Experimental Study of Performance of VCR Diesel Engine Using CME & SBME Blends

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Abstract- **Fossil fuels play a vital role in rapid depletion of conventional energy reserves along with increasing demand and also major contributors of air pollutants. Major portion of today's energy demand in India is being met with fossil fuels. Hence it is high time that alternate fuels for engines should be derived from indigenous sources. As India is an agricultural country, there is a wide scope for the production of vegetable oils (both edible and non-edible) from different oil seeds. The main aim of the present experiment is to convert the vegetable oil to biodiesel by reducing viscosity close to that of conventional oil and to analyze the performance characteristics of a single cylinder, VCR diesel engine fuelled with cotton seed oil methyl esters and soya been seed oil methyl esters biodiesel blends. In the initial stage the tests are conducted on the four stroke single cylinder VCR diesel engine with constant speed by using diesel and base line data is generated by varying loads. In second stage, experimental investigation has been carried out on the same engine with same operating parameters by using the Ethyl Esters of Cotton seed oils in different proportions as CB10, CB20 and CB30, and to find out the performance parameters at different compression ratios of CR17 and CR21. Finally concluded that the bio fuels having the better performance than diesel in different aspects**

Index Terms- **Bio-Diesel, VCR Diesel Engine, Soya bean oil methyl esters, Cotton seed oil methyl esters.**

I. INTRODUCTION

In this modern world, almost all countries overly dependent on fossil fuels to meet their requirements. The requirements include power generation and developing the country in economical way. Rising prices of these fossil fuels and their potential shortages have raised uncertainties about the security of energy supply in future and increasing the use of fossil fuels causes serious environmental problems. Hence, there is a primary need to use some alternative sources. Some well-known alternative fuels are bio- alcohols, biodiesel, chemically stored electricity i.e. batteries and fuel cells, hydrogen, vegetable oil and other biomass sources. Bio-alcohols include methanol, ethanol, propanol, and butanol. Bio-butanol can be used directly in a gasoline engine and is often claimed as a direct replacement for gasoline. Ethanol and methanol are most commonly used biofuels worldwide. Rapid growth of industrialization and depleting resources of fossil fuels coupled with air pollution caused by exhaust gases emitted by diesel engines thereby causing global warming has necessitated the need for alternatefuel.

Alternative fuels are commonly known as nonconventional or advanced fuels which are derived from renewable bio-mass resources. It has strengthened the hands of the governments to promote sustainable development and ways to supplement conventional energy resources in meeting energy requirements of transportation fuels an India's vast rural population. In India, very little effort has been made towards research, development and production of bio fuels. Developing countries also view bio fuels as a potential means to stimulate rural development and create employment opportunities. Therefore, keeping in view farmer's interest and food security, efforts are being made to develop bio fuels based on non-food feed stocks in India as Indian economy is largely dependent upon agricultural produce and the feed stocks could be produced on wastelands which are otherwise not suitable for agricultural production, thereby avoiding a possible conflict of fuel vs. food security.

Some of the most researched bio fuels and having found use in quite a few European countries are: -Bio fuels -Biodiesel -Bio- alcohol (methanol, ethanol and butanol) Hydrogen, Non-fossil methane, propane and natural gas other biomass sources. Cotton seed has a similar structure to other oilseeds such as sunflower seed, having an oil-bearing kernel surrounded by a hard outer hull; in processing, the oil is extracted from the kernel. Cottonseed oil is used for salad oil, mayonnaise, salad dressing, and similar products because of its flavour stability. Once processed, cottonseed oil has a mild taste and appears generally clear with a light golden colour, the amount of colour depending on the amount of refining. It has a relatively high smoke point as a frying medium. Density ranges from 0.917 g/cm^3 to 0.933 g/cm^3. Like other long-chain fatty acid oils, cottonseed oil has a smoke point of about 450 °F (232 °C), and is high in to copherols, which also contribute its stability, giving products that contain it a long shelf life, hence manufacturers' proclivity to use it in packaged goods.

The present study covers the various aspects of biodiesels fuel derived from crude cotton and soya bean oil and performance emissions study on four stroke compression ignition engine with both the oils. Crude oil is converted to cotton and soya bean oil methyl esters by transesterification process. The obtained bio-diesel fuel properties are measured.

In the initial stage the tests are conducted on the four stroke single cylinder water cooled direct injection diesel engine with constant speed by using diesel and base line data is generated by varying loads with constant loads.

In second stage, experimental investigation has been carried out on the same engine with same operating parameters by using the cotton seed oil and after that soya bean oil of methyl esters are used in different proportions as B10, B20 and B30 to find out the performance and emission. The performance and emission parameters obtained by the above are compared with the base line data obtained earlier by using diesel and optimum blend is obtained.

II TRANSESTERIFICATION PROCESS

There are so many investigations on bio-diesel production of non-conventional feed stocks of oils have done in last few years. Overview of transesterification process to produce biodiesel was given for introductory purpose. It is reported that enzymes, alkalis, or acids can catalyse process. Alkalis result in fast process. It is mentioned that catalysed process is easy but supercritical method gives better result. Adaptation of the vegetable oil as a CI engine fuel can be done by four methods Pyrolysis, Micro emulsification, Dilution, and Transesterification. Out of these in this study transesterification process is used.

A successful transesterification reaction is signified by the separation of the ester and glycerol layer after the reaction time. The heavier, co-product, glycerol settles out and may be sold as it is or it may be purified for use in other industries, e.g. the pharmaceutical, cosmetics etc.

In this experiment first 250ml of Ethanol is take in conical flask .The amount of KOH required is determined by titration process by slowly adding of potassium hydroxide to ethanol. In this trill I observer 5.5grams of KOH is needed for every 250ml of ethanol. After this mixture is mixed with one litre of raw oil, are heated and maintained at 65-70^{0}C for 8hr, while the solution is continuously stirred. Two distinct layers are formed, the lower layer is glycerin and the upper layer is ester. The upper layer (ester) is separated and moisture is removed from the ester by using calcium chloride. It is observed that 90% ester can be obtained from vegetable oils.

The products of the reaction are the biodiesel itself and glycerol. The Flow chart of transesterification process of blends shown in figure below. Heating of esters is necessary after water washing to remove the water particles and exes ethanol present in the bio-fuel. The standards say it always absorbs some water from the atmosphere, 1,200ppm or more, but this is dissolved water, which is harmless, unlike suspended water, which must be removed. The bio-fuel is heated to a temperature of above the boiling point of water i.e., above 100ºC. At that temperature the water particles in the bio-fuel gets evaporated. After the heating process the pure bio-diesel can be obtained.

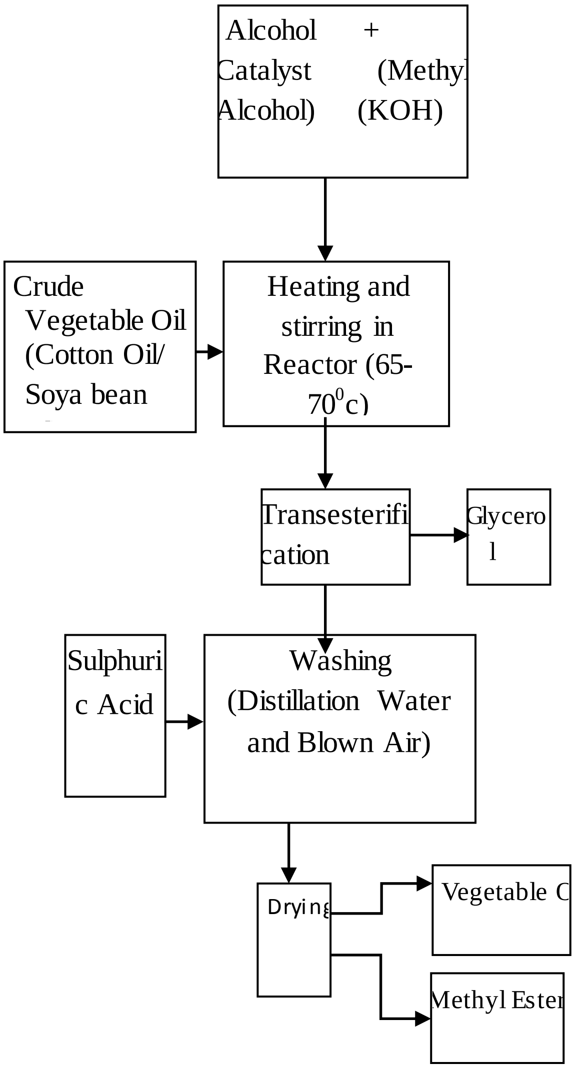

Fig.1 Flowchart of Transesterification Process

III EXPERIMENTAL SETUP

Using cotton seed oil methyl esters and soya bean oil methyl esters tests are to be conducting on different equipment's, to be found some of the fuel properties. Later performance tests were conducted on 4- stroke single cylinder water cooled VCR diesel engine with electrical loading.

A. VCR DIESEL ENGINE

The present project was carried out to investigate performance of single cylinder, VCR Diesel engine to compare it both Diesel fuel and Bio-Diesel. Technical specifications of the engine are given below. The engine was connected to Electrical generator. The engine was first operated on Diesel first and then on different types of produced Bio-Diesels. The different blends of different oils were subjected to performance tests on engine. The performance data were analysed form of graphs reading brake thermal efficiency, indicated power, specific fuel consumption, air fuel ratio, frictional power, speed v_s load and finalize which fuels are better performance.

Table.1: Specifications of VCR Diesel engine

Number of Strokes	4- Stroke
Fuel	Diesel
Made	Kiroloskar
Rated Power	5 HP
Cylinder bore & Stroke	80mm*110mm
Compression Ratio	13 to 30
Cylinder Capacity	553cc
Speed	1500rpm
Starting	Self starting
Load Type	Generator
Break Drum Diameter	0.2m
Type of cooling	Water cooled

B. EXPERIMENTAL SETUP

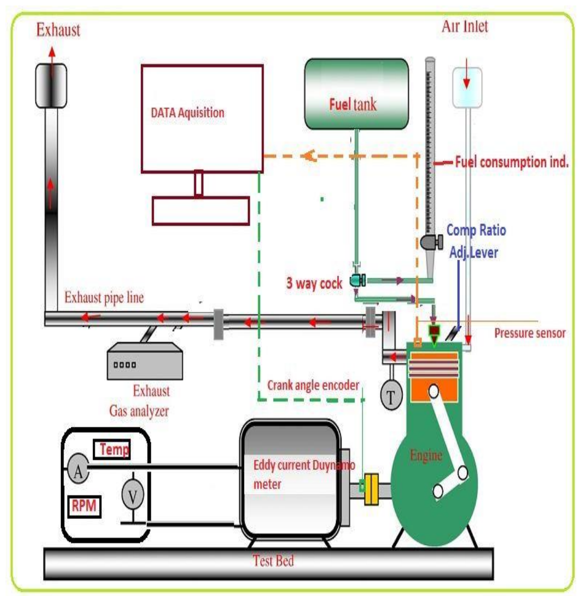

Fig.2: Experimental set up

IV RESULTS AND DISCUSSIONS

The experiments are conducted on the four stroke single cylinder water cooled variable compression diesel engine at constant speed (1500 rpm) with varying 0 to 100% loads with diesel and different blends of CSOME, SBOME like B10, B20 and B30.

The performance parameters such as brake thermal efficiency and brake specific fuel consumption were calculated from the observed parameters and shown in the graphs. The variation of performance parameters for diesel fuel, diesel-biodiesel blends are discussed in below.

A. *BRAKE THERMAL EFFICIENCY*

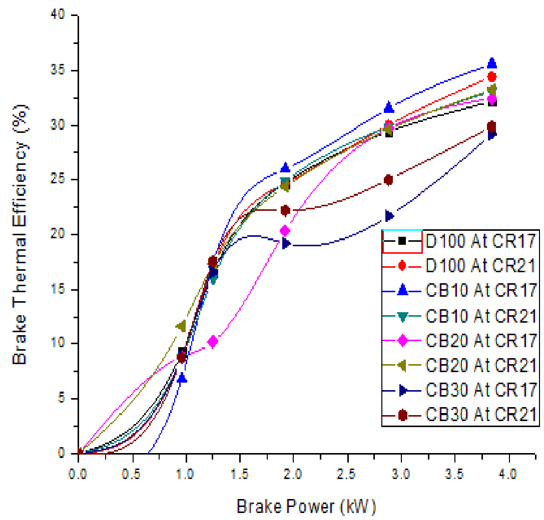

Fig: 2. Variation of Brake Thermal Efficiency with Diesel and CSOME Blends with different compression ratios

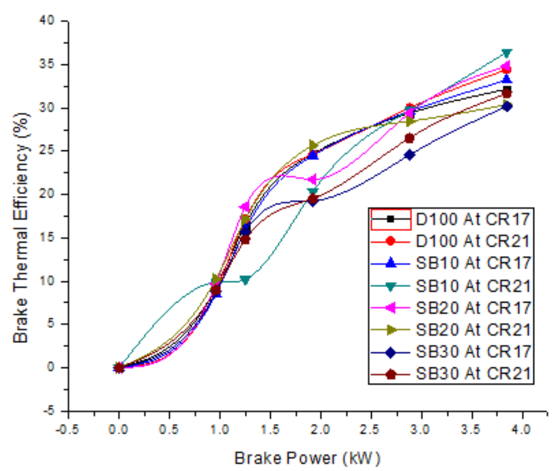

Fig:3. Variation of Brake Thermal Efficiency with Diesel and SBOME Blends with different compression ratios.

From the plot it is observed as the BP increases there is considerable increase in the BTE. The BTE of diesel at full load with compression ratio 17 is 32.16% and compression ratio at 21 is 34.14. For the blends of CB10 at compression ratio 17 is 35.59% and for compression ratio 21 is 33.1%. Among the blends maximum BTE is 35.59% which is obtained for CB10 at compression ratio 17. The BTE of CB10 is increases up to 9.63% as compared with diesel at full load condition. For soya bean oil methyl esters the value of BTE is 33.21% at CR17 and 36.43% at CR21. The BTE of SB10 is increases up to 9.14% as compared with diesel at full load condition.

B. *BRAKE SPECIFIC FUEL CONSUMPTION*

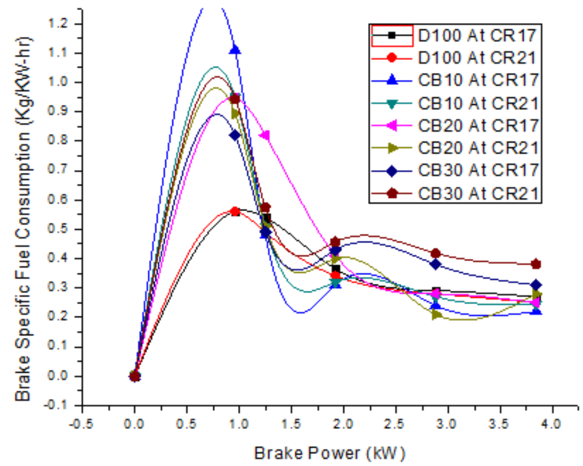

Fig.4: Variation of Brake specific fuel consumption with Brake Power using Diesel and CSOME Blends

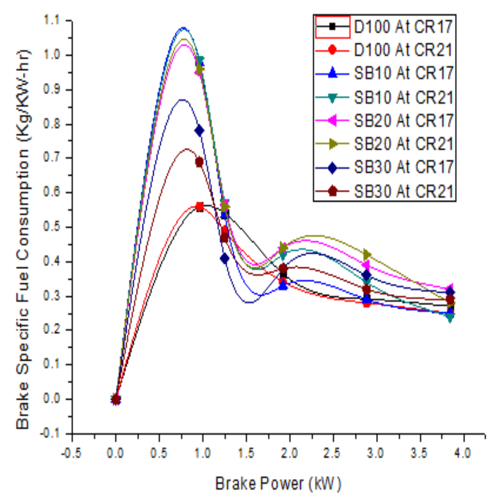

Fig.5: Variation of Brake specific fuel consumption with Brake Power using Diesel and SBOME Blends

At full load condition the BSFC obtained for diesel are 0.26 kg/kW-hr at CR17 and 0.243 kg/kW-hr at CR21. For CSOME10 at CR17 is 0.235 kg/kW-hr and 0.243 kg/kW-hr at CR21. For SBOME10 at CR17 is 0.25 kg/kW-hr, and 0.24 kg/kW-hr at CR21.

C. *AIR-FUEL RATIO*

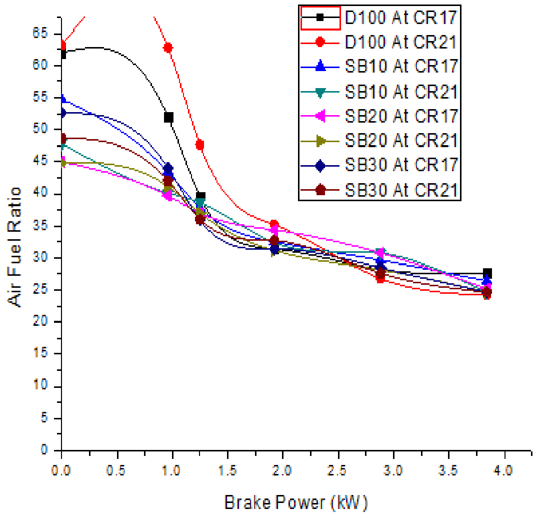

Fig.6: Variation of Air Fuel Ratio with Brake Power using Diesel and SBOME Blends

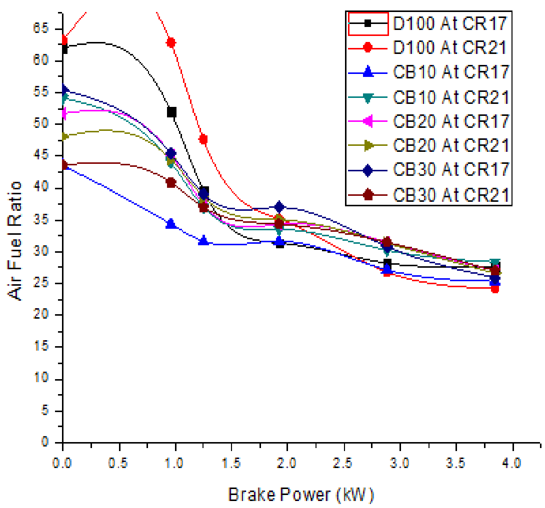

Fig.7: Variation of Air Fuel Ratio with Brake Power using Diesel and CSOME Blends

From the plots it is observed that A/F for diesel is 27.68 at CR17 and 24.2 at CR21, where as in case of CSOME10 is 25.33 at CR17 and 28.58 at CR21. From that it is observed decrease in A/F up to 8.48% at CR17 when compares with diesel at full load condition. In the same way for SBOME10 A/F is 24.6 at CR21, from that it is observed increase in A/F up to 1.6% at CR21 when compares with diesel at full load condition.

V. CONCLUSION

The conclusions of this investigation are compared with diesel base line data at full load as follows:

- The brake thermal efficiency increases with increase biodiesel percentage. Out of all the blends CB10 at CR17 and SB10 at CR21 show best performance parameters. The maximum brake thermal efficiency obtained is 35.59% with CB10 blend at CR17.
- The maximum brake thermal efficiency obtained is 36.43% with SB10 blend at CR21.
- The BTE of CB10 is increases up to 9.63% as compared with diesel at full load condition.
- The BTE of SB10 is increases up to 9.14% as compared with diesel at full load condition.
- Brake specific fuel consumption is decreases in blended fuels. In CSOME10 at CR17 (0.235 kg/kW-hr) fuel the BSFC is lower than the diesel (0.26 kg/kW-hr) in 9.61%.
- In SBOME10 at CR21 (0.24 kg/kW-hr) fuel the BSFC is lower than the diesel (0.234 kg/kW-hr) in 1.23%.
- Vegetable oils, based methyl esters (Biodiesel) can be directly used in Diesel engines without any engine modification.
- It is not advisable to use B100 in CI engines unless its properties are comparable with Diesel fuel.
- A/F for diesel is 27.68 at CR17 and 24.2 at CR21, where as in case of CSOME10 is 25.33 at CR17 and 28.58 at CR21. From that it is observed decrease in A/F up to 8.48% at CR17 when compares with diesel at full load condition.
- In the same way for SBOME10 A/F is 24.6 at CR21, from that it is observed increase in A/F up to 1.6% at CR21 when compares with diesel at full load condition.

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