transesterification process followed by transesterification was done using conventional alkali catalyst potassium hydroxide (KOH). The objective of this study was to examine the relationship between the reaction temperatures, reaction time and methanol to oil molar ratio in the pre-treatment step. Central Composite Design (CCD) and Response Surface Methodology (RSM) were utilized to conclude the best operating condition for the pre-treatment step. Biodiesel produced by this process was tested for its fuel properties.[13]

Shi *et al*.,[14] studied finest injection strategies for a heavy duty CI engine fuelled with diesel and gasoline like fuels. A CFD tool with detailed fuel chemistry was used to calculate engine performance and poison emissions. The CFD tools feature a recently developed efficient chemistry solver that allowed the optimization tasks to be completed in practical computer times. A non-dominated sorting genetic algorithm II was coupled with the CFD tool to seek optimal combinations of injection system variables to achieve clean and efficient combustion. This optimization study identified several key factors that play an important role in engine performance. It was found that the fuel volatility and reactivity play an important role in mid load condition, while at high load condition the performance of the engine is less sensitive to fuel reactivity. The study indicated that high volatility fuels such as gasoline and E10 are beneficial at high load giving good fuel budget [14].

Duraisamy *et al*. [15] presented the effect of compression ratio on CI engine fuelled with methyl esters of Thevetia peruviana seed oil. They used Blend of 20% methyl ester of Thevetia peruviana seed oil blended with 80% diesel (B20). It was observed that the performance of the engine increased appreciably by increase in compression ratio for bio fuel blends with slight increase in bsfc. Also it was observed that increase in compression ratio pointedly reduced CO, HC, NO_X and smoke emission but with slight increase in CO_2 up to 75% load. While increasing compression ratio from 14.5 to 20.6, brake thermal efficiency, air fuel ratio, CO_2 and NO_X increased to 4%, 43.66%, 30.4% and 68.7% at maximum load operation respectively. [15]

R. Silambarasan *et al*.[16] This study aims to find at the optimum performance and emission characteristics of single cylinder Variable Compression Ratio (VCR) Engine with different blends of Annona Methyl Ester (AME) as fuel. The performance parameters such as specific fuel consumption (SFC), brake thermal efficiency (BTHE) and emissions levels of HC, CO, Smoke and NOx were compared with the diesel fuel. It is found that, at compression ratio of 19.5:1 for A20 blended fuel (20%AME+80%Diesel) shows better performance and lower emission level which is very close to neat diesel fuel. The engine was operated with different values of compression ratio (16.5, 18.5and19.5) to find out best possible combination for operating engine with blends of AME. It is also found that the increase of compression ratio increases the BTE and reduces BSFC and having lower emission without any engine in design modifications. They found by the calculations that the optimum compression ratio for A20 blend is 19.5:1. When compared with other compression ratios the brake thermal efficiency and reduced emission for A20 blend are obtained at compression ratios of 19.5:1. Hence 20% methyl ester of Annona oil and 80% of diesel blend at with a standard compression ratio of 17.5:1 gives slightly better performance and reduced emission when compared to diesel fuel.

Venkateswara Rao P. *et al.[*17] In this paper an attempt has been made to investigate the effect of compression ratio (CR) on performance characteristics of diesel engine with 20% Jatropha oil methyl ester (JOME) mixed with 80% diesel to form as B20D80 blend fuel (BF). Experiments were conducted on a variable compression ratio (VCR) engine at compression ratio of 14, 16, 18 and 20 for BF and at 14 and 20 for diesel fuel to compare the results. Based on the experiments conducted on diesel engine with 20% biodiesel blended with 80% diesel, the following conclusions were drawn: Maximum brake thermal efficiency is obtained at minimum BSFC for blend fuel at compression ratio of 20:1. Due to complete combustion of blend fuel CO, smoke density and hydrocarbons are minimum level where as NOx and CO2 are at higher level for compression ratio of 20:1. Blend fuel of biodiesel B20D80 revealed that a significant improvement in performance and emissions reduction of the engine at higher CR compared to pure diesel operation.[17]

M.Varman *et.al* [18] investigates the engine performance parameters and emissions characteristics for direct injection diesel engine using coconut biodiesel blends without any engine modifications. A total of three fuel samples, such as DF (100% diesel fuel), CB5 (5% coconut biodiesel and95% DF), and CB15 (15% CB and 85% DF) respectively are used. Engine performance test has been carried out at 100% load, keeping throttle 100% wide open with variable speeds of 1500 to 2400 rpm at an interval of 100 rpm. experimental investigations in terms of engine performance and emissions of using diesel fuelas baseline and biodiesel blends such as CB5 and CB15 respectively. The experimental results of this research work can be summarized as follows .Compared to diesel fuel, engine torque and brake power for biodiesel blends were decreased, mainly due to their respective lower heating values. The bsfc values for biodiesel blends were higher when compared to diesel fuel due to lowerheating values and higher densities**.[18]**

Senthil Ramalingam *et.al* [19] in this paper finding the effects of the engine design parameters viz. compression ratio (CR) and fuel injection timing (IT) jointly on the performance with regard to specific fuel consumption (SFC), brake thermal efficiency (BTHE) and emissions of CO, HC, Smoke and NOx with Annona methyl ester (A20) as fuel. Thus A20 can be effectively used in a diesel engine without any modification. Compression ratio of 19.5 along with injection timing of 30bTDC (before top dead centre) will give better performance and lower emission which is very close to diesel It is found that the com-bined increase of compression ratio and injection timing increases the BTE and reduces SFC while having lower emissions. For all tested values, A20 provides best results in terms of BTE, higher heat release rate, and lower emissions of HC, CO and NOx. Hence A20 can be effectively used as an alternative biodiesel with Injection timing of 30bTDC along with compression ratio of 19.5 in tested engine. Even though only 20% of Annona methyl ester is added with 80% pure diesel, will meet to a certain extent the shortage of availability of pure diesel. Annona is available with lower cost when compared to diesel in present scenario. Hence AME will be economical also for diesel trains. **[19]**

Rinu Thomas *et al.* [20] The present work is an experimental investigation to examine the variation of different parameters such as brake thermal efficiency, exhaust gas temperature and emissions with respect to change in compression ratio in a single-cylinder carbureted SI engine at different loads with two different fuels. A judicious application of the concept of variable compression ratio (VCR) at different loading conditions is a viable alternative for better engine performance as well as emission characteristics. The present experimental study has shown that the use of alcoholic fuels like n-butanol has indeed improved the engine performance at higher compression ratios. The effect of blending percentages of such fuels can be further studied for SI engines. Proper emission control systems can be designed for higher compression ratios to keep the UBHC and NO in check**. [20]**

C.Srinidhi *et al.*[21] found using Callophyllum Biodiesel at blending ratio 20, 40, 60, 80 and 100 with pure diesel. The experimentation was performed on DI-CI engine with fixed CR of 17.5. They concluded that BTHE, BSFC, and NOx emission was higher. They stated that Biodiesel has positive effects like lower CO, HC emissions

III. CONCLUSION

This paper validates the information of Biodiesel derived feedstocks like edible and non edible sources prove to be positive fuel for CI engine. Majority of researchers reveal an important fact that usage of Biodiesel in CI engine, shoots the oxides of emissions decreasing the carbon monoxide and un burnt Hydrocarbon emission. On the Contrary, eve The BTHE(Brake thermal Efficiency) also rises up for the same parameters of engine. But an important fact that the Combustion analysis of CI engine fuelled with Esterified Oil is still in on lower side. Also the right blend is yet to be known.

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