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Reduction Of Bio Diesel Emissions By Injection Advance In VCR Engine

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Emissions

Abstract

Biodiesel in present trend is important due to depletion of non-renewable resources. The shortage of fossil fuels brings usage of bio diesel into limelight. Therefore usage of bio diesel is preferred than usage of conventional diesel as the properties of both are almost same. A lot of research has undergone on bio diesel and doesn't show any significant variation in emissions compared to conventional diesel. Due to high emissions of harmful gases global warming increases which is not preferable. In this paper Flax seed is used for bio diesel preparation which is abundantly available in mountainous areas and cooler regions. Flax seed commonly known as lin seed has binomial name Linum usitatissium. In this process the oil is transesterified using methanol to produce methyl esters in presence of base catalyst. Methanol is mixed with flax seed oil in the ratio 1:5 and 0.5 to 5% base catalyst is added. This mixture is constantly stirred at 55°C.

Due to high viscosity it is difficult for biodiesel to mix with air in the combustion chamber and results in increase of emissions . As the fuel injection is advanced by change in crank angle up to certain extent in a VCR engine, the time available for mixing fuel with air is increased ensuring increased mixing of fuel with air, and By increasing the compression ratio the pressure in combustion chamber increases which helps high viscous fuel to mix completely, due to high temperature because of the high pressure in the combustion chamber the combustion characteristics of charge increased results in lowering the engine emissions. The above tests were conducted using conventional diesel, and different proportions of blends of bio diesel and results were compared by varying crank angle and compression ratios.

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1. Introduction

Biodiesel, "The mono alkyl esters of long chain fatty acids derived from renewable lipid feedstock, such as vegetable oils or animal fats for use in compression ignition (diesel) engines", is made by Transesterification of linseed oil.

The trend of Biodiesel is being practiced all over the globe. In most European countries the production of Biodiesel is from sunflower and rapeseed whereas in USA it is produced from soybean. Thailand uses palm oil as a raw material for the production of Biodiesel, while Ireland uses frying and animal fats. India is facing a shortage of edible oil in not meeting the demand.

Fuel injection pressures in diesel engine plays an important role for engine performance treatment of combustion. The present diesel engines such as fuel direct injection, the pressures can be increased to about 100 – 210 bars in fuel pump injection system. Experiments were conducted to assess effects of fuel injection pressure on engine performance. Naga Sarada et al concluded that the best performance of the pressure injection can be obtained at 220 bars, specific fuel consumption has been obtained at 200 bars for fixed load - variable speeds and at 180 bars for variable loads – fixed speed .

The major problem with the direct use of vegetable oils as fuel into CI engines is their higher viscosity. This property in vegetable oils can be overcome by techniques such as heating of fuel lines, transesterification, modification of injection system etc. Tests were conducted with cotton seed oil and diesel. To improve the combustion characteristics of cotton seed oil in an unmodified engine, effect of increase in injection pressure was studied. When the injection pressure was increased from 180 bars to 240 bars (in steps of 15 bar), the investigation revealed that the optimum pressure for cottonseed oil as 210 bars. Performance comparison of the engine was studied in terms of brake specific fuel consumption, brake thermal efficiency, indicated thermal efficiency, mechanical efficiency and exhaust emissions. Suryawanshi et al. examine the effects of steam injection into the intake manifold of a single cylinder, low speed, and direct injection diesel engine fuelled with biodiesel palm methylester. Nurun Nabi et al. studied the blends of varying proportions of Honge Oil Methyl Ester and diesel to run a double cylinder CI engine and observed significant improvements in engine performance and emission characteristics. The thermal efficiency of the engine was improved, and emission of smoke was reduced. Sippy Kalra Chauhan showed that biodiesel gives almost similar thermal efficiency, lower carbon monoxide (CO) and particulate matter (PM) while slightly higher nitrogen oxide (NOx) emission was experienced when compared with neat diesel fuel . The advantage of biodiesel over gasoline and petroleum/diesel is its eco-friendly nature. This article reviews the production, characterization and current status of bio-fuels mainly biodiesel along with the environmental impacts of particulate matter, greenhouse gas emissions originated from biodiesel . Roman et al. suggested that biodiesel with high levels of methyl oleate will have excellent, if not optimal, characteristics with regard to ignition quality, NOx emissions and fuel stability. Additionally, it has been estimated that biodiesel fuels with an average of 1.5 double bonds per molecule will produce an equivalent amount of NOx to conventional diesel, thus a fuel high in oleates (one double bond per molecule) should not result in higher Nox emissions .

ESTERIFICATION:

Linseeds and the production of biodiesel (methyl ester) by transesterification is shown. First oil is produced by using the press machine squeezing the Linseed. Normally there are different kinds of production of oil from their seeds. The oil produced by this mechanism has some residues remained with it, and then it requires some filtration using filter. Therefore the oil has been filtered. The following steps are required to prepare biodiesel from raw oil:

A. Acid treatment followed by settling process
B. Base treatment followed by settling process
C. Water washing
D. Dehydration

A. Acid treatment:

Raw oil is heated up to 60 0 C and 100ml methanol and 2-3 ml of sulphuric acid is added. Settling is carried out in decanter for 3 Hrs. Pulp is separated from the oil. It gives the raw oil heating.

B. Base treatment

Base treatment is carried out at 60 0 C. In this process a mixture of methanol and sodium hydroxide (Sodium methoxide) is added to the acid treated oil. . For the preparation of the potassium methoxide, 250 ml methanol is used to dissolve 6-7.5 grams of potassium hydroxide pellets. It is an exothermic reaction. Separation of biodiesel and glycerol takes place by gravity. The black part is glycerol in the separation funnel. Settling is carried out in the decanter for 6 Hrs and the settled glycerol will be drained out.

C. Water washing:

The base treated oil is washed with the distilled water bye circulating of air by air motor. Wash the oil till the oil and water are clear.

D. Dehydration process:

Dehydration is carried out at 100 0 C and the biodiesel is obtained.

Blending:

The blends of varying proportion of cotton seed, coconut oils and diesel were prepared, analyzed and compared with diesel fuel. From properties and engine test result it can be established that two oils can be substituted for diesel without any engine modification and without preheating of the blends. The various blends are 25% alternative oil and 75% diesel, 75% alternative oil and 25% diesel, 50% alternative oil and diesel 50% pure alternative oil.

2. Research Method

As per the authors knowledge the use of Flax Seed methyl ester (CIME) at full load conditions by varying compression ratio and crank angle is not reported in literature. The objective of the present work is to study through the experiments on the performance and the emission characteristics of CIME at various compression ratios and crank angles.

The various components of experimental set up are described below. The important components of the system are (i) The engine (ii) Dynamometer (iii)Smoke meter (iv)Exhaust gas analyzer

The Engine: The Engine chosen to carry out experimentation is a single cylinder, four stroke, vertical, water cooled, direct injection computerized Kirloskar make CI Engine. This engine can withstand higher pressures encountered and also is used extensively in agriculture and industrial sectors. Therefore this 14 engine is selected for carrying experiments.

Dynamometer: The engine has a DC electrical dynamometer to measure its output. The dynamometer is calibrated statistically before use. The dynamometer is reversible i.e., it works as monitoring as well as an absorbing device. Load is controlled by changing the field current. Eddy-Current Dynamometer's theory is based on Eddy-Current (Fleming's right hand law). The construction of eddy-current dynamometer has a notched disc(rotor) which is driven by a prime mover(such as engine, etc.) and magnetic poles(stators) are located outside with a gap. The coil which excites the magnetic pole is wound in circumferential direction. When current runs through exciting coil, a magnetic flux loop is formed around the exciting coil through stators and a rotor. The rotation of rotor produces density difference, and then eddy current goes to stator. The electromagnetic force is applied opposite to the rotational direction by the product of this eddy-current.

Exhaust Gas Analyzer: All emissions like Carbon monoxide, Carbon dioxide, Un-Burnt Hydrocarbons, Nitrogen oxide and unused oxygen are found in 5 gas emission analyzer of model "5G -10 , PLANET EQUIPMENT" is used. In this cable one end is connected to the inlet of the analyzer and the other end is connected at the end of the exhaust gas outlet. Continuous charging of the analyzer is essential to work in an effective way. The measuring method is based on the principle of light absorption in the infrared region, known as "non-dispersive infrared absorption". The broadband infrared radiation produced by the light source passes through a chamber filled with gas, generally methane or carbon dioxide. This gas absorbs radiation of a known wavelength and this absorption is a measure of the concentration of the gas. There is a narrow bandwidth optical filter at 16 the end of the chamber to remove all other wavelengths before it is measured with a pyro-electric detector.

ENGINE SETUP:

Flash And Fire Point:

Flash and fire point of the bio-diesel is determined by using cleaveland open cup apparatus. Fill the cup with the bio diesel and apply heat initially to cup at right angles and a thermometer is placed for temperature measurement. Whenever the flash originates for a fraction of second and stops that temperature at that instant is called flash point and fire arises called as fire point. Flash Point: 185^0C

ENGINE SPECIFICATIONS:

S.No	Description	Specification
1	No. of cylinders	1
2	No. of strokes	4
3	Bore	875mm
4	Stroke	110mm
5	Connecting rod	234mm
6	Orfice diameter	20mm
7	Dynamometer arm length	185mm
8	Power	3.5 Kw
9	Speed	1500 rpm

Injection point adjustment to desired point (On line adjustment):

• It is presumed that engine is running in Diesel mode and On-line Diesel injection plot is being displayed on the monitor using software.

• Note the injection point displayed on the monitor.

• Turn the injection point adjusting nut gradually and note its effect on Diesel injection plot. The Diesel injection plot shifts horizontally to retard/advance injection point depending upon the direction of rotation. Adjust the nut till desired injection point is obtained.

COMPRESSIONRATIO ADGUSTMENT:

Slightly loosen 6 Allen bolts provided for clamping the tilting block. Loosen the lock nut on the adjuster and rotate the adjuster so that the compression ratio is set to “maximum”. Refer the marking on the CR indicator. Lock the adjuster by the lock nut. Tighten all the 6 Allen bolts gently. You may measure and note the centre distance between two pivot pins of the CR indicator. After changing the compression ratio the difference (Δ) can be used to know new CR. Switch on the pump after providing electric supply to it and ensure water circulation through engine, calorimeter and dynamometer. Keep the Load knob on the dynamometer loading unit at minimum position.

P- Ɵ DIAGRAMS:

The p-θ diagrams for crank angle in advance by 1̊ , 3̊ ,5̊ are shown in figures. In 1̊ crank angle advance the mixing of fuel doesn't take place well and ignition lag is more so that knocking may take place. The start of combustion and end of combustion takes place in a regular manner but pressure developed in it are not sufficient for proper mixing.

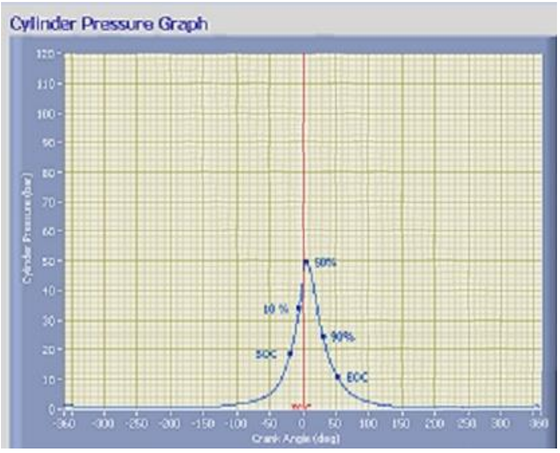

Fig 1: p-θ diagram for 1̊ advance in crank angle

For 3̊ advance in crank angle proper mixing of fuel takes place and ignition lag gets reduced. We can know it from below diagram. Sufficient time is available for proper mixing of fuel. The pressure obtained from this is 55 bar which is optimum pressure for proper mixing of fuel.

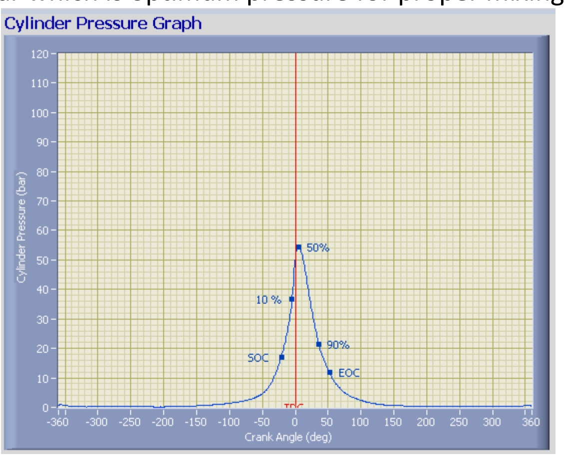

Fig 2: p-θ diagram for 3̊ advance in crank angle

For 5̊ degree advance in crank angle mixing of fuel doesn't takes place because the time given for mixing of fuel is decreased due to more turn in degrees. And the pressure developed here(60 bar) is more than 3̊ advance in crank angle but time is not sufficient for proper atomization of fuel.

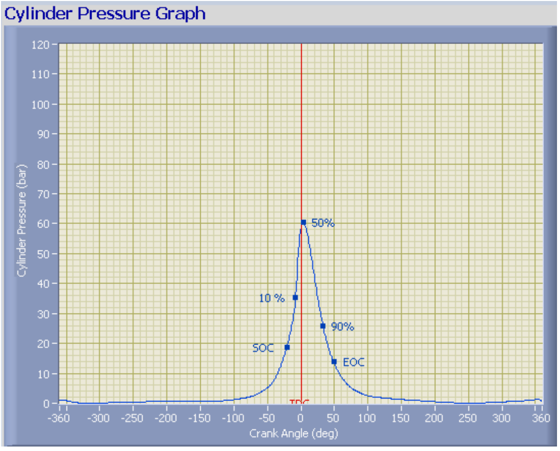

Fig 3: p-θ diagram for 5°advance in crank angle

3. Results andConclusion

It is observed that at compression ratio 18 with crank advance of 3° gives the better result compared to 1° and 5° of advance. It is analysed that due to advance of 3° of crank angle enhances better mixing and combustion properties from pressure and crank angle diagram(p-θ).

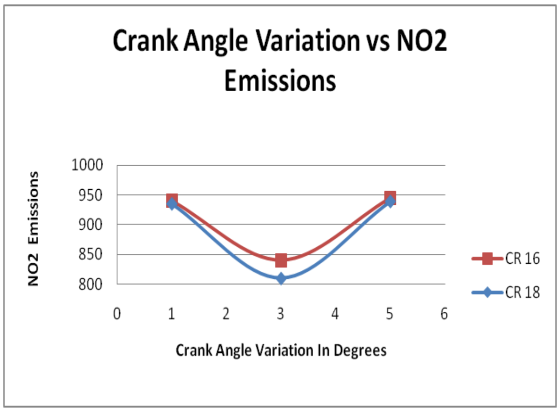

Fig- 4 Showing NO2 Emissions Vs variation in crank angle

The decrease of emissions occours in compression ratio 18 when crank angle is advanced by 3 degrees. The decrease percentage when compared to cr 16 is 3.25%.

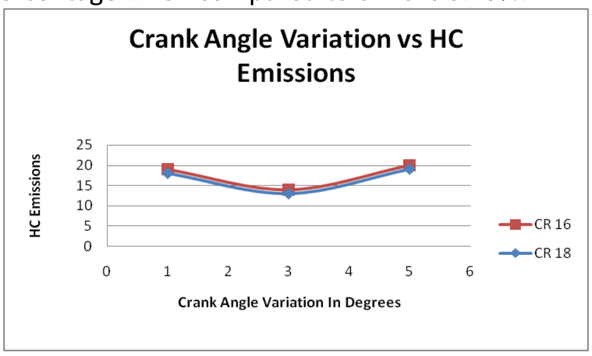

Fig-5 HC Emissions vs Crank Angle Variations

The HC emissions when compared cr 16 with compression ratio 18 gets reduced by 1.75%.

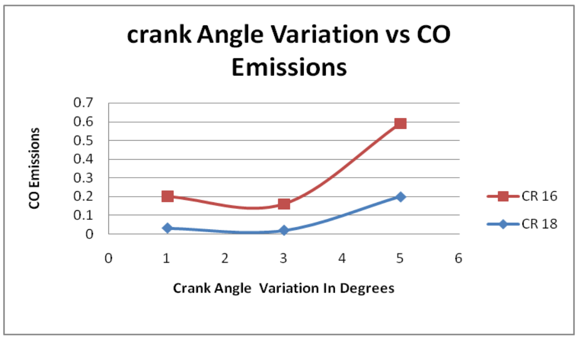

Fig-6 CO emissions vs Crank Angle Variation Degrees

The CO emissions when compared compression ratio 16 to compression ratio 18 gets reduced by 4.22%.

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