PERFORMANCE AND EMISSION ANALSYS OF VCR DIESEL ENGINE FUELED WITH LEMONGRASS AND TAMARIND SEED BIODIESEL

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Abstract : Growing environmental awareness and increase in fuel prices, it has become the need of the hour to consider alternate energy and fuel source. Biodiesel fuel is the alternative which is becoming more and more popular today, because bio-diesel is a cleaner burning diesel fuel, made from 100% natural, 100% renewable resources. It can mix with mineral oil and used in standard diesel engine with minor or modifications. The present study covers the various aspects of biodiesels fuel derived from crude lemongrass and tamarind seed oils and ignition improver 20ml showed best performances increase in brake thermal efficiency, decrease in BSFC (Break Specific Fuel Consumption) and reductions in emissions CO and HC. The engine performance and emissions has justified the potentiality of the lemongrass and tamarind seed oils as alternative fuel for compression ignition engine fuel.

***IndexTerms* - Biodiesel, crude lemongrass, tamarind seed oils, BSFC**

I. INTRODUCTION

Energy is key input for technological, industrial, social and economical development of a nation. Five generations (125 years) ago, wood supplied up to 90%of our energy needs. Due to the convenience and low prices of fossil fuels wood use has fallen globally. The present energy scenario now is heavily biased towards the conventional energy sources such as petroleum products, coal, atomic energy etc., which are finite in nature besides causing environmental pollution. Of the available energy, the present energy utilization pattern is heavily biased for meeting the high energy requirement in urban and metropolitan cities. The extensive use of energy operated devices in domestic, industrial, transport and agricultural sectors in urban and rural areas have resulted in overall economic development of the society. The electricity available for farming operations and in rural and urban areas is been generated using the fossil and static energy resources such as petroleum oil, coal and atomic energy and to a limited extent by hydropower. These all sources have a great influence on our economy and environmental aspects. These have resulted in serious considerations for the use and availability of various energy resources.

2. LITERATURE REVIEW:

DhanaRaju .v and P.S. Kishore (2018) [1].Their experimental investigation focused on tamarind seed methyl ester (TSME) biodiesel blend with addition of Dimethyl carbonate (DMC) and 1-Pentanol as oxygenated fuel additives to investigate the performance, combustion and emission characteristics .Tests were conducted on single cylinder diesel engine operating at varying load conditions for the fuels of Diesel , TSME20 and K. Yamini, V. Dhana Raju and P.S. Kishore (2017) [2].The increasing industrialization and motorization there is a scarcity of petroleum products. So, there is a need for suitable alternative fuels for diesel engines. In the present study, Tamarind seed oil methyl esters (TSOME) were prepared through Transesterification process and the properties of oil were found within acceptable limits. K.SolomonBinu, S. Prabhakar, S.AshfAque Ahmed and C. JagdeeshVikram (2013) [3].Due to the concern on the availability of recoverable fossil fuel reserves and the environmental problems caused by the use of those fossil fuels, considerable attention has been given to biodiesel production as an alternative to Petro diesel. P. Brijesh and S. Sreedhara (2013) [4]. Extensive usage of automobiles has certain disadvantages and one of them is its negative effect on environment. Carbon dioxide(CO_2),Carbon monoxide (CO), Hydrocarbons (HC) ,Oxides of Nitrogen (NO), Sulphur dioxide (S02) and particulate matter (PM) come out as harmful products during incomplete combustion from internal combustion (IC) engines. S. Savariraj, and T. Ganapathy (2011) [5].Biodiesel derived from nonedible feed stocks such as Mustard, Jatropha, Pongamia are reported to be feasible choices for developing countries including India. S.S Ragit, Sk. Mohapatra, K. Kundu and P. Gill (2011) [6].The biodiesel produced from selected non-edible oils are prepared by a method of alkaline catalysed transesterification. Esters of non-edible vegetable oils. The study is carried out to investigate the performance and emission characteristics of selected fuel in a stationary single cylinder, four stroke, naturally aspirated direct injection diesel engine and compare it with mineral diesel. P V Rao, Stephen Clark, Richard Brown, Kai-Sten Wu (2015)[7]. Biodiesel is a renewable fuel that has been shown to reduce many exhaust emissions except oxides of nitrogen (NOx) in diesel engine cars. This is of special concern in inner urban areas that are subject to strict environmental regulations. Also the use of pure biodiesel (B100)is inhibited because of its higher NOx emissions compared to petroleum diesel fuel. Poonam Singh Nigam, Anoop Singh (2011) [8]. Renewable bio-resources are available globally in the form of residual agricultural biomass and wastes, which can be transformed into liquid biofuels. However, the process of conversion, or chemical transformation, could every expensive and not worthwhile to use for an economical large-scale commercial supply of biofuels.

3. EXPERIMENTAL WORK:

Using lemongrass and tamarind seed oils tests are to be conducting on different equipment's, to be found some of the fuel properties. Later performance and emission tests were conducted on 4- stroke single cylinder water cooled diesel engine coupled with a rope brake dynamometer, with the help of Smoke meter and multigap analyzer.

3.2 Fuel propertymeasurement

The improvement in the performance of the CI engines, over the past century, has resulted from the complimentary refinement of the engine design and fuel properties. Calculate the fuel properties like flash point, fire point, specific gravity, calorific value for different oils for different blends using the suitable equipment.

3.2.1 Some of the fuel properties include

I. Flash point
II. Fire point
III. Specific gravity
IV. Calorific value

3.3 Flashand Firepointtest

A key property for determining the flammability of fuel is the flash point. The flash point is the lowest temperature at which an applied ignition source causes the vapors of sample to ignite. The fire point is sometimes used to designate the fuel temperature producing sufficient vapor to maintain a continuous flame. The fire point is the minimum temperature to which it must be heated so that vapors burn at least 5 seconds. The two parameters have a great importance while determining the fire hazards.

3.3.1 Mechanism

Every flammable liquid has a vapour pressure, which is a function of that liquid's temperature. As the temperature increases, the vapour pressure increases. As the vapour pressure increases, the concentration of evaporated flammable liquid in the air increases. Hence it is that temperature, which determines the concentration of evaporated flammable liquid in the air under equilibrium conditions. Different flammable liquids require different concentrations of the fuel in air to sustain combustion. The flash point is that minimum temperature at which there is a sufficient concentration of evaporated fuel in the air for combustion to propagate after an ignition source has been introduced.

Flame exposure device:

The lid is equipped with a brass shutter operating on the plane of the upper surface of the cover proper. The shutter is so shaped and mounted on the lid that, when it is in one position, the holes are completely closed and when in the other these orifices are completely opened. Flash and fire point are obtained by using pen sky test. The apparatus consists of a brass cup and cover fitted with shutter mechanism without shutter mechanism (open cup), test flame arrangement, hand stirrer (closed cup), thermometer socket etc., heated with energy regulator, a thermometer socket made of copper.

Cleveland Apparatus

Specific Gravity test

Specific Gravity test

Specific gravity is the relative measure of the density of a substance. It is defined as the ratio of the density of the substance, ρ, to a reference density. With the help of digital balance to find out specific gravity it is shown in fig 4.2. The specific gravity of conventional diesel fuel is about 0.830.

Calorific Value

The calorific value of a fuel is the thermal energy released per unit quantity of fuel when the fuel is burned completely, and the products of combustion are cooled back to the initial temperature of the combustible mixture. It measures the energy content in a fuel. This is an important property of biodiesel that determines the suitability of the material as alternative to diesel fuels.

A bomb calorimeter will measure the amount of heat generated when matter is burnt in a sealed chamber (Bomb) in an atmosphere of pure oxygen gas. A known amount of the sample of fuel is burnt in the sealed bomb, the air in the bomb being replaced by pure oxygen under pressure. The sample is ignited electrically. As the sample burns heat is produced and rises in the temperature. Since the amount of heat produced by burning the sample must be equal to the amount of heat absorbed by the calorimeter assembly and rise in temperature enables the determination of heat of the combustion of the sample. Bomb calorimeter experimental setup shown in fig 3.3.

If W = Water equivalent of the calorimeter in calories per degree centigrade
T = Rise in temperature (registered by a sensitive thermometer) in degrees centigrade.
H = Heat of combustion of material in calories per gram.
M = Mass of sample burnt in grams.

$$W \times T = H \times M$$

Bomb Calorimeter

Preparation of Blends with Diesel

The obtained Bio- Diesel is blended for conducting the performance test, the Bio- Diesel is mixed in proper proportions.

1. The Bio- Diesel is first filtered form impurities
2. Required amount of fuel and Bio- Diesel is taken into the measuring jar and mixed thoroughly the amount of proportions shown in table 3.1.
3. Obtained lemongrass and tamarind seed fuel properties are find out and these values are tabulated in tables 3.2 to 3.3.

Notation Fuel	Quantity	Bio-Diesel Quantity	Diesel Quantity
Blend 1	1Litre Fuel	100 ml	900 ml
Blend 2	1Litre Fuel	200 ml	800 ml
Blend 3	1Litre Fuel	300 ml	700 ml
D100	1Litre Fuel	0 ml	1000 ml

Table: 1 Blending Percentage of Fuel

Blend B1 **Blend B2** **Blend B3**

Properties of various fuels at room temperature:

Property	Diesel	Lemon Grass Oil	Tamarind Seed Oil
Specific Gravity	0.826	0.902	0.896
Calorific Value	42531	36270	37490
Density	826	902	896
Flash Point	56	98	87
Fire Point	63	105	93

Table. various properties at room temperature

Diesel Engine

Experimental set up consists of a water-cooled single cylinder vertical diesel engine coupled to a rope pulley brake arrangement it shown in plate 4.6, to absorb the power produced necessary weights and spring balances are induced to apply load on the brake drum suitable cooling water arrangement for the brake drum is provided. A fuel measuring system consists of a fuel tank mounted on a stand, burette and a three-way cock. Air consumption is measured by using a mild steel tank which is fitted with an orifice and a U-tube water manometer that measures the pressures inside the tank. For measuring the emissions, the gas analyzer is connected to the exhaust flow.

3.8 Description

This is a water-cooled single cylinder vertical diesel engine is coupled to a rope pulley brake arrangement to absorb the power produced necessary weights and spring balances are induced to apply load on the brake drum suitable cooling water arrangement for the brake drum is provided. Separate cooling water lines are provided for measuring temperature. A fuel measuring system consists of a fuel tank mounted on a stand, burette and a three-way cock. Air consumption is measured by using a mild steel tank which is fitted with an orifice and a U-tube water manometer that measures the pressures inside the tank. Also, digital temperature indicator with selector switch for temperature measurement and a digital rpm indicator for speed measurement are provided on the panel board. A governor is provided to maintain the constant speed. For measuring the emissions, the gas analyzer is connected to the exhaust flow.

Procedure

Note down engine specifications and ambient temperature.

1. Calculate full load (W) that can be applied on the engine using engine specifications.
2. Clean the fuel filter and remove the air lock.
3. Check for fuel, lubricating oil and cooling water supply.
4. Start the engine using decompression lever ensuring that no load on the engine and supply the cooling water
5. Allow the engine for 10 minutes on no load to get stabilization.
6. Note down the total dead weight, spring balance reading, speed, time taken for20cc of fuel consumption and the manometer readings.
7. Repeat the above step for different loads up to full load.
8. Allow the engine to stabilize on every load change and then take the readings.
9. Before stopping the engine remove the loads and make the engine stabilized.
10. Stop the engine pulling the governor lever towards the engine cranking side.

Check that there is no load on engine while stopping.

Gas Analyzer

Netel's smoke meter Model NPM-SM-111B has been designed and developed to get an accurate reading of diesel engine smoke emissions, like smoke density(HSU), absorption co-efficient (K) obtain.

3.9.2 Operating principle

Nettle's smoke meter model NPM-DSM is based on the principle of absorption/obstruction of light, whish's indicative of the quality of smoke in an exhaust gas sample. A Green LED, driven by a pulsating constant current source, emits a light beam having peak spectral Intensity between 550 to 570 nm wavelength. The beam passes through a smoke cell and onto a silicon photo detector which continuously senses the intensity of light incident on it, and Converts it into an electrical signal, which is further processed by precise signal handling circuits. This all-solid-state design ensures high stability. The output of this stage is given to a Microprocessor for further processing and to convert it into suitable units including Percentage opacity or light absorption coefficient (K). Smoke sampling is of partial flow Type, adjusted by a control valve. Smoke is measured in a smoke cell that has an effective Length of 0.4 meter.


Gas Analyzer **four stroke diesel engine** **Computerized diesel test rig**

4. Results and discussion:

The experiments are conducted on the four-stroke single cylinder water-cooled diesel engine at constant speed (1500 rpm) with varying 0 to100%loads with diesel and different blends of lemongrass and tamarind seed oils like B1, B2, B3,and 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 other emissions parameters such as exhaust gas emissions such as Carbon monoxide, hydrocarbons, and carbon dioxide, unused oxygen and smoke were represented in the form of graphs from the measured values.

The performance and emission characteristics of conventional diesel, and biodiesel blends were investigated on a computerized diesel engine VCR single cylinder diesel engine. The discussions of this investigation are as follows:

The brake thermal efficiency increases with increase biodiesel percentage. Out of all these, B2 at compression ratio17.5 shows best performance.

1) The maximum brake thermal efficiency obtained is 24.9% in B2 blend. the maximum thermal efficiency of diesel is 20.19%. Thermal efficiency of B2 more compare to diesel.
2) The maximum Mechanical efficiency obtained is 72.21% in B2 blend. the maximum thermal efficiency of diesel is 71.29%. Mechanical efficiency of B2 is more comparing to diesel.
3) The Percentage of carbon monoxide emissions are lesser in Blend 2 as compare to diesel. The CO of diesel is 0.002% and Co of B2 is 0.111 at maximum load condition.
4) Since B2 blend reduces the environmental pollution without much loss in thermal efficiency when compared with diesel it will be a promising renewable energy source for sustaining the energy.

Performance and Emissions curves:

For Diesel:

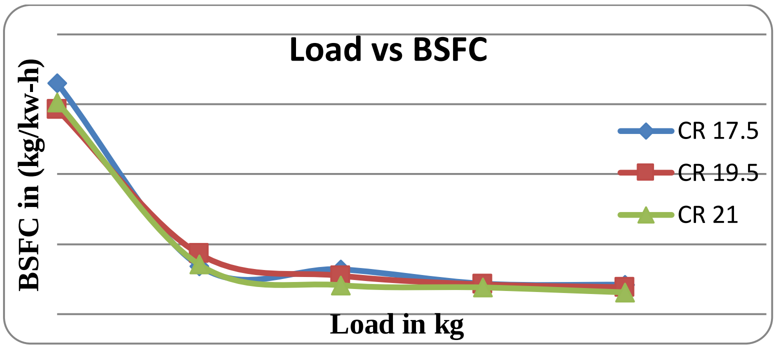

Fig. 1 Variation of Brake Specific Fuel Consumption with load

The graph is plotted between BSFC(Break specific fuel consumption) and load.The graph shows best performance at no load and full load conditions for diesel at compression ratios 19.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 21.

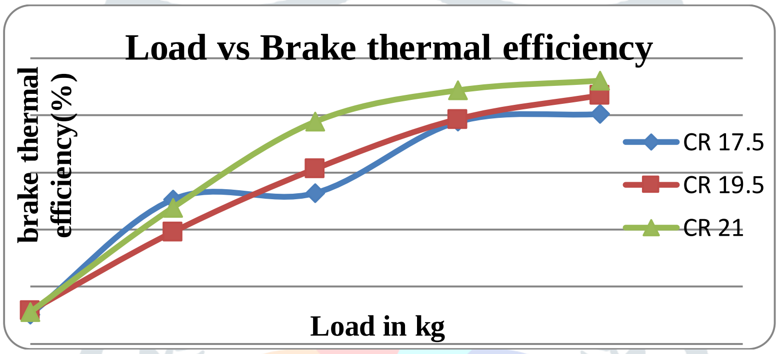

Fig.2 Variation of Brake thermal efficiency with load

The graph is plotted between Break thermal efficiency and load. This graph shows the best performance at no load and full load conditions for diesel at compression ratios 19.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 21.

The graph is plotted between Hydro carbons(HC) and load. The graph shows best performance at no load condition and full load condition for diesel at compression ratios 19.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 21.

FOR BLEND B1:

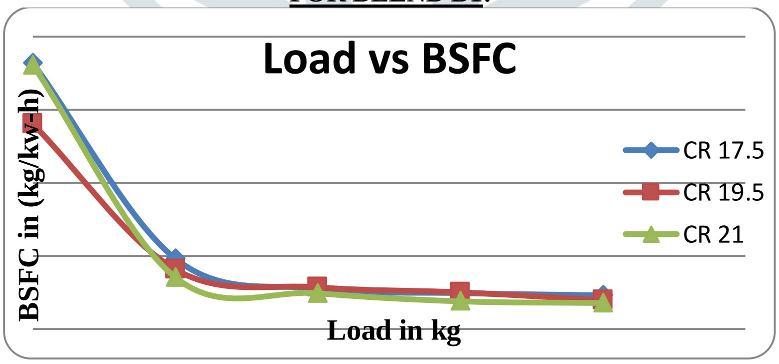

Fig. Variation of Brake Specific Fuel Consumption with load

The graph is plotted between BSFC(Break specific fuel consumption) and load. The graph shows best performance at no load and full load conditions for Blend B1 at compression ratios 17.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 21.

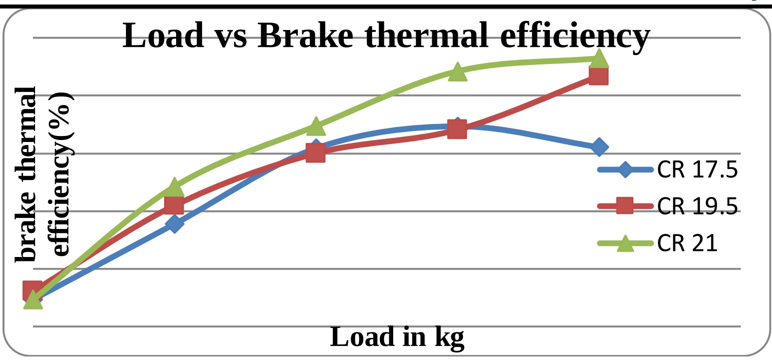

Fig. 5.9 Variation of Brake thermal efficiency with load

The graph is plotted between Break thermal efficiency and load. This graph shows the best performance at no load and full load conditions for Blend B1 at compression ratios 17.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 21.

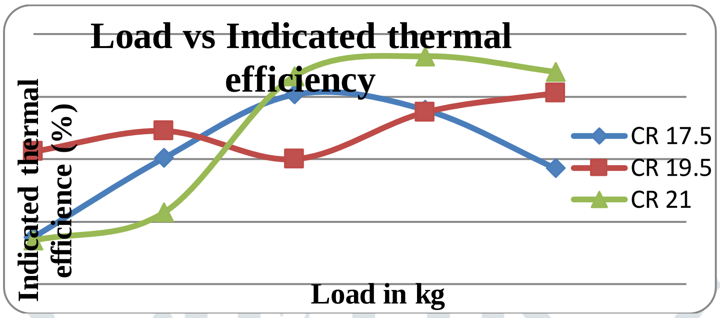

Fig. 5.10 Variation of indicated thermal efficiency with load

For Blend B2:

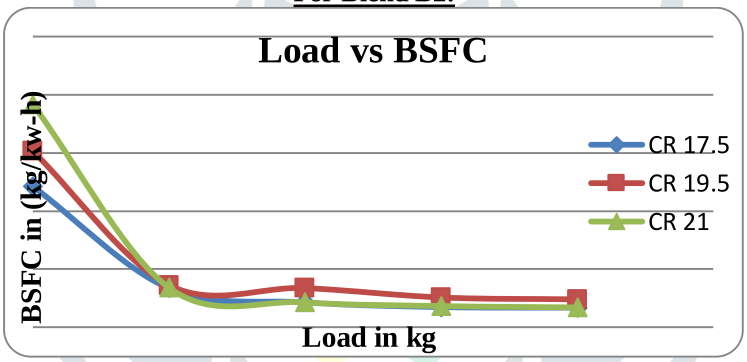

Fig. 5.15 Variation of Brake Specific Fuel Consumption with load

The graph is plotted between BSFC(Break specific fuel consumption) and load. The graph shows best performance at no load and full load conditions for Blend B2 at compression ratios 17.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 17.5.

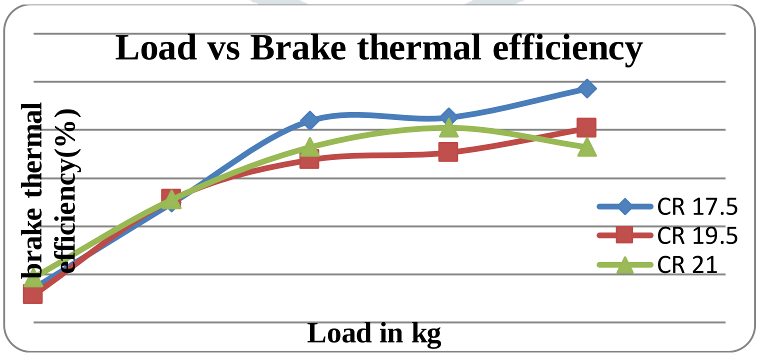

Fig. 5.16 Variation of Brake thermal efficiency with load

The graph is plotted between Break thermal efficiency and load. This graph shows the best performance at no load and full load conditions for Blend B2 at compression ratios17.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 17.5.

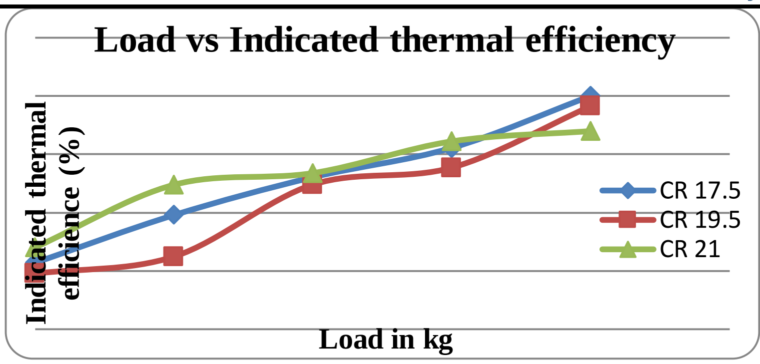

Fig. 5.17 Variation of indicated thermal efficiency with load

The graph is plotted between Indicated thermal efficiency and load. The graph shows the best performance at no load condition and full load condition for Blend B2 at compression ratio 17.5 and 21.By comparing both compression ratios the engine give best performance at compression ratio 17.5.

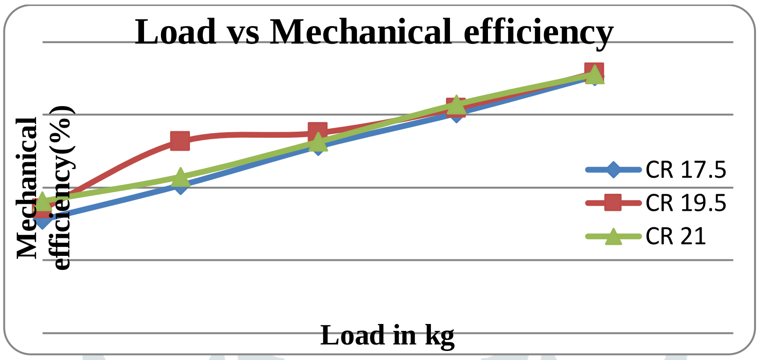

Fig. 5.18 Variation of Mechanical efficiency with load

The graph is plotted between Mechanical efficiency and load. The graph shows best performance at no load condition and full load condition for Blend B2 at compression ratio 17.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 17.5.

For Blend B3:

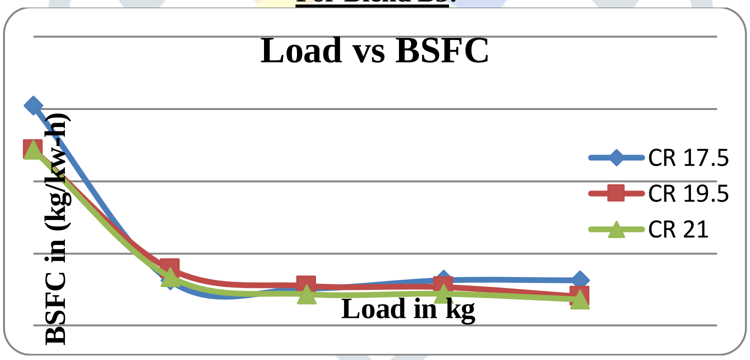

Fig. 5.22 Variation of Brake Specific Fuel Consumption with load

The graph is plotted between BSFC(Break specific fuel consumption) and load. The graph shows best performance at no load and full load conditions for Blend B3 at compression ratios 19.5 and 21. By comparing both compression ratios the engine give best performance at compression ratio 21.

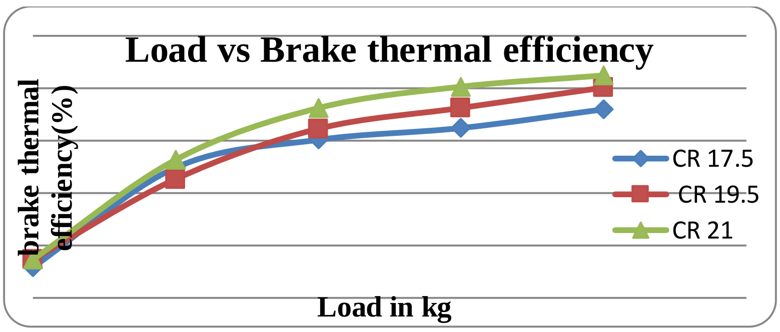

Fig. 5.23 Variation of Brake thermal efficiency with load

5. CONCLUSION

In this investigation experiments were conducted on four stroke single cylinder water cooled diesel engine at constant speed using biofuel blends and wedetermine that how an engine will operate with an alternative fuel.

The following points were observed in the usage of Alternative fuels:

1. The physical and chemical properties of crude seed oil not suitable to used directly as CI engine fuel due to higher viscosity and density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion and carbon deposition combustion chamber.
2. For this reason's crude lemon grass and tamarind seed oil is converted to tamarind seed oil of methyl esters by transesterification process. Transesterification process is a method to reduce viscosity of crude tamarind seed oil with low production cost.
3. In order to achieve maximum yield of tamarind seed and lemongrass oils, transesterification of crude oil of this species was carried out at 65-70^{0}C. It is observed base catalyst performs better results than acid catalyst.
4. The fuel properties of obtained tamarind seed and lemon grass oil, that is specific gravity, flashpoint, fire point, calorific value and carbon residue of biodiesel were tested.
5. Results obtained in this work show that biodiesel obtained from tamarind seed and lemon grass oils has properties close to diesel. Therefore, it can be used as a substitute for diesel oil. The lemon grass oil has the advantage that it is a non-polluting source of energy; hence, it can help in reducing the emission of greenhouse gases and other emissions that are toxic and cacogenic.

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