Evaluation of Performance and Emission Characteristics of C.I. Engine by using biodiesel and its blends

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Abstract : As the biodiesel industry grows, honing a cost-effective and diverse feedstock supply out as a top challenge. There is a need to diversify the sources and methods used to generate biofuel products to achieve food security, energy security and sustainable development and carbon Current work investigate the characteristics of a single cylinder CI Engines operated on biodiesel blends. The main aim of the study was to optimize the diesel engine for Mahua biodiesel for feasibility of replacing diesel in CI engine. Various parameters (Load, Speed, Compression Ratio, Efficiency etc.) are considered for experimental study and to review and compare the literature of various biodiesel studies. This project includes design of experiment optimization method also the evaluation, performance and emission of C.I. engine using Mahua and Canola biodiesel. The project has many other positive economic, social and environmental impacts.

IndexTerms – Biodiesel, Mahua, Environmental Impact etc.

I. INTRODUCTION

Biofuel is an example of renewable energy source that can be used as alternative Fuel. Biodiesel burns completely and do not emits hazardous gases or toxic gases. It can be used with Current diesel engine without any modification or minor modifications. Various crops or seeds are considered for production of biodiesel such as Sunflower, rapeseeds in Europe, Canola oil in Canada, Palm oil in South-east Asia (Malaysia and Indonesia), and Neem oil in India Subcontinent. According to Indian climate and environmental conditions Canola, Jathropha curcus oil, Simarouba oil, Neem oil, cellulosic materials, Pongamia pinnata (Karanja) are used for biodiesel production. Types seeds used for production of biodiesel are Neem oil, Soybean oil, Canola flower, Palm tree Karanja seeds and Jathropha tree etc.

Figure 1: Seeds Used For Production of Biodiesel

Biodiesel is a renewable fuel produced from vegetable oil or animal fat through a chemical process and it can be defined as fatty acid ethyl or methyl esters made from virgin or used vegetable oils (both edible and non-edible) and animal fats.
Biodiesel is prepared through a chemical process called “trans esterification” whereby the glycerol is separated from the fat or vegetable oil. ASTM D6751 definition of biodiesel states that biodiesel is composed of mono-alkyl esters of long chain fatty acids, oxygenated fuel derived from plant oils or animal fats. Also, biodiesel can be made from methyl, ethyl, isopropyl and other alcohols. But most biodiesel research focuses on methyl esters. Biodiesel prepared from ethyl esters i.e. ethanol are known as ethyl ester biodiesel. However, high prices of ethanol, government’s legislations on ethanol, and low ethyl esters conversions had restricted use of ethyl esters.
Use of biodiesel can extend life of CI Engine because it is more lubricating and energy secure source than petroleum diesel fuel. Owing to this, biodiesel with NOx emission reduction techniques in C.I. Engine will not only solve energy crises but also bring vital revolution in C.I. Engine development.

Biodiesel is a clean burning alternative fuel, produced from domestic, renewable resources. It can be used in C.I. Engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

Figure 2: Jathropha Seed and Plant

II. LITERATURE REVIEW

N. R. Banapurmath and P. G. Tewari., (2010) [1] investigated characteristics of a single cylinder CI Engines operated on ethanol-biodiesel blends. The variable load tests were conducted at three injection timings of 190, 230 and 270 and injection pressure varied from 205 to 280 bars. The break thermal efficiency values at all injection timing were lower for biodiesel, and biodiesel ethanol blends than diesel fuel. The decrease in brake thermal efficiency for Hong oil methyl ester (HOME) and Jatropha oil methyl ester (JOME) were might be due to lower energy content of fuel, and higher viscosity of biodiesel. The ethanol blend with 15% ethanol shows better performance than 5% or 10% ethanol.

M. Venkatraman and G. Devaradjane, (2010) [2] have been carried the experimental investigation to examine the performance-emission effect at different compression ratio, injection timing and injection pressure. Engine was used direct injection, air cooled, rated for 4.4 kW at 1500 rpm. It was found that combined increase of compression ratio; injection timing and injection pressure increases the BTE and reduces BSFC. The optimum operating condition was found as CR of 19:1 with IP of 240 bar and injection timing of 270BTDC. The tests were conducted for various blend 10%, 20%, 30% of pungam oil methyl ester.

N.R. Banapurmath et al., (2009) [3] described systematically, effect of nozzle geometry on the performance of CI Engines operated on vegetable oils. They used different vegetable oils such as honge oil, jatropha, neem, rice bran oil, sunflower oil, palm oil, soybean oils for study. Also, they considered three injector with different number of hole geometry. In additions, injection rate for selected oil was varied in order to study effects of spray characterizes. He concluded that, spray pattern of vegetable oil gets affected due to relative higher viscosity leading to larger fuel droplet. It was observed that, spray pattern of jatropha and honge oil was better compared to other fuel.

N. Reddy et al., (2006) [4] have conducted experiments on a direct injection (DI), diesel engine using neat jatropha oil. Injection timing, injector opening pressure and injection rate were changed to study their influence on performance, emissions and combustion and are compared with total diesel operation. Results show that, for neat jatropha oil by increasing 15 bar in injector opening pressure and 3º in fuel injection advance, an improved brake thermal efficiency, the peak heat release rate were observed.

P. K. Devan et al., (2009) [5] studied the performance, emission and combustion characteristics of diesel engine running on methyl ester of paradise oil (MPSE) and concluded that Brake thermal efficiencies of MEPS and its diesel blends were slightly lower than that of std. diesel. A significant reduction in HC and Smoke emissions by 22% and 33% respectively were recorded for MEPS 50 blend whereas, 27% and 40% reductions were recorded for MEPS 100. A slight increase of 5% and 8% NOx emissions were recorded for MEPS 50 and MEPS 100 respectively. From the engine analysis, they found that the performance of MEPS and its diesel blends were similar to that of standard diesel and combustion characteristics of MEPS and its diesel blends are comparable with those of standard diesel.

H. Raheman et al., (2013) [6] have studied the performance of a diesel engine with blends of mixture from simarouba and mahua. Based on the minimum BSFC, maximum BTE, and minimum EGT, the biodiesel blend, B10, was found suitable for the running diesel engine without compromising engine performance when operated with High Speed Diesel (HSD). However, from the emission point of view, this blend (B10) was found to produce higher CO and HC and lower NOx emissions as compared with B20. However, both fuel blends tested exhibited lower CO and HC and higher NOx emissions as compared with HSD. Considering both performance and emissions, B10 was considered as the suitable blend for replacing HSD in diesel engine and also in the long-term test of the engine that was conducted.

III. LITERATURE GAP

Engine performance (brake specific fuel consumption, brake thermal efficiency) and emission were measured to evaluate and compute behavior of diesel engine running on biodiesel. The reduction in exhaust emission and brake thermal efficiency consumption together with increase brake power, brake thermal efficiency made the blend of biodiesel a suitable alternative fuel for diesel and thus could help in controlling air pollution.

IV. PROBLEM STATEMENT

The problem statement include, the study to optimize the diesel engine for Canola and Mahua biodiesel for feasibility of replacing diesel in CI engine. Also to check properties of Canola, Mahua and B20, B40 blends. Also To decide various parameters (Load, Speed, Compression Ratio, Efficiency, SFC, etc.) for experimental study. Evaluation of performance and emission of C.I. Engine Fuelled with Canola, Mahua and its blends with diesel.

V. ENGINE PERFORMANCE

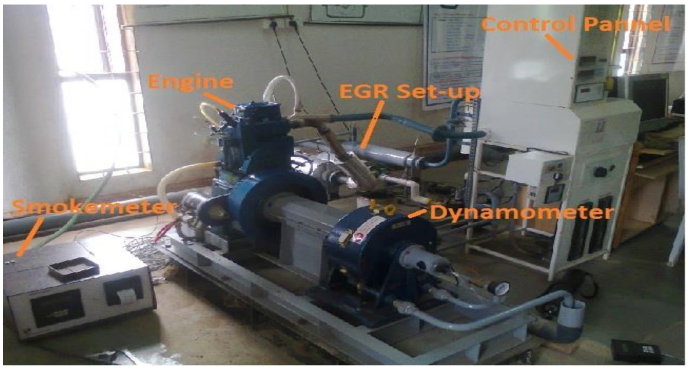

Figure 2: Engine Setup

VCR Engine is used for test. The test bed consists of a diesel engine, an eddy current dynamometer; fuel tank with thermostat-controlled heater is inbuilt in control panel with fuel measuring unit, and a data acquisition system. Two filters are installed: one at exit of tank and other one at fuel pump. Fuel is fed to the injector pump under gravity. Lubricating oil temperature is measured by using a thermocouple. The cooling water temperature is maintained constant (65 to 700 °C) throughout the work by controlling the flow rate of fuel. Smoke opacity was measured using smoke opacity meter. The engine tests were conducted for entire load range (0 to 100%) at constant speed of 1500 rpm.

VI. RESULTS AND DISCUSSIONS

Properties of Mahua Biodiesel and its Blends, D100 Biodiesel 0% + Diesel 100%, B20 Biodiesel 20% + Diesel 80%, B40 Biodiesel 40% + Diesel 60%, B60 Biodiesel 60% + Diesel 40%, B80 Biodiesel 80% + Diesel 20%

BRAKE THERMAL EFFICIENCY

As the load increases the brake thermal efficiency also increases. This improved performance of the engine at higher compression ratio may be due to the reduced ignition delay. Effect of biodiesel was studied on the engine with varying compression ratio from 15, 16, 17 and 18. It is shown in figure 3 that 18 compression ratio gives better thermal efficiency i.e. 26.03% among all of them. As the compression ratio increases further the results shows decrease in BTE this is may be due to increase in temperature at higher compression ratio causes early ignition of fuel takes place.

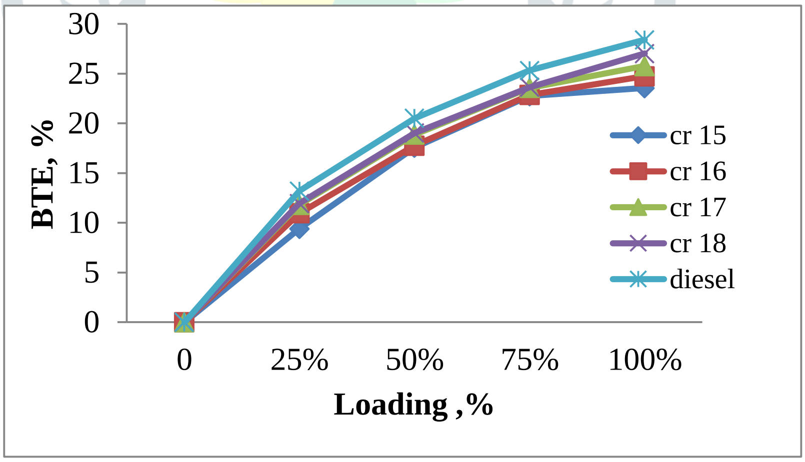

Figure 3: BTE vs. Loading

BRAKE SPECIFIC FUEL CONSUMPTION (BSFC)

Variation of brake specific fuel consumption is studied on increasing the load from 0 to 100% by interval of 25% and varying compression ratio such as 15, 16, 17 and 18. The graph shows that specific fuel consumption decreases with increasing load; the trend shows decrease in specific fuel consumption. This behaviour may be due to lower volatility and higher cetane number of biodiesel compared to diesel fuel which will result in improved combustion at higher compression ratios

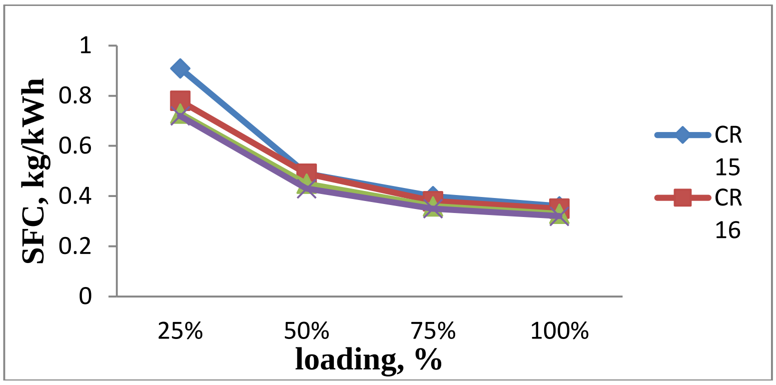

Figure 3: SFC vs. Loading

SMOKE EMISSION

Effect of varying compression ratio with increase in load is shown in figure 5.3. As load increases smoke emission is also increases. It is clear from the figure that as compression ratio increases smoke emission decreases, the possible reason for this trend could be that the increased compression ratio actually increases the air temperature inside the cylinder consequently reducing the delay period causing better and more complete burning of the fuel.

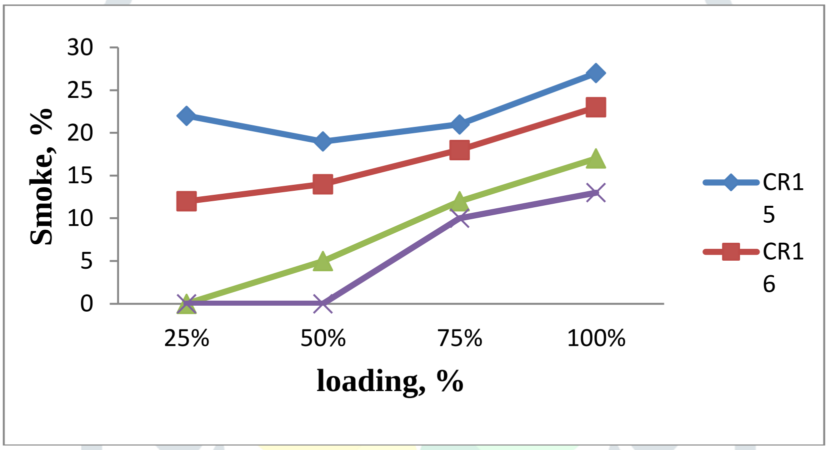

Figure 4: Smoke vs. Loading

VII. CONCLUSION

Based on the results of the study, conclusions drawn were Mahua oil was prepared and blended with diesel in varying proportions. Engine starting was normal with Mahua and its blend with diesel. Hence from the above study it is concluded that, fuel properties of diesel, Mahua oil and its blends are comparable. Brake thermal efficiency and smoke increases with loading and specific fuel consumption decreases.

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