Performance Analysis of aVariable compression ratio Diesel engine Fueled with Linseed Biodiesel Blends

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ABSTRACT

In this work the experiment is carried out to examine and evaluate the engine performance and exhaust emission characteristics of a variable compression ratio (CR) engine powered with linseed biodiesel blends (linseed biodiesel and diesel).Blends are prepared by taking linseed methyl ester and diesel in the ratio of 20%, 30%, 40% and 50% by volume. All the results are recorded at full load, at fixed RPM of engine while changing the compression ratio(15.5, 17, 18.5, and 20). Performance of engine is measured by brake thermal efficiency (BTE), brake specific fuel consumption (BSFC). Resultsshow that all biodiesel blends and pure diesel (PD) at higher compression ratio have better brake thermal efficiency and lower brake specific fuel consumption.

Keywords : Biodiesel, Compression ratio, Brake specific fuel consumption andBrake thermal efficiency.

I INTRODUCTION

Due to scarcity and increasing costs of conventional fossil fuels, biodiesel as a fuel became more suitable fuel. Diesel and petroleum fuel can be replaced by biodiesel made from vegetable oils. Biodiesel is now mainly being produced from soybean, rapeseed, linseed and palm oils. Biodiesel is a renewable substitute for petroleum and diesel fuels, non toxic, readily available and biodegradable fuel, having higher flash point, and better lubrication properties than diesel. Instead of having advantage biodiesel also has some disadvantages like higher viscosity, lower calorific value as compared to convention diesel.Soo-Young No [1] studied that brake specific fuel consumption of pure linseed biodiesel is higher than that of linseed oil blends and diesel fuel at all the compression ratios.Dawady et.al [2] conducted experiment with different compression ratios of 15, 16, 17.5 and 19 at a constant speed of 1500 rpm by using the different blends of soybean biodiesel (B20, B40 and B100) and compared with respect to diesel fuel. They found that soybean biodiesel blends have higher BSFCS and lower BTE than that of the diesel fuel. This is due to the lower heating values of the methyl esters that are about 12.4% less than that of diesel fuel.Raheman et al. [3]evaluated the performance of Ricardo E6 diesel engine with biodiesel from mahua oil by varying the compression ratio. They observed that brake thermal efficiency decreases, brake specific fuel consumption (BSFC) increases at all compression ratio (18:1 to 20:1) with increase in percentage of biodiesel in diesel.Nagaraja et al. [4] were conducted experiments on direct injection variable compression ratio (16:1, 17:1, 18:1, 19:1 and 20:1.) engine when fueled with pre- heated palm oil and its blends (5%, 10%, 15%, 20%) with diesel (on a volume basis). On investigation and comparison with standard diesel at constant speed and full load, the brake power of B20 is higher than that of standard diesel and other tested fuels at higher compression ratio and full load condition.Silambarasan et al. [5]observed that the BTE gradually increase with increasing compression ratio. At maximum load with the compression ratio of 19.5, the BTE of Annona methyl ester blend 20 is 31.67% and it is almost equal to the neat diesel fuel. They also observed that the BSFC is gradually decreases with increasing compression ratio.At maximum load with the compression ratio of 19.5, the BSFC for A20 is 0.301kg/kW-hr. Nabi and Hoque [6] conducted the experiment from Linseed biodiesel and performance study of a diesel engine with diesel was carried out. Efficiency of biodiesel (B10, B20) is 1% and 2% lower than diesel fuel due to low volatility, higher viscosity and density.

II PREPARATION OF BLENDS

To make methyl ester of Linseed biodiesel trans-esterification process was used. This process comprises of two processes in first process, specific quantity of 500 ml Linseed oil in a round flask is taken and it is heated to temperature of about 53°C on a hot plate magnetic stirrer after that 100 ml methanol with 5 ml H_2SO_4 is added to it. This mixture is stirred at a RPM of 1500 and at 53°C constant temperature, for around two hours till ester formation starts. After that this mixture is kept stationary for around eighteen hours, in a separating funnel. Two layers are formed, lower layer is glycerol and lower layer is separated out. Upper layer is used for post processing. In post processing the pre-processed Linseed oil is heated to 53°C, after that mixture of 100 ml methanol with 5 gm of NaOH is added to it and stirred again at RPM of 1500 and at 53°C constant temperature till ester formation starts. Again this mixture is kept stationary for around eighteen hours, in a separating funnel. Two layers are formed, lower layer is glycerol and lower layer is separated out. The top layer is methyl ester of linseed oil. Blends are prepared by taking linseed methyl ester and diesel in the ratio of 20:80, 30:70, 40:60 and 50:50 by volume before conducting the experiment.

Table 1.Results of physico-chemical properties of diesel with linseed methyl ester blends

S.N	Blends	Kin.Viscosity(cst)@40^{o}C	Density(g/ml)@15^{o}C	Calorific value(cal/gm)
1	Pure diesel	2.72	0.850	10455
2	B20	3.04	0.857	10292

3	B30	3.21	0.860	10211
4	B40	3.37	0.864	10129
5	B50	3.53	0.867	10047
6	B100	4.34	0.885	9640
Test Method		IS 1448 P-25	IS 1448 P-32	IS 1448 P-6

III EXPERIMENTAL PROCEDURE

The experiments is carried out on a single cylinder, four stroke, water cooled, direct injection, variable compression ratio engine (TV1, Kirloskar oil Engine Ltd. India). The compression ratio of the engine can be changedby lowering or raising the head assembly from outside of engine. The measurement of linear movement of head assembly gives micrometer reading, which can be directly used for measurement of compression ratio, with the help of table/graph showing micrometer reading corresponding to the value of compression ratio. Two fuel tanks are attached to the engine, one for conventional fuel and second is for test fuel. For easy switching between fuels valves are provided, so that we can switch between two fuels while running engine condition. Test fuel tank is attached to a weighting machine, the output signal of fuel weight is supplied to control panel by means of output cable from weighting machine. Eddy current dynamometer is coupled to the engine for applying brake load the variation of load with respect to current is shown on the control unit. Initially the engine is started with diesel and is allowed to run for 20 to 25 minute to warm up. Once the engine is warmed up, the blend of linseed biodiesel is poured in to the primary tank with the help of funnel.After 5-6 minute the valve which allows the diesel to flow into the engine is closed and the other valve allowing linseed biodiesel blend to the cylinder is opened .And then the compression ratio is set by raising and lowering the cylinder head. And once the engine reached at full load condition corresponding reading were recorded with help EPA software and exhaust analyzer. And same procedure is followed for taking the reading of next blend.

IV PERFORMANCE ANALYSIS

4.1. Brake thermal efficiency: The Brake Thermal Efficiency of all linseed biodiesel blends is found to be lower than that of diesel fuel. The reason behind the lower efficiency is the higher viscosity as well as lower calorific value of linseed biodiesel blends as compared to pure diesel. The lower calorific value & higher viscosity causes improper atomization inside the combustion chamber leading a reduction in the efficiency of the engine[**6].**In the experiment brake thermal efficiency increases as the compression ratio increases for different biodiesel blends and diesel.This is because as CR increases there is decrease in viscosity and improvement in atomization of fuel and better mixing of fuel with air hence better combustion **[7].**

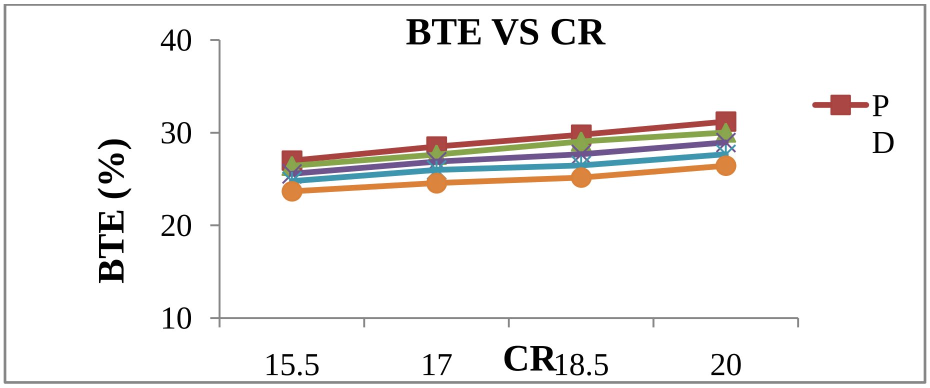

Fig.1 BTE for different fuel blends at different CR at full Load

4.2. Brake Specific Fuel Consumption (BSFC) It can be seen from the graph that the BSFC is lower for diesel at all compression ratios and increases as the blend proportion is increased. At higher percentage of blends, the specific fuel consumption is more. This is due to the decrease in calorific value and increase in density of fuel. It can also be seen from the graph as compression ratio increases the BSFC decreases for all blends of LME as well as pure diesel. It is due that increase in compression ratio results decrease in viscosity of fuel which causes proper atomization of fuel and better combustion which reduces the mass of fuel per unit brake power.

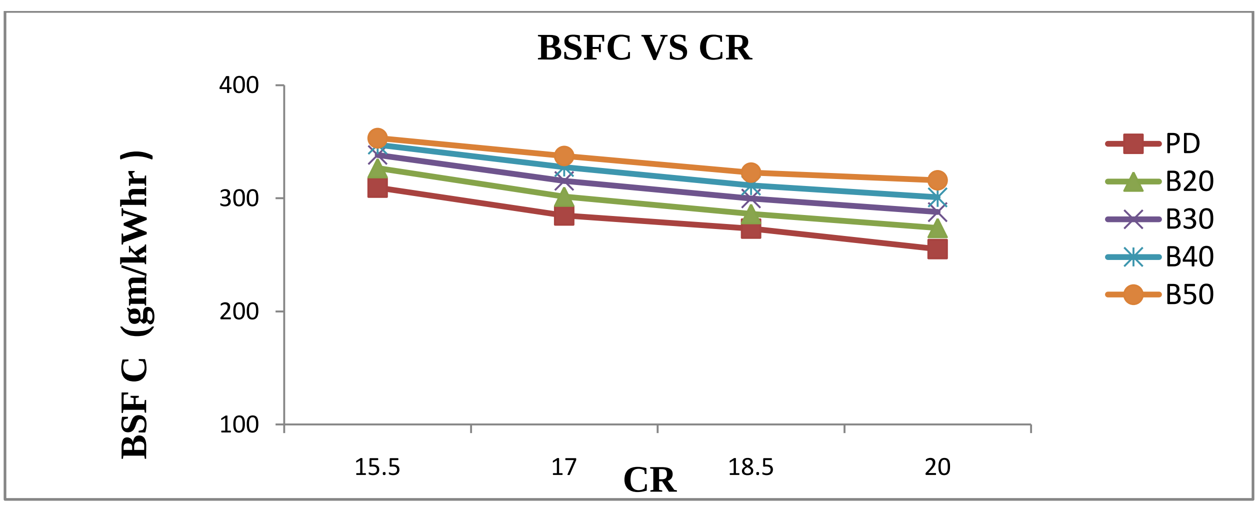

Fig.2BSFC for different fuel blends at different CR at full Load

V.CONCLUSION

Effect of variation in compression ratio of engine is analyzed and it is found that higher compression ratio gives better results such as increase in BTE and decrease in BSFC.B20 results in 3.78% decrease in BTE, 7.24% increase in BSFC as compared with pure diesel. While B30 results in 7.24 % decrease in BTE, 12.80 % increase in BSFC as compared with pure diesel. Also B20 results in 13.58% increase in BTE, 16.19% decrease in BSFC from CR15.5 to CR20. From the results it can be concluded that higher compression ratio i.e. 20 gives more suitable results for performance. B20 blend can be considered as suitable blend with slight decrease in BTE. Further emission analysis can also be done in future to reduce harmful emissions from engine.

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