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EFFECT OF VARIABLE COMPRESSION RATIOS ON C.I ENGINE FUELED WITH LINSEED BIODIESEL

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Abstract: Experimental degradation and scarcity are the main problems associated with petroleum derived diesel. Biodiesels are emerged as an alternative in recent days. Many edible oils derived biodiesels giving good performance and less emission compared to diesel but it will cause hike in the price of edible oils. Present work concentrated on generating biodiesel from non-edible oil (Linseed oil) by two stage transesterification process. The biodiesel properties were compared with diesel. Compression ratio is fixed in conventional engines. To achieve the higher efficiency and good performance change of compression ratio is used. The effect of compression ratio was studied on diesel engine without any modification with linseed biodiesel as a fuel. The optimum parameters were found to prepare biodiesel from the crude linseed oil .The prepared biodiesel has 5.4% less calorific valve than the diesel and 23.5% higher kinematic viscosity. UHC and CO_2 were less in case of biodiesel (B20). Higher compression ratio is better for biodiesel as it is showing better performance and less emission.

Keywords: Linseed Biodiesel, VCR engine, Combustion, Performance and Emissions characteristics.

I.INTRODUCTION

Bio means life or involving life or living organism. Diesel is a fossil fuel used in internal combustion engine. Bio diesel is an alternative fuel for diesel which derived from the fats of animal s, vegetable oils and waste oils from the cooking. Chemically specking Biodiesel is alkyl esters of the long chain fatty acid. Biodiesel can be used in internal combustion engine that are made to work with diesel without any modifications. World energy demand is increasing day by day. The scarcity of petroleum based fuels making biodiesel as important alternative fuel moreover petroleum reserves in the world are constrained to some geographical regions. Due to this every country is giving very high importance to biodiesel which can save a lot of foreign exchange. Environmental concerns also us to move towards a less polluting fuel such as biodiesel. The blends of biodiesel with fossil fuels have many benefits like less emission, increase in efficiency, decrease in fuel consumption etc. The calorific valves of biodieselsare higher than the fossil fuels. There will be decrease in greenhouse gases and biodiesel feedstock can be developed locally which increases local economy. Due to agriculture, economic and environmental factors making the biodiesel as an important. India is a country which is having stable economy growth in the world and developing at faster rate. This means energy requirement of India increasing drastically particularly in transportation sector. The transportation sector depends on fuel which imported due to lack of petroleum reserves. So this is the time to India to search for alternative fuels to sustain and maintain the growth rate. With vast vegetation and land availability biodiesel seems to available source.

1. VARIABLE COMPRESSION RATIO (VCR) ENGINE:

The main purpose of VCR engine is to run at different compression ratio according to the vehicles power requirements. VCR engine will change its combustion volume continuously so that compression ratio will change. Whenever the vehicle requires low power then VCR will operate at high compression ratio so that we can attain the fuel efficient and at high power requirements it will run at low compression ratio to prevent knocking of the engine. Optimum compression ratio depends many parameters like loading on the engine, rating of the fuel, inlet temperatures of the air and coolant water, outlet temperature of exhaust gases etc. The power to weight ratio for VCR engine is high which means it is compact. The change in compression ratio has a significant role in improving thermal efficiency of cycle.The main challenge to the automotive industry is high thermal efficiency and low emission levels. From the theory, we can say that efficiency of a diesel engine is given by which indicates that thermal efficiency of diesel cycle is greatly affect by compression ratio. From this it is clear that by increasing the compression ration thermal efficiency will increase. The operating conditions for the C.I engine varies based upon its use in motor vehicles, such as stop, city traffic, highway cruising etc.

2. EXTRACTION OF OIL FROM LINSEED:

The seeds were separated from the crop. The separated seeds were washed with to clean the dirt and other impurities. The clean seeds were dried in the sunlight or drying machine to reduce the moisture content in it. The moisture content in the seed will reduce the amount of oil extracted. The dried seed will yield good amount of oil. The seeds will be converted into oil pressing. Before sending the seeds into press seeds will be converted into flakes to increase the amount of oil recovered. Mechanical pressing is the method conventionally used to convert into oil. The seeds were fed into press by means of hopper. High amount of crushing force is applied onto it by means of mechanical or hydraulic system. Then the oil from the seeds will be separated leaving solid cake. That solid cake be used as food for poultry, cattle. The oil will be collected into large tanks. Double pressing is used to extract more amount of oil from it. Pressing at high temperature is also a good method to improve conversion efficiency. The extracted oil is left for some time to settle down the particle matter and impurities in it. Then the oil will be separated from the settling tanks and filtered. The filtered oil will be water washed and separated from water by centrifugal separation method. Degumming, neutralization, washing will be performed on the oil. The crude linseed oil consists of mainly triglyceride and minor quantities of diglycerides, pigments, tocopherols, phenolic etc. There are new extraction methods are coming up such as super critical co_2 extraction, organic solvent extraction etc.

3. BIODIESEL PREPARATION FROM OIL:

Biodiesel can be prepared from the raw in different manners. Those are pyrolysis, macro emulsion, dilution and transesterification. Transesterification is the most widely used process because it is simple, efficient and economical. Here two stage transesterifications are used to convert the raw oil into biodiesel. The detailed process of conversion is explained here. In transesterification process use of catalyst is important. That catalyst may be base, acid, enzyme. In this process first esterification of raw oil is performed and the transesterification was performed on that esterified oil. So the two stages are 1. Esterification and 2.Transesterification.

S.NO	Property	LME	Diesel
1	Calorific valve (kJ /kg)	39764	44296
2	Density (kg/m^3) at 40 ^{0}C	876	824
3	Kinematic viscosity at 40 ^{0}C (mm^2/s)	3.57	2.89
4	Flash point	95^{0}C	75^{0}C
	Fire point	98^{0}C	81^{0}C

Table 1: Properties of Linseed Biodiesel and Diesel.

II. BLOCK DIAGRAM:

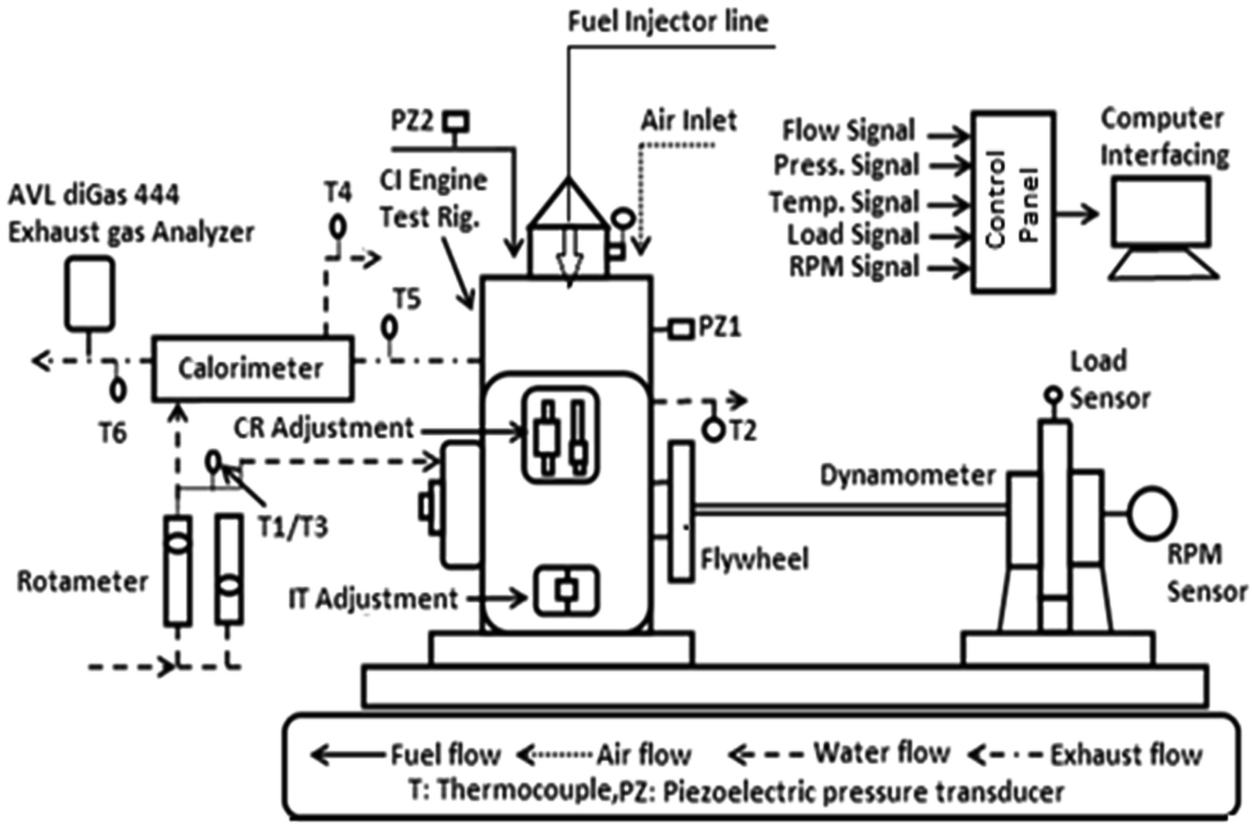

Fig. 1: Block diagram of VCR engine

III. EXPERIMENTAL PROCEDURE

Engine is started with the help of the battery. The rated speed is maintained using the screw provided for speed adjustment. The engine is left to run for 5 minutes to get all the parameters to stabilize. Now the computer is connected to measure and record its performance. With the help of eddy current dynamometer loading is done. At every load rated speed is maintained and left for some time to stabilize. For accuracy 5 readings were taken at each load and average is calculated. The gas analyzer probe is kept in the exhaust pipe and readings were taken. For accuracy purpose readings were taken two times. Smoke reading was measured with the help of smoke meter.

The compression ratio was changed and the same procedure is repeated. The prepared biodiesel used early to avoid oxidation of biodiesel. So that the properties of biodiesel won't change.

IV.RESULTS AND DISUSSION

1. PERFORMANCE ANALYSIS:

1.1 BRAKE THERMAL EFFICIENCY (BTE):It is an indicator for how much of amount of energy is converted into useful brake power or the shaft power.

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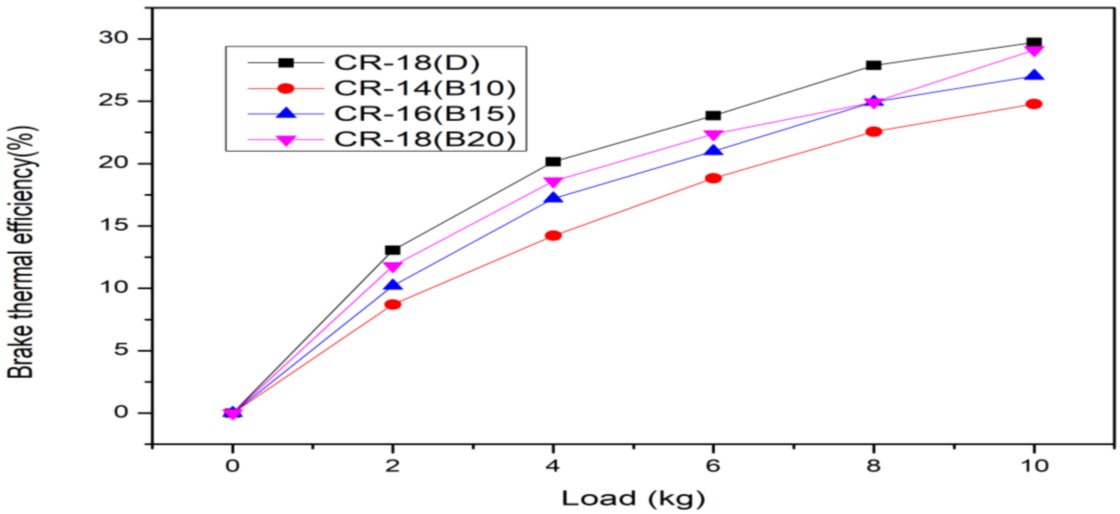

Fig.2. Load Vs Brake Thermal Efficiency

Shows the variation of brake thermal efficiency with respect to the load. Load is taken on x-axis and efficiency is taken on y-axis. The graph shows change in thermal efficiency with change in compression ratio, load and fuel. It can be seen that diesel at compression ratio 18 showing the highest efficiency and Biodiesel at compression ratio 14(B10)is showing less efficiency among all the plots.

The reason for the high efficiency in case of diesel is that it has high calorific value than the biodiesel.

1.2 BRAKE SPECIFIC FUEL CONSUMPTION (BSFC):

Brake specific fuel consumption is a performance indicator which shows the efficiency of the fuel i.e. how much fuel is required to develop 1 kW power.

Figure 2 shows the change in brake specific fuel consumption with respect to the load. It can be seen that with increase in load, the BSFC is decreasing. By increasing compression ratio BSFC is decreasing. Diesel is having less BSFC than the linseed biodiesel.

At higher compression ratio, the fuel conversion efficiency is high so the amount of fuel required to develop same power is less, so BSFC is less

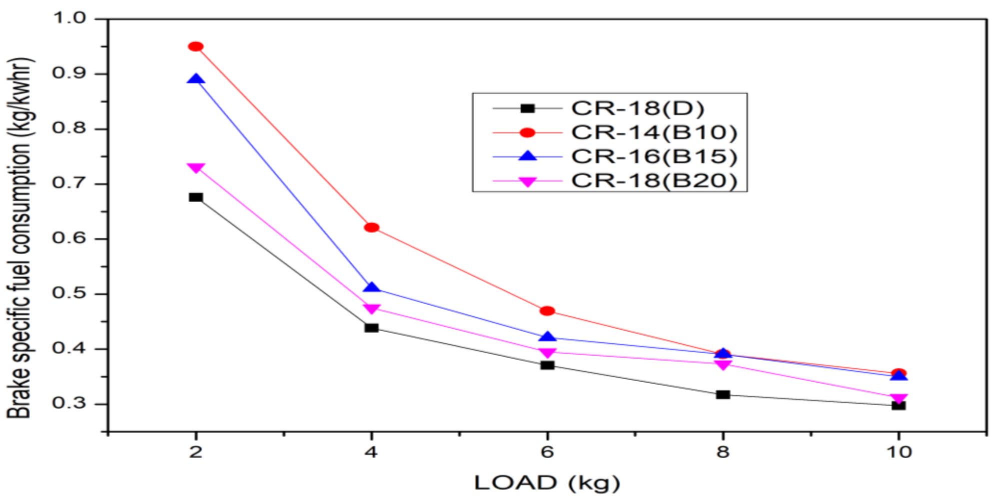

Fig 3.Load Vs Brake Specific Fuel Consumption

2. EMISSION ANALYSIS:

2.1 CARBON MONOXIDE(CO):

The change of carbon monoxide with respect to the load in percentage is shown in figure6.1. B10, B15, B20 are the graphs corresponding to linseed biodiesel at 10, 15, 20 compression ratio respectively. D14, D16, D18 are the readings corresponding to diesel with 14,16,18 compression ratio respectively.

From the figure 4 it is observed that at lower loads the carbon monoxide emission is high and decreases with increasing the load. At lower compression ratio the CO emission are high. With increase in compression ratio, CO emissions decrease. It is also observed that Biodiesel is having higher emission than the diesel at all loads and at all compression ratios. At high compression ratio the emissions are almost constant. The reason for the high CO emissions in biodiesel is that high viscosity and poor atomization which leads to poor combustion. This causes to produce CO in higher than the diesel. At high compression ratio, high temperature causes complete burning results in less CO.

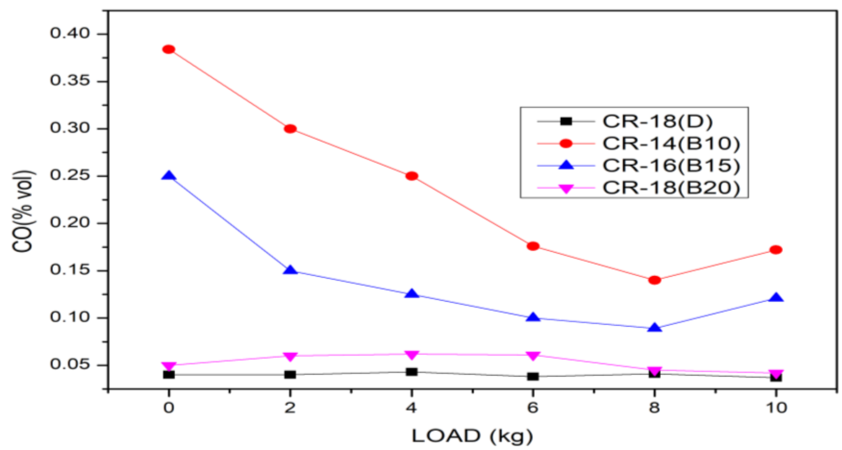

Fig.4. Load Vs Carbon Monoxide

2.2 UNBURNT HYDROCARBON (UHC):

Figure 5show the graph between change of unburnt hydrocarbon with the respective to different loads at different compression ratios with diesel and biodiesel as a fuel. It is observed that at low compression ratio biodiesel is having high unburnt hydrocarbons. But at high compression ratio i.e.CR 18(B20) biodiesel is having less unburnt hydrocarbon irrespective of the load.

At Lower compression ratio the fuel leaves the injector with slow velocity due to its high viscosity which results in under mixing and incomplete combustion produces hydrocarbons. At higher compression ratio fuel and air mixes properly, complete combustion takes place so less hydro carbons will be produced.

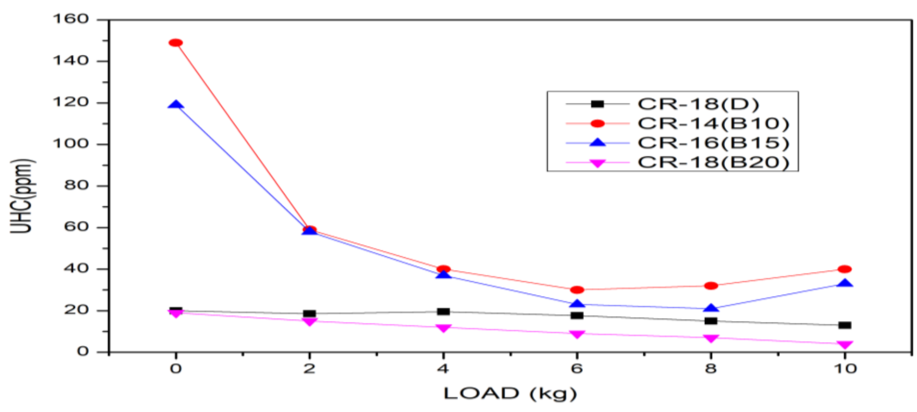

Fig. 5 Load Vs Unburnt Hydrocarbons

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2.3 CARBON DIOXIDE:

Figure 6 shows the variation in carbon dioxide emission with respect to the load at different compression ratio. It is observed that CO2 emissions are high at low compression ratio and reduces with increase in compression ratio. Biodiesel is having less CO2 emissions than the diesel fuel at all loads but at higher compression ratio diesel and biodiesel are showing similar behavior.

At low compression ratio, carbon monoxide reacts with O2 and forms carbon dioxide. At higher compression ratio less carbon monoxide is available to convert into carbon dioxide resulting in less carbon dioxide emission at higher compression ratio.

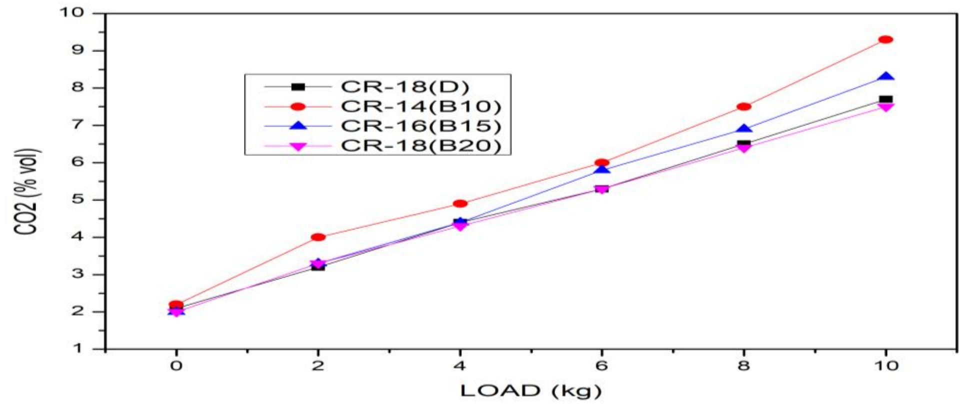

Fig.6 Load Vs Carbon Dioxide

2.4 OXIDES OF NITROGEN(NO_X):

Figure 7 shows the variation in oxides of nitrogen in the exhaust gas of the internal combustion engine at different loads and at different compression ratio with diesel and biodiesel as a fuel. It is observed that with increase in load, NO_X increases drastically. With increase in compression ratio Nox increases. Biodiesel(B20) is showing higher NO_X than the diesel at all loads and all compression ratios.

As the linseed biodiesel has oxygen content in it, more oxygen is available for the formation of NO_X resulting in higher NO_X than the diesel at all compression ratios and loads. The formation of NO_X is highly depending upon the temperature. At higher compression ratio, the exhaust gas temperature is high which causes formation of more NO_X. At low compression ratio the temperature of exhaust gas is less resulting in formation of less NO_X.

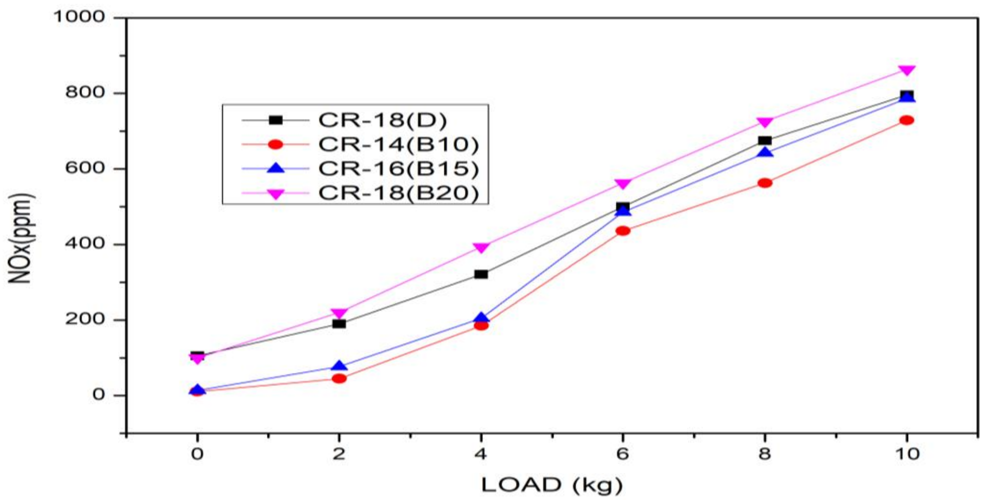

Fig. 7 Load Vs NO_X

V.CONCLUSIONS

The following conclusions can be drawn

1. The kinematic viscosity of diesel and Linseed methyl ester were found as 2.89 and 3.57 cSts respectively at 40^0 C. The results indicate that linseed methyl ester had kinematic viscosity 23.5 % more than that of diesel fuel.
2. The calorific values of the diesel and linseed methyl ester were found as 44.296 and 39.764 MJ/kg respectively. The calorific value of linseed methyl ester is 5.4 % less than that of the diesel fuel.
3. CO and NO_X emissions of LME are higher than the diesel, but at high compression ratio they are almost equal to diesel.
4. UHC and CO_2emissions are less than the diesel which is good sign. If we operate at high compression ratio emissions are still decreasing.
5. BSFC is high for LME compared with diesel due to lower calorific value.
6. Brake Thermal Efficiency of diesel is better than the LME. To overcome this, run the engine at high compression ratio.

From the above all, it is clear that diesel can be replaced by LME at high compression ratio. The problems related to LME were it has more NO_X.

VI. ACKNOWLEDGEMENT

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