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"Study of Characteristics Performance of VCR Engine for Different Fuels"

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Abstract: In the present investigation experimental work will be carrying out to estimate the performance, combustion and emission characteristics of a single cylinder, four stroke variable compression ratio multi fuel engine fuelled with honge oil blended with standard diesel. Tests has been conducted using the biodiesel blends of , 20%, 40% and biodiesel with standard diesel, with compression ratio 16:1-18:1 and an engine speed of 1500 rpm at different loading conditions. Present paper deals with effect of variation in compression ratio on engine performance and emission. Paper deals with effects on engine fueled with diesel, blend of diesel with biodiesel with a view to provide a platform for comparison of the parameter on various fuels. The performance parameters includes brake thermal efficiency (BTE), specific fuel consumption (SFC), brake power (BP), indicated mean effective pressure (IMEP), mechanical efficiency and exhaust gas temperature. The exhaust gas emission is found to contain carbon monoxide (CO), hydrocarbon (HC), nitrogen oxides (NOx) and carbon dioxide (CO_2).

Keywords**:** Biodiesel, Honge oil, VCR engine, Performance, Combustion, Emission.

INTRODUCTION:

Increasing concern for environmental pollution along with maintaining performance of diesel engines has led to extensive research in domain of fuel. Among various options investigated for diesel fuel, biodiesel have proven to be most suitable for diesel engines. Various research work have proved that performance of biodiesel is nearly similar to diesel engines with fewer emissions. Further, engine parameters such as compression ratio, Injection Timing & Injection Pressure are also found to be significant factors contributing on performance and exhaust emissions of diesel engine, fueled with biodiesel. Present paper focuses on effect on one parameter viz. Compression Ratio. Study of effect of CR on engine performance and emissions have been carried out number of researches. The paper provides a platform for comparison of effect of varying CR on performance of engine fueled by (a) 100% diesel Blend of diesel & Biodiesel 100% Biodiesel. The paper deals with results of varying CR on Brake Specific Fuel Consumption (BFSC), Brake Thermal Efficiency (BTE), Smoke Opacity and Carbon Monoxide Emissions, obtain after vigorous study of various research papers.

TEST CONDITIONS

Test conditions for the specified three fuels are as follows:

A. 100% Diesel

Injection pressure 200 bars, injection 23^0 & 17.24^0BTDC, Speed constant 1500 rpm,

B. 20 & 40% Biodiesel

Honge oil, Injection pressure 200 bar, Injection timing 23^0 BTDC and 17.24^0 , speed 1500 rpm,

Compression ratio varied from 16-18

EFFECT ON BRAKE SPECIFIC FUEL CONSUMPTION (BSFC)

The result of effect on BSFC for all three cases is represented in following graphs: For 100% diesel, fuel consumption was minimum at CR 17. At higher values and lower values, consumption increased. The reason attributed is charge dilution at higher values and incomplete combustion at lower values. (Shown in Figure 1) For B20 blend, increase in CR decreased BSFC, lowest observed at CR 20.6. However it was higher than 100% diesel, reason being lower calorific value of biodiesel. For B100, lowest BSFC was observed at CR-18. However, similar to B20 it was higher than diesel owing to lower calorific value of biodiesel.

The use of natural gas in Diesel engines has both economic and environmental advantages. Over past few years, stringent emission regulations have been imposed on NOx, smoke and particulate emissions emitted from automotive diesel engines worldwide. Diesel engines are typically characterized by low fuel consumption and very low CO emissions. However, the NOx emissions from diesel engines still remain high. Hence, in order to meet the environmental regulations, it is highly desirable to reduce the amount of NOx in the exhaust gas. Diesel engines are predominantly used to steer tractors, heavy Lorries and trucks. Owing to their low fuel consumption, they have become increasingly attractive for smaller Lorries and passenger cars also. But higher NOx emissions from diesel engine remain a major problem in the pollution aspect. In order to reduce emission levels, some external engine features can be applied, such as EGR or after-treatment systems. Cooled EGR systems have been used to reduce emissions of nitrogen oxides (NO_x) from diesel engines. Depending on the engine operating conditions, these systems divert 5-30% of an engine exhaust stream through a cooler then back to the combustion chamber. The percentage of exhaust gas recirculation is defined as volume of the EGR to total intake charge into the cylinder.

The optimization of the piston bowl and injector design may also bring significant improvements on NO_x and soot reduction. Piston bowl profile, injector nozzle diameter and angle, injector position on combustion chamber, and calibration variables (injection start, fuel mass, etc.) are some of the parameters that can be set for this purpose. NO and NO_2 together is called NO_x emissions. NO is formed during the post flame combustion process in a high temperature region. The principal source of NO formation is the oxidation of the nitrogen present in atmospheric air. The nitric oxide formation chain reactions are initiated by atomic oxygen, which forms from the dissociation of oxygen molecules at the high temperatures reached during the combustion process.

The world is presently confronted with the twin crises of fossil fuel depletion and environmental degradation. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground-based carbon resources. Alcohol fuels particularly ethanol can be produced by fermentation of

Bio mass crops, mainly sugar cane, wheat and wood. Usage of alcohols and liquefied petroleum gas as a fuel for spark ignition engines has some advantage to compare the gasoline. The engine thermal efficiency can be improved with increasing of compression ratio. Alcohols burns with lower flame temperatures and luminosity owing to decreasing the peak temperature inside the cylinder and hence the heat losses and NOx emissions are lower. The effect of ethanol gasoline blends on spark ignition engine performance and exhaust gas emissions at different compression ratios. In their study, test fuels were prepared using 99.9% pure ethanol and gasoline blend with the volumetric ratios of 0 to 30%. A comparative evaluation of the performance characteristics of a spark ignition engine using hydrogen and compressed natural gas as an alternative fuel. It has been observed in their study that the brake specific fuel consumption was reduced and the brake thermal efficiency improved with hydrogen operation compared to the system running on compressed natural gas. Using ethanol as a fuel additive to unleaded gasoline causes an improvement in engine performance and exhaust emissions. Investigated on a commercially available diesel engine so as to explore the possibility of working at the existing CR of 18:1 and optimizing the same. On the onset of investigation, it was perceived that increase in CR could have conflicting effects on the power output of the engine.

Magnus Christensen. *et al*, [1] (1999) studied that "Multi Fuel Capability of a Homogeneous Charge Compression Ignition Engine (HCCI) with Variable Compression Ratio". Their experiment was conducted with a constant air/fuel equivalence ratio (λ) of 3.0 Their test results show that almost any liquid fuel can be used in a HCCI engine using a variable compression ratio. Operation with pure n-heptane required a compression ratio of about 11:1 to get auto-ignition at TDC, without the use of inlet air preheating. The NOx emissions were generally very low. They did not increase much with increased fuel octane number and increased compression ratio.

Objectives

By studying the various literature there no one conducted the experiments on by varying the fuel injector position and fuel injection timing (crank position),so we estimated to achieve the following objectives

- Investigate the properties of biodiesel as well as blends of bio diesel with pure diesel.
- Experimental investigation of Variable Compression Ratio on VCR engine

EXPERIMENTAL SETUP AND METHODOLOGY

fig :1.Actual engine setup

The experiments are conducted on direct injection, single cylinder four stroke Kirloskar diesel engine. The layout of experimental test rig and its instrumentation is shown in Fig. 3.2. It is a water cooled engine with a rated power of 3.5 kW at 1500 rpm having bore 87.5mm and stroke 110mm,compression ratio of 17.5, injection pressure of 200 bar at 23obTDC injection time. It consists of a test bed, a diesel engine with an eddy current dynamometer, a computer with a software called engine soft, an AVL444 make (5-gas analyzer) exhaust gas analyzer, AVL437 make smoke meter, a pressure sensor to measure the cylinder pressure, TDC sensor records pressure for every two degrees of crank rotation, with which P-curve is plotted. The engine is connected to eddy current dynamometer. The eddy current dynamometer is mounted on base frame and connected to engine. The engine is subjected to different loads with the help of dynamometer. A rotameter is provided for engine cooling water flow measurement. A pipe in pipe type calorimeter is fitted at the exhaust gas outlet line of the engine.

The calorimeter cooling water flow is measured and adjusted by the rotameter. Temperature sensors are fitted at the inlet and outlet of the calorimeter for temperature measurement. The pump is provided for supplying water to eddy current dynamometer, engine cooling and calorimeter. A fuel tank is fitted inside control panel along with fuel measuring unit. An air box is powered for damping pulsation in air flow line. An orifice meter with manometer is fitted at the inlet of air box for flow measurement. Piezo-electric type sensor with water cooled adapter is fitted in cylinder head for combustion pressure measurement. This sensor is connected to an engine indicator fitted in control panel, which scans the pressure and crank-angle data is interfaced with computer through COM port. An encoder is a device, circuit, transducer, software program, algorithm that converts information from one format to another. Rotary encoder is an optical sensor used for speed and crank angle measurement. The sensor is mounted on dynamometer shaft and connected to engine indicator.

Thermocouple type temperature sensors measure cooling water inlet, outlet and exhaust temperatures. These temperatures are digitally indicated on indicator suited on control panel. Opacity meter and diesel smoke opacity meter is distributary sample type. It equips gas temperature pressure and distributor control cell in order to ensure metrical stability and repeat. It measures the whole burthen opacity smoke degree continuously and free speed up opacity smoke degree. The exhaust gas analyzer is used to measure the relative volumes of gaseous constituents in the exhaust gases of the engine. The engine used for this study is a single cylinder, four stroke, direct injection,

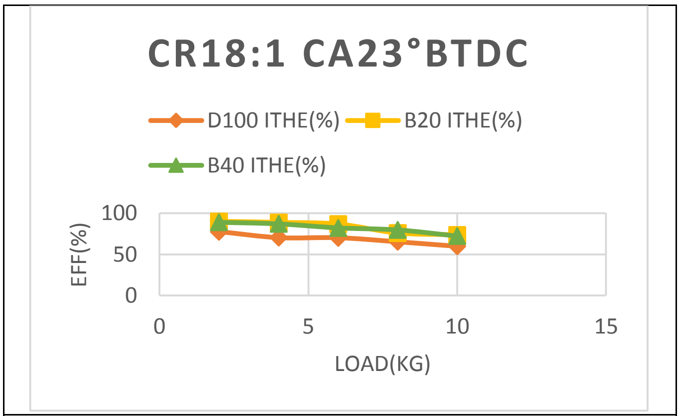

Fig:4.CR18:1 CA23°bTDC

water cooled, and diesel engine. The engine is coupled to an electrical generator through which load was applied. A fixed 200 bar injection pressure and 17.5 compression ratio are used throughout the experiments. Indicators on the test bed show the following quantities which are measured electrically: engine speed, brake power and various temperatures. The computer is interfaced with engine. The PCI 1050 IC card is connected to COM port of CPU. Engine soft is the software used to control the entire engine readings. It is lab view based software. The engine is tested at constant rated speed of 1500 rpm throughout its power range using B20, B40, and blends.

RESULTS AND CONCLUSION:

BTHE (%) For the compression ratio of 18:1 & crank angle 23° bTDC

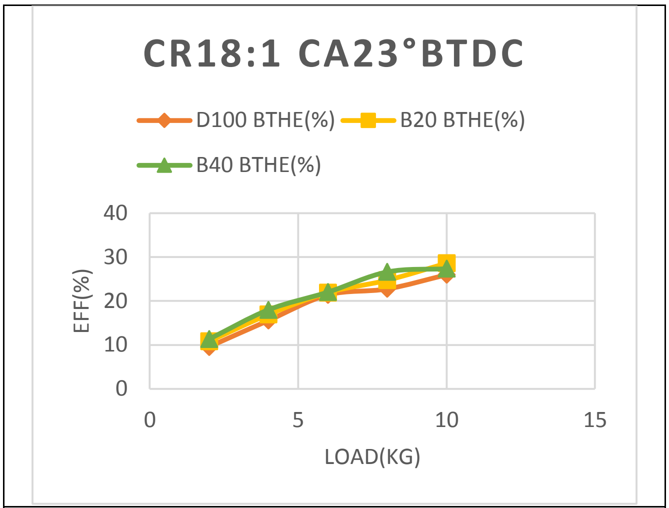

Fig.3. CR18:1 CA23°bTDC

Fig: 3.shows the effect of Crank Angle (CA) on brake thermal efficiency for different
Blends.

Initially at a load of 2kg BTHE for B20 and B40 is more as compared to D100.As we observed from the graph the load increases BTHE increases gradually up to certain limit. At load of 10kg the BTHE of B40 is decreases than B20.

ITHE (%) For the compression ratio of 18:1 & crank angle 23° bTDC

Fig.4.shows the effect of Crank Angle (CA) on indicated thermal efficiency for different
Blends.

Initially at a load of 2kg ITHE for B20 and B40 is more as compared to D100.As we observed from the graph the load increases ITHE decreases gradually up to certain limit. At load of 10kg the ITHE of B40 is decreases than B20.

BTHE (%) For the compression ratio of 16:1 & crank angle 23° bTDC

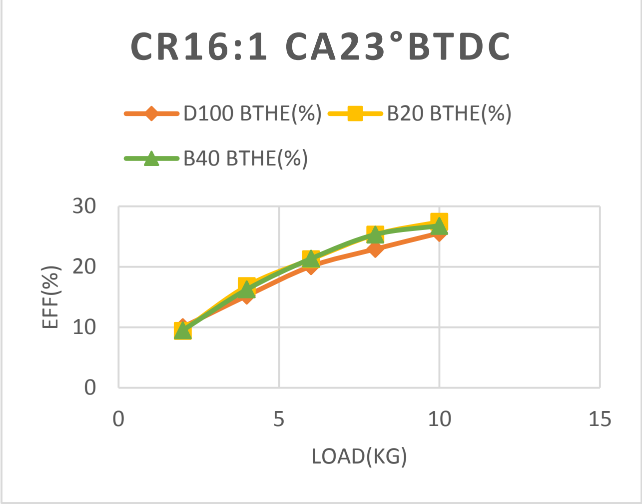

Fig.5.shows Load (kg) vs BTHE (%)

ITHE (%) For the compression ratio of 16:1 & crank angle 23° bTDC

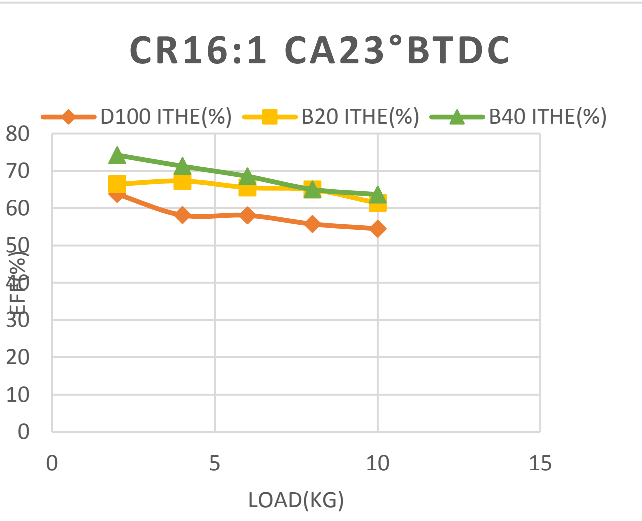

Fig.6.shows Load (kg) vs ITHE (%)

Fig.5&6.shows the effect of Crank Angle (CA) on Brake thermal efficiency & indicated thermal efficiency for different Blends.

Initially at a load of 2kg Brake thermal efficiency is low and is gradually increasing as the load increases, for the pure diesel BTHE is slightly lower as compared to the other blends and when the load is increases the peak of the graph is higher for the B20 and B40 is more as compared to D100. ITHE for B20 and B40 is more as compared to D100.As we observed from the graph the load increases ITHE decreases gradually up to certain limit. At load of 10kg the ITHE of B40 is decreases than B20 and they attain the same efficiency for the lower load conditions.

Conclusion:

Varying compression ratio follows almost similar results on engine running with diesel, blend of diesel and biodiesel & biodiesel. Increasing compression ratio until certain limits increases brake thermal efficiency decreasing brake specific fuel consumption & smoke-CO emissions. However, the results can vary with change in other parameters like injection pressure and injection timings also. Exhaust gas temperature increases with increase in compression ratio.

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