Major project Report On

Production and engine testing of Biodiesel

Project report submitted in partial fulfilment of the requirement

For

B-Tech ADE (Automotive design engineering)

A project work submitted by

Abhinav Agarwal

Akantik Mahajan

Amarjeet Talwar

Nishant Kapoor

Under the guidance of

Dr. Pradeepta Kumar Sahoo

University of Petroleum and Energy Studies

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From this work, We have begun to appreciate how a structured, directed and enthusiastic approach to projects such as this has many benefits.

We are thankful to the University Of Petroleum and Energy Studies for providing us an opportunity to pursue our major project work and for providing us sufficient help whenever needed.

Abhinav Agarwal

Akantik Mahajan

Amarjeet Talwar

Nishant Kapoor

CERTIFICATE

This is to certify that the Major Project Report on **"Production and Engine Testing of Biodiesel"** completed and submitted to the University of Petroleum & Energy Studies, Dehradun in partial fulfilment of the requirement for **B.Tech-Automotive Design Engineering**, is a bonfide work carried out by him under my supervision and guidance.

To the best of my knowledge and belief the work has based on investigation made, data collected and analyzed by them and this work has not been submitted anywhere else to any other University or Institution for the award of any Degree/Diploma.

Pradeepta 15/05/2010

Dr. Pradeepta Kumar Sahoo

College of Engineering Studies

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1. Introduction:

1.1 Energy demand in automotive sector-

Energy is essential input for economics growth, social development, human welfare and improving the quality of life. Since their exploration, the fossil fuels continued as the major conventional energy source. With increasing trend of modernization and industrialization, the world energy demand is also growing at faster rate. Apart from their indigenous production, majority of developing countries import crude oil to cope up their increasing energy demand. Thus, a major chunk of their hard earned export earnings is spent for purchase of petroleum products.

Besides the energy (fuel) crisis, the other problem of concern is the degradation of environment due to fossil fuel combustion. Thus life at the present moment is caught between two major crises due to fossil fuel depletion and environmental degradation. Internal combustion engines (both petrol and diesel engines) have fallen victim to the crises. Thus it is essential that low emission alternate fuels must be developed for use in diesel engines. Vegetable oil is one of the main sources from which alternate fuel can be generated for use in the CI engines.

Use of vegetable oil in diesel engines is not a radically new concept as the inventor of diesel engine ''Rudolf Diesel'' demonstrated his first diesel engine at the World Exhibition at Paris in 1900 by using peanut oil as fuel.

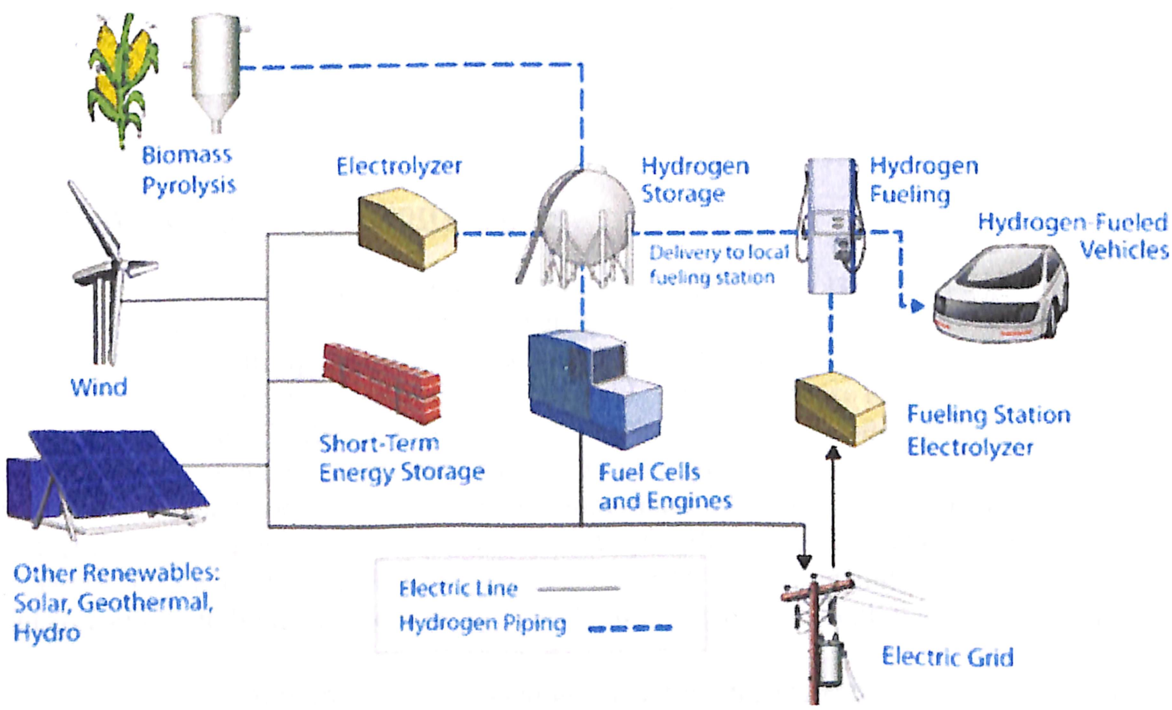
However due to abundant supply of petro-diesel, R&D activities on vegetable oil were not seriously pursued. It received attention only recently when it was conclusively realized that petroleum fuels are dwindling fast and environment-friendly renewable substitutes must be identified. In the recent years, serious efforts have been made by several researchers to use different vegetable oils as fuel in existing diesel engines.

The most predominantly oil bearing crops considered as fuel substituted are sunflower, safflower, soybean, cotton, winter rape, canola and peanut. Further, the investigator discussed the transesterification, oil processing and storage, filtration and engine test aspects.

The research and development activities in several countries on this subject have been mostly on sunflowers, saffola, soybean, rapeseed, pea nut and a host of others. Most of these oils are edible in Indian context. Thus the emphasis of the present work is to experimentally evaluate the possibilities of using biodiesel developed from one of the number of non-edible oil seeds available in India. Biodiesel can be produced from non-edible oil seeds like jatropha, karanja and can be grown in the waste lands of the country. Other non-edible oilseeds tree such as neem, cotton, rubber and polanga (undi), etc. have an estimated annual production potential of more than 20 megatonnes, of which polanga contributes 70 thousand metric tonnes. These oils have a great potential to produce biodiesel.

1.2 RENEWABLE SOURCES OF ENERGY:-

Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). In 2006, about 18% of global final energy consumption came from renewables, with 13% coming from traditional biomass, which is mainly used for heating, and 3% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 2.4% and are growing very rapidly. The share of renewables in electricity generation is around 18%, with 15% of global electricity coming from hydroelectricity and 3.4% from new renewables.



BIOMASS:-

Biomass (plant material) is a renewable energy source because the energy it contains comes from the sun. Through the process of photosynthesis, plants capture the sun's energy. When the plants are burned, they release the sun's energy they contain. In this way, biomass functions as a sort of natural battery for storing solar energy. As long as biomass is produced sustainably, with only as much used as is grown, the battery will last indefinitely.

In general there are two main approaches to using plants for energy production: growing plants specifically for energy use, and using the residues from plants that are used for other things. The best approaches vary from region to region according to climate, soils and geography.

BIOFUEL:-

Bioethanol is an alcohol made by fermenting the sugar components of plant materials and it is made mostly from sugar and starch crops. With advanced technology being developed, cellulosic biomass, such as trees and grasses, are also used as feedstocks for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions. Bioethanol is widely used in the USA and in Brazil.

Biodiesel is made from vegetable oils, animal fats or recycled greases. Biodiesel can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles. Biodiesel is produced from oils or fats using transesterification and is the most common biofuel in Europe

1.3 Biodiesel as an automotive fuel-

BIODIESEL is an alternative fuel for diesel engines that is produced by chemically reacting a vegetable oil or animal fat with an alcohol such as methanol. The reaction requires a catalyst, usually a strong acid or base such as sulphuric acid sodium or potassium hydroxide, and produces new chemical compounds called methyl esters. It is these esters that have come to be known as biodiesel. Biodiesel, produced from different vegetable oils (soybean, rapeseed and sunflower, for example), seems very interesting for several reasons: it can replace diesel oil in boilers and internal combustion engines without major adjustments; only a small decrease in performances is reported; almost zero emissions of sulfates; a small net contribution of carbon dioxide (CO2) when the whole life-cycle is considered (including cultivation, production of oil and conversion to biodiesel); emission of pollutants comparable with that of diesel oil.

Tests show the use of biodiesel in diesel engines results in substantial reductions of unburned hydrocarbons, carbon monoxide, and particulate matter. The exhaust emissions of total hydrocarbons (a contributing factor in the localized formation of smog and ozone) are on average 67 percent lower for biodiesel than diesel fuel. The exhaust emissions of carbon monoxide (a poisonous gas) from biodiesel are on average 48 percent lower than carbon monoxide emissions from diesel. The exhaust emissions of particulate matter from biodiesel are about 47 percent lower than overall particulate matter emissions from diesel. Emissions of nitrogen oxides stay the same or are slightly increased. However, some companies have successfully developed additives to reduce NOx emissions in biodiesel blends.

With the small modifications in the diesel engine the emissions can lowered and engine's life can be increased. The modifications are:

Rubber Seals
With some older vehicles rubber seals used in the fuel lines may require replacing with non-rubber products. This is due to the way biodiesel reacts with rubber. If a low blend is used (5% biodiesel for example) then the concentration of biodiesel isn't high enough to cause this problem.

Cold Starting
Cold starting can sometimes be a problem when using higher blends. This is due to biodiesel thickening more during cold weather than fossil diesel. Arrangements would have to be made for this, either by having a fuel heating system or using biodegradable additives which reduce the viscosity. This effect is only a problem with higher blends.

Oil Changing
It was noticed that during many field trials that engines running on biodiesel tended to require more frequent oil changes. This was generally the case with blends above 20%. It was found that the bus running on biodiesel required an oil change after 12,000 km compared to 21,000 km for the bus running fossil diesel. It is worth noting however that the engine had not been significantly effected in any adverse manner.

Engine Timing
For higher blends engine performance will be improved with a slight change to engine timing, 2 or 3 degrees for a 100% blend. The use of advanced injection timing and increased injection pressure has been known to reduce NOx emissions. It is worth noting that catalytic converters are just as effective on biodiesel emissions as on fossil diesel.

1.4 BIODIESEL:

Biodiesel refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow)) with an alcohol.

Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used alone, or blended with petrodiesel.

The term "biodiesel" is standardized as mono-alkyl ester in the United States.

Biodiesel can be formed from both edible and non edible renewable resources. Thus has a great future ahead. Biodiesel from jatropha is considered for non edible seeds and from soyabean and mustard oil as edible resources.

Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in the retail diesel fuel marketplace. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix: fuel containing

- 100% biodiesel is referred to as B100, while
- 20% biodiesel is labeled B20
- 5% biodiesel is labeled B5
- 2% biodiesel is labeled B2

Obviously, the higher the percentage of biodiesel, the more ecology-friendly the fuel is. It is common in the USA to see B99.9 because a federal tax credit is awarded to the first entity which blends petroleum diesel with pure biodiesel. Blends of 20 percent biodiesel with 80 percent petroleum diesel (B20) can generally be used in unmodified diesel engines. Biodiesel can also be used in its pure form (B100), but may require certain engine modifications to avoid maintenance and performance problems. Blending B100 with petroleum diesel may be accomplished by:

- Mixing in tanks at manufacturing point prior to delivery to tanker truck
- Splash mixing in the tanker truck
- In-line mixing, two components arrive at tanker truck simultaneously.
- Metered pump mixing, petroleum diesel and Biodiesel meters are set to X total volume, transfer pump pulls from two points and mix is complete on leaving pump.

APPLICATIONS:-

Biodiesel can be used in pure form (B100) or may be blended with petroleum diesel at any concentration in most injection pump diesel engines. New extreme high pressure (29,000 psi) common rail engines have strict factory limits of B5 or B20 depending on manufacturer.[citation needed] Biodiesel has different solvent properties than petrodiesel, and will degrade natural rubber gaskets and hoses in vehicles (mostly vehicles manufactured before 1992), although these tend to wear out naturally and most likely will have already been replaced with FKM, which is nonreactive to biodiesel. Biodiesel has been known to break down deposits of residue in the fuel lines where petrodiesel has been used.[4] As a result, fuel filters may become clogged with particulates if a quick transition to pure biodiesel is made. Therefore, it is recommended to change the fuel filters on engines and heaters shortly after first switching to a biodiesel blend.

2. LITERATURE REVIEW:

BACKGROUND: Energy is one of the basic concern about the upcoming generation. As we see that fossil fuels like petrol is being depleting with much speed due to increase in demand and less presence of it. Also these fuels resulting in global warming and green house gases which are harming the world fastly and can lead to the end if it will not stop. World is so much dependent on energy that use of fuels cannot be decreased but it keep on rising so it would be better to find an alternative fuel which can replace it easily with or without less modification in engine. Energy also plays a greater role in country economy also so if country utilize its own natural resource in developing energy it could play a huge role.

LITERATURE:

During the study of alternative energy resources we found that biodiesel from non edible resources can result in a greater energy resources for country such as INDIA because:-

- India is densely populated country and the Fallow land holding per farmer is 1 to 10 acres.
- Most of the farming in India is Organic by default.
- In India, the day to day expenses are quite low
- The prices of Petroleum Products in India

One of the best resource is Jatropha. Other benefits which are being seen is that Jatropha curcas / Castor grows almost anywhere – even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil. It can grow even in the crevices of rocks.

It is significant to point out that, the non-edible vegetable oil of Jatropha curcas / Castor has the requisite potential of providing a promising and commercially viable alternative to diesel oil. Cars could be run with Jatropha curcas without requiring much change in design. Same is the case with soyabean and mustard oil. They are being produced in INDIA as a much quantity and mostly used for lighting lamps in rural areas.

These are some points of availability now comes to the performance, emission characterstics of jatropha as a blend and as pure with diesel engine. By referencing many documents we come to certain data which are as follows:

S.No.	Fuel blend	Density (kg/m3)	CV(kJ/kg)	Viscosity at 40C	Flash point(degC)	Cloud point(degC)	Pour point(degC)
1.	Diesel	850	44000	2.87	76	6.5	3.1
2.	JB 20	852	43759.5	3.02	88	6.9	3.3
3.	JB 50	857	43323	3.59	113	7.3	3.4
4.	JB 100	873	42673	4.23	148	10.2	4.2

Combustion parameters of test fuels on diesel engine at peak load:-

Fuel and parameters	Start of injection BTDC(deg.)	Start of combustion BTDC(deg.)	Ignition delay(deg.)	Peak pressure(bar)	Peak HRR(joule/CA)
Diesel	23	14.5	8.5	78.7	90.96
JB 20	23	15.5	7.5	80.7	86.79
JB 50	23	16.8	6.2	83.71	80.52
JB 100	23	18.7	4.3	84.7	69.97

Getting the data which is best for an alternative resource is our attraction to make our project on BIODIESEL.

The other more parameters towards jatropha are:

- Grow even on **marginal**/saline/acidic/alkaline **soils** and slopy lands.
- Develop **without** much **care** and **irrigation.**
- Suit even dry-land farming and **survive drought.**
- Generate **rural employment** for cultivation, seed collection and processing.
- Need **hardly any** application of **pesticide.**
- Generate net **income** for 35-40 years @ about **Rs.10,000/acre,** from 4th year.
- Improve **soil fertility** throughout their life-cycle.
- Provide **fuel wood** after 50 years' life-span.
- Enhance **energy security** for the country.

Some **advantages** of jatropha:-

- It starts producing seeds within 12 months
- Maximum productivity level is 4-5 years
- Plant remains useful for around 35-50 years
- Seeds can produce around 37% oil content
- Kernels can produce up to 60% oil content
- Its seeds yield an annual equivalent of 0.75 to 2 tons of biodiesel per hectare
- It is a NON-FOOD CROP

Some **disadvantages**:-

- The Jatropha Curcas nut and oil are inedible, but its price is not distorted by competing food uses.
- Potential gender conflicts.
- If there is too little water, the plant will not produce the nut.
- It is excellent at preventing soil erosion
- The plant prefers alkaline soils
- 20 per cent of seedlings planted will not survive
- Yield seeds in the first year after plantation

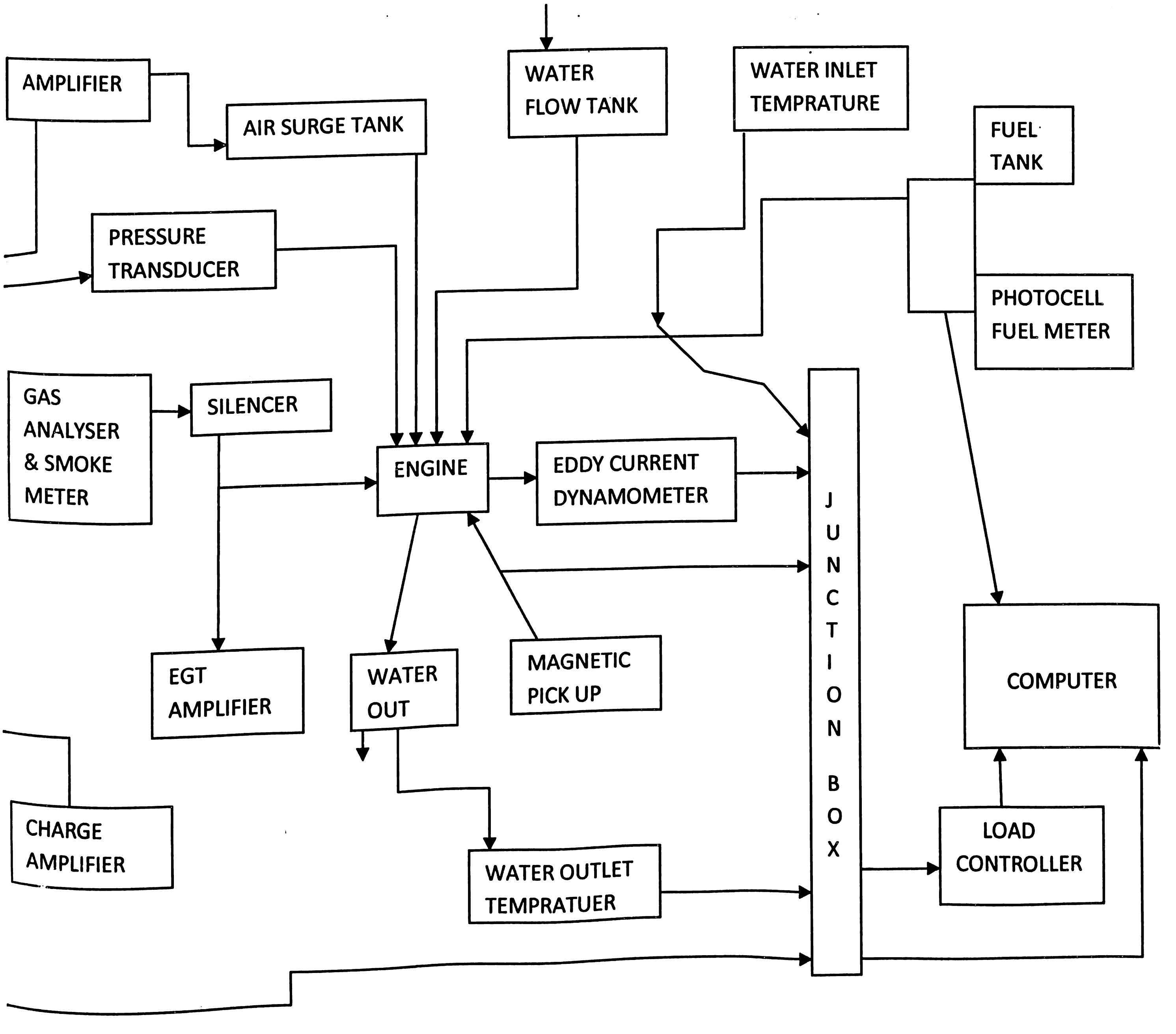
The cost of plantation has been estimated to be Rs. 25,000 per hectare, inclusive of plantation and maintenance for one year, training, overheads etc.

3. OBJECTIVES

To produce biodiesel from vegetable oils like jatropha oil, soyabean oil and mustard oil and determine the engine performance, fuel consumption, combustion and exhaust emission by the application of biodiesel.

4. METHODOLOGY

4.1 Experimental setup.



4.1.1 *Engine*: Engine used in the experiment is a 4 stroke cycled engine made by kirloskar oil engine limited. in a water cooled, naturally aspirated, direct injection engine having specifications:-

No. of cylinder-1

Bore * stroke-80 * 110 mm

Cubic capacity- .553litre

Compression ratio- 16.5:1

Rated output-3.7 kw (5bhp)

Sfc at rated hp/1500rpm- 245g/kwh

Fuel tank capacity- 6.5 liter

Engine weight- 114kg

Starting-hand start with crankling engine

4.1.2 *Eddy Current Dynamometer:* Dynamometer used is made by powermag control system having specifications:-

Type: - FTAC

Torque: - 2.4kgm@1500rpm

Maximum excitation: - 80V

Insulation: - class F

Operating Principle: The primary elements of powermag adjustable dynamometer are an eddy current clutch, a tachometer and a separate solid state controller. It absorb power torque and speed characteristics with a unique hysterics breaking system which provides frictionless torque loading independent of shaft speed. It provides torque by using two basic components. A reticulated pole structure with output shaft which connected to spring balance weighing gear load and a specialty steel rotor drum with input shaft assembly fitted together but not in physical contact.

When a magnetizing force from the field coil is applied to the pole structure. The air gap becomes the flux field and the rotor is magnetically restrained, providing a breaking action between whole structure and rotor drum. A solid state electronic controller is used to excite the field coil. The torque is proportional to coil current. An integral tachogenerator is mounted on the input rotor shaft, to give voltage and frequency proportional to field, which is used for speed indication (rpm) so that simultaneously torque and speed of the motor can be read under 0 to 100 % load test.

4.1.3 *Charge amplifier:* Its function is to obtain a voltage proportional to the charge and yield low output impedance hence it is a charge – to – voltage convertor.

4.1.4 *Pressure transducer:* A pressure sensor measures pressure typically of gases and liquids. It usually acts as a transducer as it generates a signal as a function of pressure imposed.

4.1.5 *Exhaust gas temperature(EGT) amplifier:* It is used for recording exhaust gas temperatures during dyno testing of engine. An exhaust gas sensor is provided to generate a signal representing the air fuel ratio within the exhaust system. The deviation of the air fuel ratio from the average value of the sensor output is detected by a comparator.

4.1.6 *Smoke Meter:* A diesel smoke meter which uses micro-waves to detect the density of black smoke contained in the exhaust gas discharged from the diesel engine through an exhaust pipe. A micro-wave transmitting device is coupled to the exhaust pipe and transmits micro-waves into the exhaust pipe.

Micro-waves transiting the exhaust pipe are attenuated by the black smoke in the exhaust gas. A micro-wave receiving device receives the attenuated micro-waves and provides a received signal which varies in accordance with the signal level of the attenuated micro-waves. A measuring device receives the received signal and provides an output indicative of the density of black smoke in the exhaust gas.

Operating Principle: A subset of the exhaust gas is taken from the exhaust gas line with a probe and sucked through a filter paper. The blackening of the filter paper caused thereby is measured with a reflectometer and indicates the soot content in the exhaust gas.The blackening of the filter paper primarily depends on the soot concentration in the exhaust gas and the "effective filter length" (exhaust gas volume related to the filter area.) The value 0 is assigned to the unloaded, clean filter paper and the absolutely black paper filter that is loaded with soot is assigned to the value SZB 10 (blackening number according to Bosch), or 100 % blackening.

4.1.7 ***Load Controller:*** A load controller, consist of a first input circuit which detects that a drive instruction signal by the operation of a drive instructing unit is less or equal to a first input threshold value, a first constant current source activated in accordance with a detection by the first input circuit, a first constant control signal supply unit that is activated by the first constant current source and supplies a first constant control signal, a second constant control signal supply unit that supplies a second constant control signal in accordance with the activation of a second constant current source during the failure of the first input circuit or the first constant current source, a drive control unit that generates a constant drive control signal in accordance with the first constant control signal supplied from the first constant control signal supply unit or the second constant control signal supplied from the second constant control signal supply unit, and a load driving element that is controlled by the constant drive control signal supplied from the drive control unit so as to drive a load.

4.1.8 ***Magnetic Pickup:*** A magnetic pickup having an electronic switch circuit incorporated in the sensing unit to generate a high level digital signal, improving the signal form and the signal-to-noise ratio. The switch has an input transistor with a base bias circuit including a diode having a characteristic comparable with that of the base emitter junction of the input transistor, to stabilize the bias and the sensitivity of the switch. In one form of the invention, the emitter coupling element of the transistorized switching circuit has a constant voltage independent of the supply potential, enabling the use of one circuit over a range of operating voltages.

4.1.9 ***Junction Box:*** A junction box of the present invention includes a junction box body, and a casing for housing the junction box body in either an upright position or a horizontal position. On the junction box body, provided is first locking piece to be engaged with a first inner side face of the casing in a state of upright disposition of the junction box body. The first locking piece abuts on a second inner side face of the casing in a state of horizontal disposition of the junction box body. In addition, also provided is second locking piece to be engaged with the first inner side face of the casing in the state of horizontal disposition of the junction box body. The second locking piece abuts on the second inner side face of the casing in the state of upright disposition of the junction box body.

4.1.10 ***Air Surge Tank:*** The disclosed device is directed towards a surge tank. The surge tank comprises a side wall including an interior surface. A bottom of tank is coupled to the side wall, wherein the side wall and the bottom of tank define an interior of the surge tank and an exterior of the surge tank. At least one inlet is configured to fluidly couple the exterior of the surge tank with the interior of the surge tank. A weir is fluidly coupled to the inlet at the interior of the surge tank. A flexible element is coupled to the weir proximate to the bottom of tank. An outlet is defined in the bottom of tank.

4.1.11 ***Silencer:*** A silencer having improved noise reduction characteristics is disclosed. The silencer includes a first cylindrical connection pipe for guiding the flow of a gases, a cylindrical expansion pipe communicating with the first connection pipe at one end thereof for guiding the flow of the gas, the expansion pipe having a sectional area greater than that of the first connection pipe, and a second cylindrical connection pipe communicating with the other end of the expansion pipe for guiding the flow of the gas. According to the present invention, resonance caused by a pipe connected to the silencer is prevented, and therefore, the noise reduction efficiency of the silencer is improved.

4.1.12 ***Water Flow Meter:*** The main function of liquid flow meter is to measure the flow and quantity of moving water. It utilizes four types of metering technologies such as differential pressure, positive displacement, velocity, and true mass. It varies in terms of features and operating performance. Differential pressure flow meters obtain a liquid's flow rate by measuring the pressure differential and extracting the square root. Positive displacement flow meters divide the liquid into specific increments, which are counted by mechanical or electronic techniques.

4.1.13 ***Fuel tank:*** A fuel tank is safe container for flammable liquids and typically part of an engine system in which the fuel is stored and propelled (fuel pump) or released (pressurized gas) into an engine. Fuel tanks range in size and complexity from the small plastic tank of a butane lighter to the multi-chambered cryogenic Space Shuttle external tank.

4.1.14 ***Amplifier:*** An amplifier , is any device that changes, usually increases, the amplitude of a signal. The relationship of the input to the output of an amplifier-usually expressed as a function of the input frequency-is called the transfer function of the amplifier, and the magnitude of the transfer function is termed the gain

4.2 EXPERIMENTAL PROCEDURE

The investigations on the combustion characteristics were conducted on a small size 6 kW air-cooled single cylinder four-stroke diesel engine (Kirloskar Oil Engines Ltd., India) fueled with pre-pared test fuels. The experimental setup equipped with experimental technologies to measure the combustion parameters such as peak pressure, time of occurrence of peak pressure, heat release rate and ignition delay was computed. The experimental test rig consists of the engine coupled with alternator and various measuring systems. The engine was provided with a suitable arrangement, which permitted a wide variation of controlling parameters. The alternator was used for loading the engine. When the load bank was switched on, it consumed the electricity generated by alternator. The engine/alternator was loaded up to 100% load using these load banks. A variac was also connected in the load bank, so that load was controlled precisely by controlling the voltage in one of the coils of the load bank. Voltmeter and ammeter were used to measure the voltage and the current consumed by the load in the load bank. The product of voltage and current gives the actual load on engine–alternator system. The speed was also checked with an infrared-type digital tachometer.

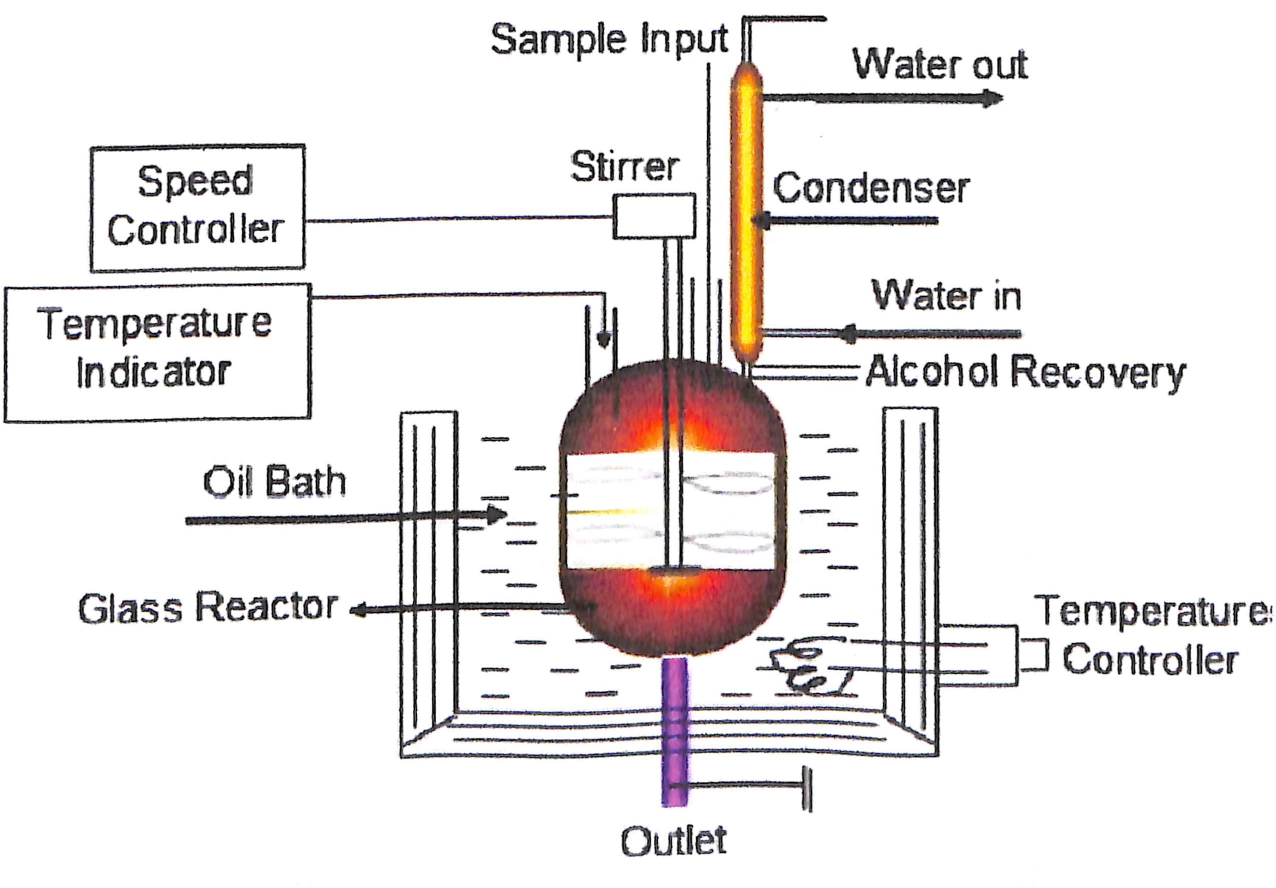
Combustion diagnosis was carried out by means of a Kistler make quartz piezoelectric pressure transducer (Model - 701A) fitted on the cylinder head and an electro magnetic pickup (Model – 3010AMa) fixed on the output shaft of the engine. The pressure and crank angle signals were fed to a console for onward transmission to a Pentium personal computer through charge amplifier (Model - 3059 HICF) and cathode ray oscilloscope (CRO). These instruments were used for measuring the cylinder gas pressure. A two-channel HP 54645A/D oscilloscope digitizing system was used for monitoring different signals such as TDC, crank angle signals for calculation of injection duration and setting the start of injection. It was also used for monitoring cylinder versus pressure crank angle diagram signals from piezoelectric pressure transducer.
The pressure transducer was mounted on the cylinder head in the standard position. Piezoelectric pressure transducer has the advantage of good frequency response and linear operating range.
A continuous circulation of water was maintained for cooling the transducer by using a small water pump to maintain the required temperature. Distilled water was circulated through the transducer to avoid corrosion of water passage. The charge amplifier and pressure transducer were calibrated by using a dead weight pressure gauge tester. The charge amplifier was used to amplify the output of pressure transducer into the desired voltage level, so that the output of the charge amplifier could be used for recording or display on the oscilloscope screen.

Combustion parameters such as peak pressure, time of occurrence of peak pressure, heat release rate and ignition delay were evaluated. All the tests were conducted by starting the engine with diesel fuel only. After the engine was warmed up, it was then switched to biodiesel and their blends. At the end of the test, the fuel was switched back to diesel and the engine was kept running for a while before shut-down to flush out the biodiesel from the fuel line and the injection system. A total of ten fuels were tested during the investigation keeping all the independent variables same. The experiments were carried out by using diesel, Jatropha biodiesel (JB), soyabean, mustard oil biodiesel and their various blends with diesel at different load conditions on the engine. The objective of such a study was to analyze and compare the suitability of each of these fuels for engine application from the point of view of normal combustion systems

4.2.1 BIO-DIESEL PRODUCTION AND TESTING:

a) JATROPHA OIL

Biodiesel from Jatropha, was produced in a laboratory scale set up (Fig. 1) which consists of heating mantle, reaction flask and mechanical stirrer. The working capacity of reaction flask is 1 l. It consists of three necks for stirrer, condenser and inlet of reactant as well as for placing the thermocouple to observe the reaction temperature. The flask has a stopcock at the bottom for collection of the final product. The procedure for preparation of methyl esters varies from oil to oil depending upon their chemical composition and free fatty acids (FFA) content. Process parameters such as the mode of reaction condition, molar ratio of alcohol to oil, type of alcohol, type and amount of catalysts, reaction time and temperature and purity of reactants were optimized.



Bio-diesel is formed from oils by a process called 'TRANSESTERIFICATION' in which vegetable oil is reacted with an alcohol in the presence of catalyst and glycerol is formed as a by product. Basically we take 1000ml of jatropha oil which is reacted with methyl alcohol(200 ml) in the presence of H_2SO_4 and stir for 3 hour which gives blackish organic waste and is removed with the help of settling flask. After removing, oil is again reacted with methyl alcohol in the presence of KOH. Thus it involes two reaction acid and base. Now this reaction produces biodiesel and glycerol. The glycerol is separated by separating flask in which glycerol settle down. After which biodiesel is washed with water and made dry with the help of silica gel(absorbing moisture).

Basic reaction

CH_2COOR' | **$CHCOOR''$** | **CH_2COOR'''**	**3 ROH**	**Catalyst**	**CH_2OH** | **CHOH** | **CH_2OH**	**R'COOR** + **R''COOR** + **R'''COOR**
60 Kg **Oil**	**6.78 Kg** **Alcohol**	**0.60Kg** **NaOH**	**6.5 Kg** **Glycerin**	**58 Kg** **Biodiesel**

After the production of bio-diesel we tested its blend with diesel and also pure bio-diesel in diesel engine for its performance, emission, and combustion. The result is calculated in the form of graphs.

ENGINE TESTING:-

First we calculate the density of the fuel or the blend we are using. For pure jatropha density is .877 and for 50% blend density is .844, now with the help of bomb caloriemeter find rise in temperature. Then calculation for calorific value as:-

$Cv = 4.18*\{T2*W-(CVt+CVw)\}/M$

Where W=water equivalent in calories

$W= \{(6319*\text{weight of benzoic acid})-(21+9.72)\}/T1$

CVt= calorific value of thread = 21

CVw= calorific value of wire = 9.72

M = weight of fuel

Now we feed the density and CV to the system software to get the performance as well as emission results:-

FOR 50% BLEND OF JATROPHA OIL

DENSITY: 0.844 gm/cc
CALORIFIC VALUE: 39770.33 kJ/kg

Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO %vol	0.09	0.006	0.06	0.08	0.08	0.08
HC ppm hex	41	36	35	42	35	41
CO2 %vol	8.8	7.2	6.0	4.7	3.6	2.2
NO ppm vol	1297	1063	819	466	270	121
SMOKE	49.9	30	28.4	25.5	20.9	11.4
ROOM TEMPERATURE(C)	40.8	40.8	40.9	41	41	40.9
HUMIDITY %	10	10	10	10	10	10

FOR 20% BLEND OF JATROPHA OIL

DENSITY: 0.877 gm/cc
CALORIFIC VALUE: 37675.92 KJ/kg

Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO %vol	0.12	0.07	0.08	0.10	0.10	0.09
HC ppm hex	64	47	42	40	33	44
CO2 %vol	9.80	7.40	5.80	4.60	3.5	2.6
NO ppm vol	1198	984	560	333	198	110
SMOKE	49.6	34.4	32.5	35.7	20.6	19.2
ROOM TEMPERATURE(C)	36.5	36.9	36.9	37	37.1	37.2
HUMIDITY %	10	10	10	10	10	10

RESULT AND DISCUSSIONS:

CHARACTERIZATION OF BIODIESEL FROM JATROPHA:

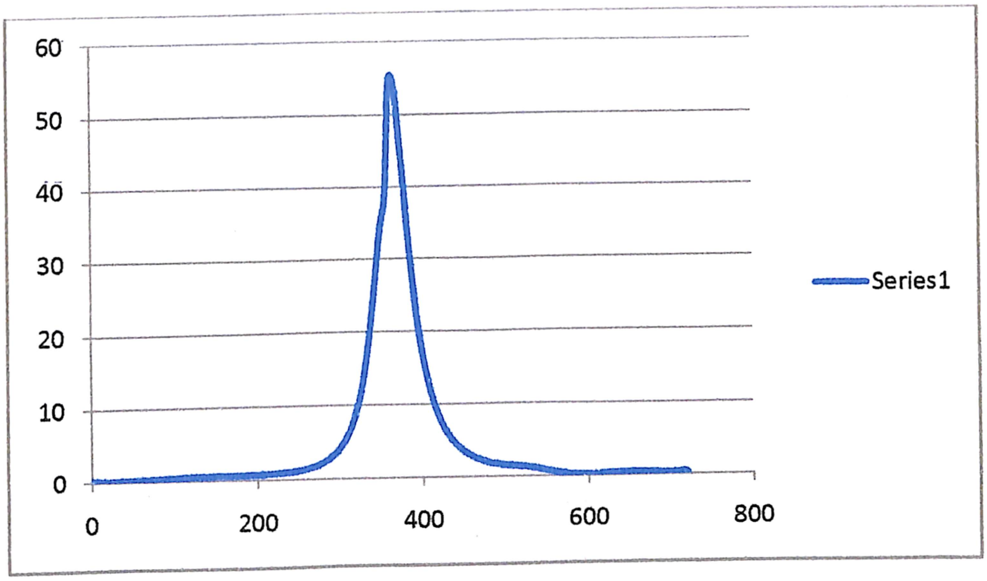
The properties of biodiesel and their blends are compared with those of ASTM biodiesel standards. Most of the fuel properties of Jatropha and their blends are comparable to those of diesel. The present results obtained show that the transesterification process improved the fuel properties of the oil with respect to density (0.877gm\cc), calorific value (37675.92kJ/kg),. The comparison of these properties with diesel shows that the methyl esters of Jatropha,oil have relatively closer fuel property values to that of diesel. Hence, no hardware modifications are required for handling these fuels (biodiesel and their blends) in the existing engine.

The calorific values of all the biodiesel and their blends are lower than that of diesel because of their oxygen content. The presence of oxygen in the biodiesel helps for complete combustion of fuel in the engine. The flash point of all the biodiesel and their blends is lowered by transesterification, but it is still higher than that of diesel. Addition of a small quantity of biodiesel with diesel increases the flash point of diesel. Hence, it is safer to store biodiesel–diesel blends as compared to diesel alone. It is observed that the typical combustion characteristics of Jatropha (JB) biodiesel (PB) are in the close range of the requirement of the engine.

COMBUSTION ANALYSIS:

Graph is plotted between crank angle and pressure for 50% blend of jatropha with diesel. Peak pressure also studied and compared with diesel.

Crank angle and pressure



EFFECT OF BLENDS ON CYLINDER PRESSURE:

We run the engine at different blends of jatropha like 20 and 50 percent and found that the peak pressure are goods. The pressure obtain is near about 55 bar.

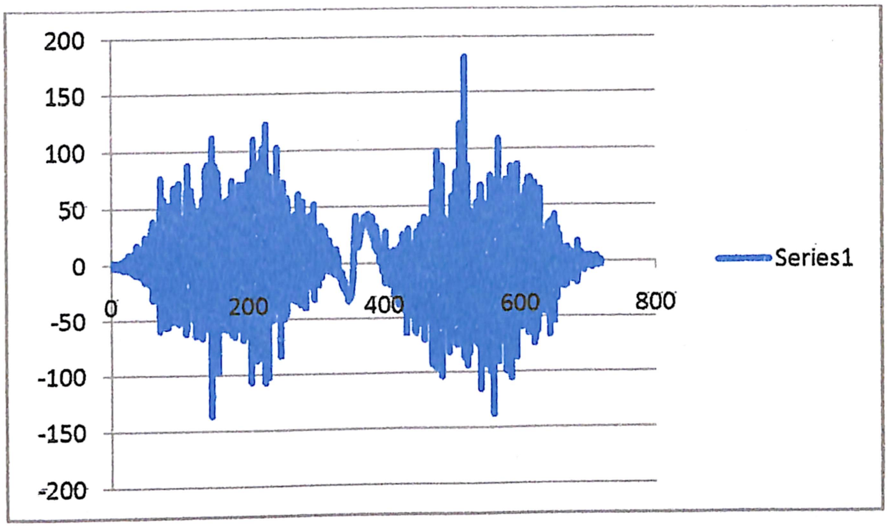
EFFECT OF BLEND ON HEAT RELEASE RATE

Heat release rate indicating that the ignition delay for biodiesel and their blends was shorter than that for diesel. It can also be seen that the maximum heat release rate of biodiesel and their blends is lower than that of diesel.

This is because, as a consequence of the shorter ignition delay, the premix combustion phase for biodiesel and their blends is less intense. On the other hand, while running with diesel, increased accumulation of fuel during the relatively longer delay period resulted in higher rate of heat release. Because of the shorter delay, maximum heat release rate occurs earlier for biodiesel and their blends in comparison with neat diesel.

However, the heat release during the late combustion phase for biodiesel and their blends is marginally lower than that of diesel. This is because the constituents with higher oxygen content are adequate to ensure complete combustion of the fuel that is left over during the main combustion phase and continue to burn in the late combustion phase.

Crank angle and heat release



b) SOYABEAN

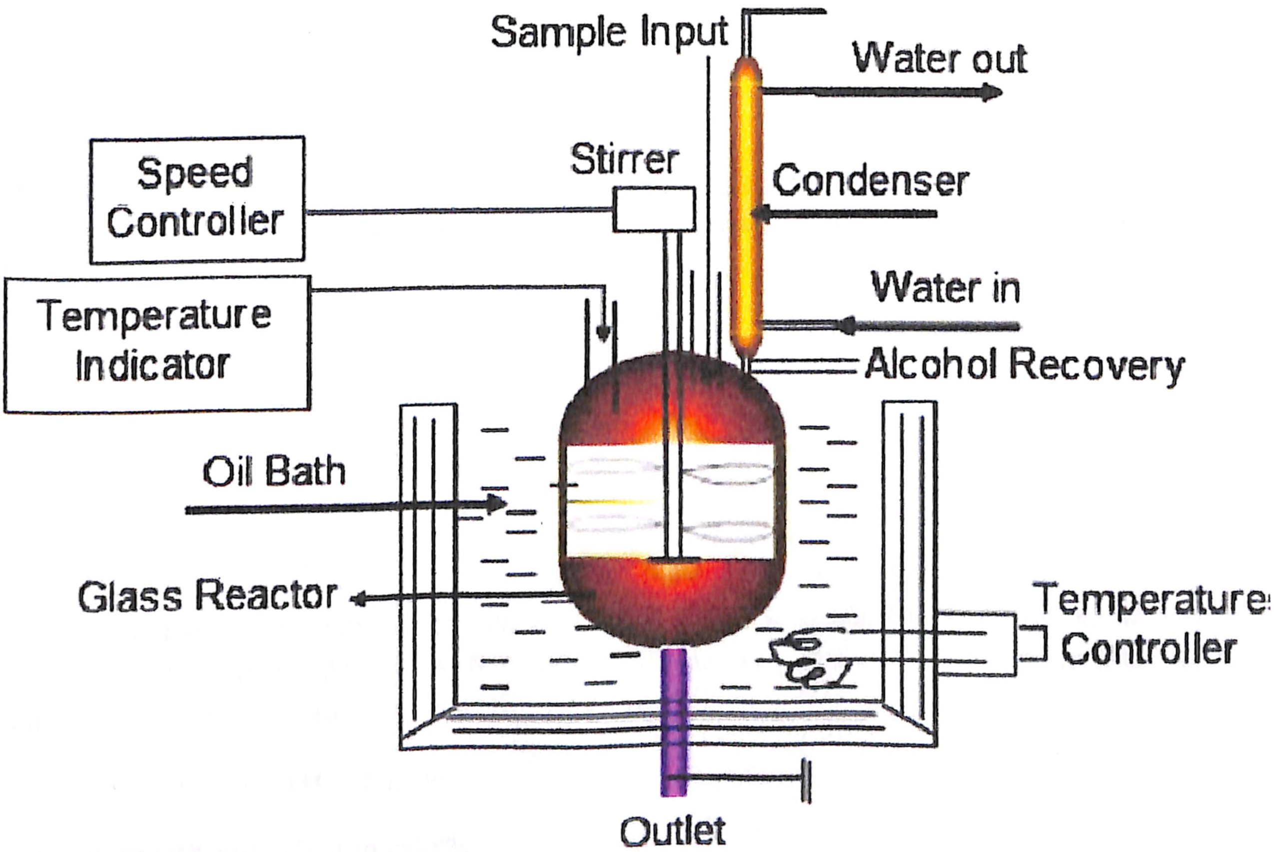
Soya biodiesel fuel is unquestionably good for the environment in several ways. First of all, in order to create soy biodiesel fuel, soybean plants must be grown. These soy crops add valuable oxygen to the air and help clean the air as the plants undergo photosynthesis.

Soy biodiesel is also beneficial to the environment because it reduces the dependence on petroleum fuel. This benefits the environment because the process of extracting petroleum virtually destroys the ground in that area. Furthermore, processing petroleum creates pollution in the atmosphere. Also, soybeans are a renewable resource and petroleum, which is a fossil fuel, is not. This means it is possible to use up all of the available petroleum fuel. Using soy biodiesel helps reduce our consumption of this valuable fossil fuel so it can be preserved for other uses.

The study showed that both corn grain ethanol and soybean biodiesel produce more energy than is needed to grow the crops and convert them into biofuels. This finding refutes other studies claiming that these biofuels require more energy to produce than they provide. The amount of energy each returns differs greatly, however. Soybean biodiesel returns 93 percent more energy than is used to produce it, while corn grain ethanol currently provides only 25 percent more energy.

Production

Biodiesel from soyabeen was produced in a laboratory scale set up (Fig. 1) which consists of heating mantle, reaction flask and mechanical stirrer. The working capacity of reaction flask is 1 l. It consists of three necks for stirrer, condenser and inlet of reactant as well as for placing the thermocouple to observe the reaction temperature. The flask has a stopcock at the bottom for collection of the final product. The procedure for preparation of methyl esters varies from oil to oil depending upon their chemical composition and free fatty acids (FFA) content. Process parameters such as the mode of reaction condition, molar ratio of alcohol to oil, type of alcohol, type and amount of catalysts, reaction time and temperature and purity of reactants were optimized



Bio-diesel is formed from oils by a process called 'TRANSESTERIFICATION' in which vegetable oil is reacted with an alcohol in the presence of catalyst and glycerol is formed as a by product. Basically we take 1000ml of soyabean oil which is reacted with methyl alcohol in the presence of KOH. It involves base reaction. Now this reaction produces biodiesel and glycerol. The glycerol is separated by separating flask in which glycerol settle down. After which biodiesel is washed with water and made dry with the help of silica gel(absorbing moisture).

Basic reaction

CH_2COOR' | $CHCOOR''$ | CH_2COOR'''	3 ROH	Catalyst	CH_2OH | CHOH | CH_2OH	R'COOR + R''COOR + R'''COOR
60 Kg Oil	6.78 Kg Alcohol	0.60Kg NaOH	6.5 Kg Glycerin	58 Kg Biodiesel

After the production of bio-diesel we tested its blend with diesel and also pure bio-diesel in diesel engine for its performance, emission, and combustion. The result is calculated in the form of graphs.

ENGINE TESTING:-

First we calculate the density of the fuel or the blend we are using. For pure soybean density is .873 and for 50% blend density is .844, now with the help of bomb caloriemeter find rise in temperature. Then calculation for calorific value as:-

Cv= 4.18*{T2*W-(CVt+CVw)}/M

Where W=water equivalent in calories

W= {(6319*weight of benzoic acid)-(21+9.72)}/T1

CVt= calorific value of thread = 21

CVw= calorific value of wire = 9.72

M = weight of fuel

Now we feed the density and CV to the system software to get the performance as well as emission results:-

<u>20% OF SOYABEAN:</u>

Density =.876 gm/cc
CV= 43959.18 kJ/kg

Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO % VOL	.10	.07	.07	.09	.10	.10
HC ppm hex	62	55	49	39	39	45
CO2 %vol	8.60	7.10	5.70	4.50	3.40	2.40
NO ppm vol	1399	1121	707	350	201	115
SMOKE	47.4	46.9	36.9	33	17	9.8
ROOM TEMPERATURE(C)	40	40.1	40.2	40.2	40.3	40.3
HUMIDITY %	10	10	10	10	10	10

50% BLEND OF SOYABEAN:

DENSITY: .844 gm/cc
CV: 42388.38 KJ/KG

Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO	0.09	.07	.07	.08	.09	.09
HC	52	42	40	43	43	41
CO2	8.6	7.1	5.7	4.4	3.3	2.3
NO	1352	1086	737	393	199	109
SMOKE	50.5	51.5	35	27.9	21	11.3
ROOM TEMPERATURE	41.5	41.7	41.8	41.6	41.6	41.6
HUMIDITY	10	10	10	10	10	10

RESULT AND DISCUSSION:

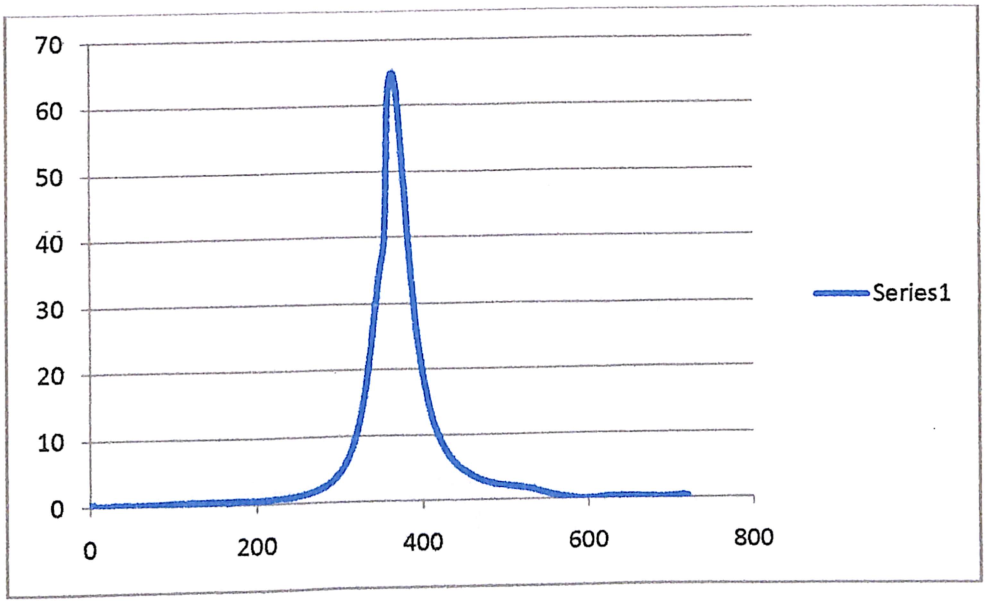
CHARACTERIZATION OF BIODIESEL FROM SOYABEAN:

The properties of biodiesel and their blends are compared with those of ASTM biodiesel standards. Most of the fuel properties of Jatropha and their blends are comparable to those of diesel. The present results obtained show that the transesterification process improved the fuel properties of the oil with respect to density (0.873gm/cc), calorific value (39770.34kJ/kg),. The comparison of these properties with diesel shows that the methyl esters of Jatropha,oil have relatively closer fuel property values to that of diesel. Hence, no hardware modifications are required for handling these fuels (biodiesel and their blends) in the existing engine.

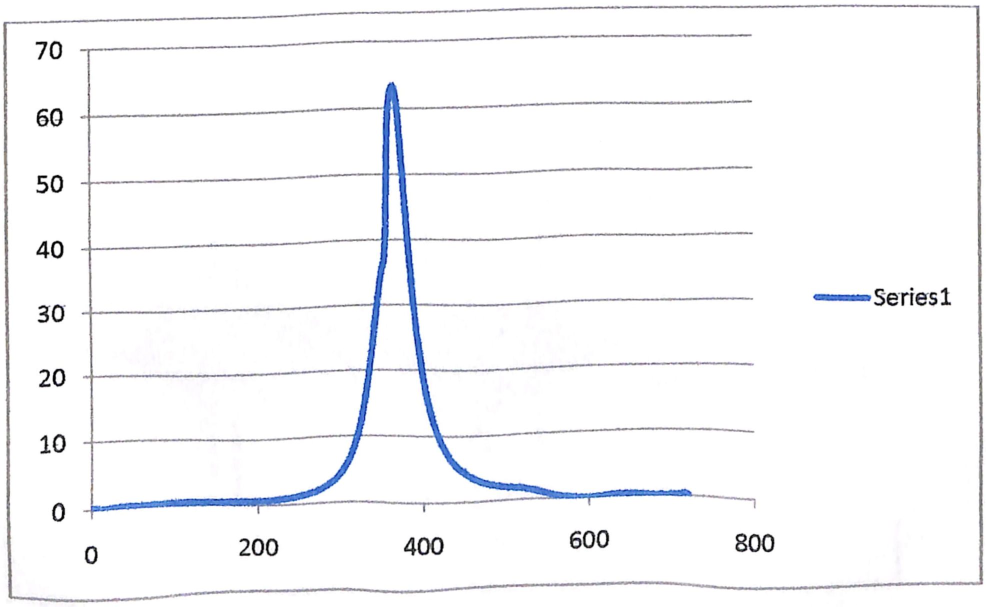
COMBUSTION ANALYSIS:

Graph is plotted between crank angle and pressure for 50% blend of jatropha with diesel. Peak pressure also studied and compared with diesel.

Crank angle and pressure



50% soybean blend



20% soybean blend

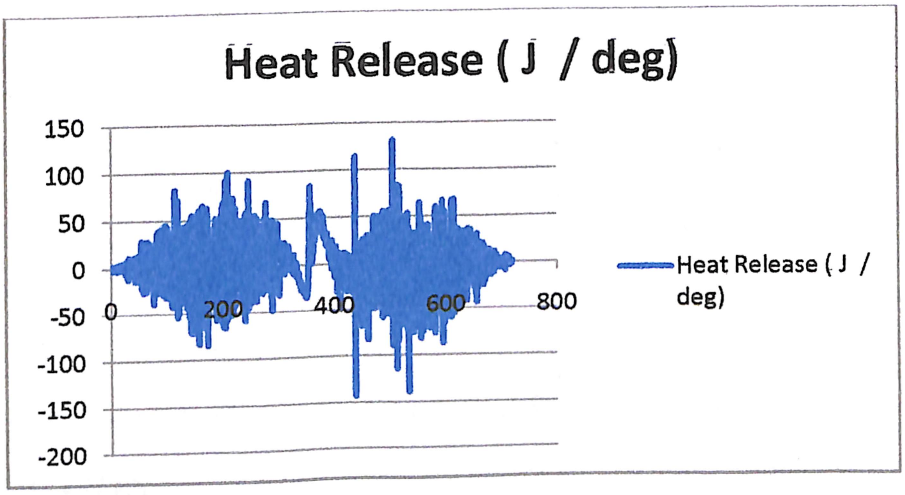
EFFECT OF BLENDS ON CYLINDER PRESSURE:

We run the engine at different blends of soyabean like 20 and 50 percent and found that the peak pressure as compared to diesel are 62 bar and 64 bar respectively.

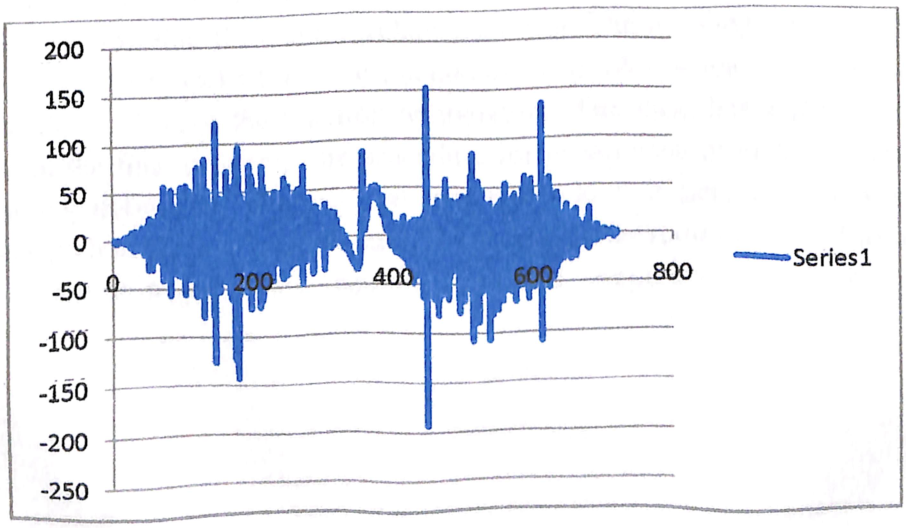
EFFECT OF BLEND ON HEAT RELEASE RATE

Heat release rate indicating that the ignition delay for biodiesel and their blends was shorter than that for diesel. It can also be seen that the maximum heat release rate of biodiesel and their blends is lower than that of diesel.

Crank angle and heat release



50%soybean blend



20%soybean blend

c) MUSTARD OIL

INTRODUCTION:

Mustard crops have been used as a green manure for hundreds of years. Mustard has been grown to a pre-seed state then plowed down for pesticide control. The active chemicals in the roots, stems and leaves that provide the pesticide effect are glucosinolates. Actually, the pesticide compounds are the breakdown products of glucosinolates: isothiocyanate, oxazolidinethione, 4-hydroxybenzyl, nitriles, thiocyanates, The glucosinolate content of the leaves, stems, and roots range from 5 to 20 μmoles/gram. The glucosinolate content of the seeds range from 90 to well over 250 μmoles/gram. We hypothesized that the meal would be a more effective pesticide than the entire plant used as green manure.

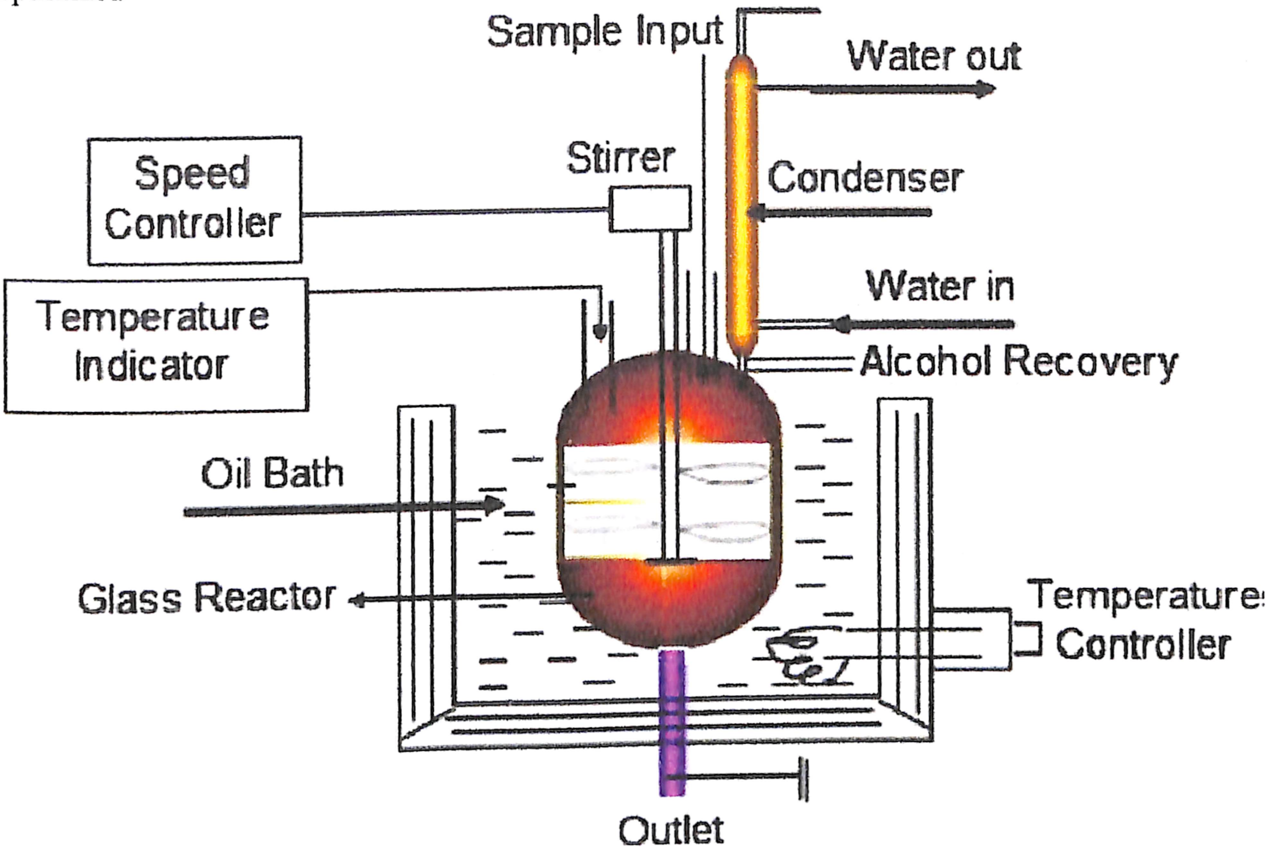
Mustard meal can be a safer, more environmentally benign compound to use compared to methyl bromide and other farm chemicals.

DISADVANTAGES

- If crop oils are available at 10 cents per pound or less, biodiesel could be made for $1.00 per gallon of B100 (pure biodiesel).
- To get the value of the oil down below market prices, the oil must be inedible for humans as well as animals.
- For the oil seed crusher to make money when the oil is nearly worthless, the meal must have a higher value than animal feed.
- There must be a large industrial market for the meal that drives demand for the crop to produce enough oil to make a national impact on oil supply.

PRODUCTION

Biodiesel from mustard oil was produced in a laboratory scale set up (Fig. 1) which consists of heating mantle, reaction flask and mechanical stirrer. The working capacity of reaction flask is 1 l. It consists of three necks for stirrer, condenser and inlet of reactant as well as for placing the thermocouple to observe the reaction temperature. The flask has a stopcock at the bottom for collection of the final product. The procedure for preparation of methyl esters varies from oil to oil depending upon their chemical composition and free fatty acids (FFA) content. Process parameters such as the mode of reaction condition, molar ratio of alcohol to oil, type of alcohol, type and amount of catalysts, reaction time and temperature and purity of reactants were optimized



Bio-diesel is formed from oils by a process called 'TRANSESTERIFICATION' in which vegetable oil is reacted with an alcohol in the presence of catalyst and glycerol is formed as a by product. Basically we take 1000ml of jatropha oil which is reacted with methyl alcohol(200 ml) in the presence of H2SO4 and stir for 3 hour which gives blackish organic waste and is removed with the help of settling flask. After removing, oil is again reacted with methyl alcohol in the presence of KOH. Thus it involes two reaction acid and base. Now this reaction produces biodiesel and glycerol. The glycerol is separated by separating flask in which glycerol settle down. After which biodiesel is washed with water and made dry with the help of silica gel(absorbing moisture).

After the production of bio-diesel we tested its blend with diesel and also pure bio-diesel in diesel engine for its performance, emission, and combustion. The result is calculated in the form of graphs.

Basic reaction

CH_2COOR' | $CHCOOR''$ | CH_2COOR'''	3 ROH	Catalyst	CH_2OH | CHOH | CH_2OH	R'COOR + R''COOR + R'''COOR
60 Kg Oil	6.78 Kg Alcohol	0.60Kg NaOH	6.5 Kg Glycerin	58 Kg Biodiesel

ENGINE TESTING:-

First we calculate the density of the fuel or the blend we are using. For mustard oil 20% blend density is .826 and for 50% blend density is .843, now with the help of bomb caloriemeter find rise in temperature. Then calculation for calorific value as:-

Cv= 4.18*{T2*W-(CVt+CVw)}/M

Where W=water equivalent in calories

W= {(6319*weight of benzoic acid)-(21+9.72)}/T1

CVt= calorific value of thread = 21

CVw= calorific value of wire = 9.72

M = weight of fuel

Now we feed the density and CV to the system software to get the performance as well as emission results:-

FOR 20 % BLEND OF MUSTARD OIL

DENSITY: 0.826 gm/cc
CALORIFIC VALUE: 46681.93 KJ/KG

Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO %vol	0.08	0.06	0.06	0.08	0.08	0.08
HC ppm hex	44	39	46	41	39	41
CO2 %vol	8.4	6.9	5.6	4.3	3.3	2.4
NO ppm vol	1246	1029	743	386	222	117
SMOKE	61.1	33.5	29.8	25.3	19.8	10.6
ROOM TEMPERATURE(C)	41	41.1	41.2	41.2	41.2	41.2
HUMIDITY %	10	10	10	10	10	10

FOR 50% BLEND OF MUSTARD OIL

DENSITY: 0.843 gm/cc
CALORIFIC VALUE: 41864.76 KJ/KG

Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO %vol	0.08	0.06	0.07	0.09	0.09	0.09
HC ppm hex	42	36	33	29	28	31
CO2 %vol	8.6	7.0	5.5	4.5	3.0	2.4
NO ppm vol	1243	1079	756	409	227	121
SMOKE	65.1	53.8	51.9	31.6	.30.3	14.3

ROOM TEMPERATURE(C)	41.5	41.7	41.7	41.6	41.6	41.6
HUMIDITY %	10	10	10	10	10	10

RESULT AND DISCUSSION:

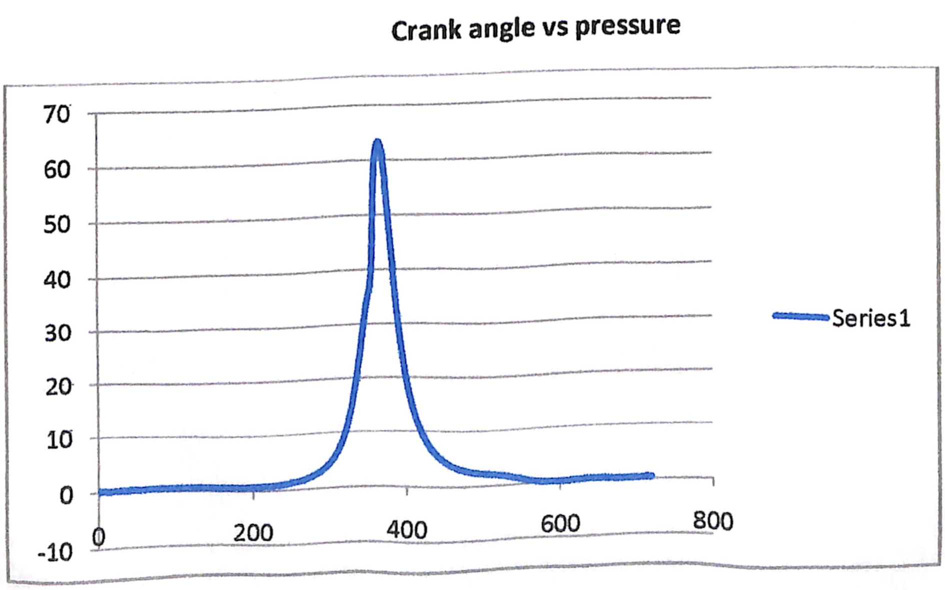
CHARACTERIZATION OF BIODIESEL FROM MUSTARD:

The properties of biodiesel and their blends are compared with those of ASTM biodiesel standards. Most of the fuel properties of mustard and their blends are comparable to those of diesel. The present results obtained show that the transesterification process improved the fuel properties of the oil with respect to density (0.869gm/cc), calorific value (39738.26kJ/kg),.

The calorific values of all the biodiesel and their blends are lower than that of diesel because of their oxygen content. The flash point of all the biodiesel and their blends is lowered by transesterification, but it is still higher than that of diesel. Addition of a small quantity of biodiesel with diesel increases the flash point of diesel. Hence, it is safer to store biodiesel–diesel blends as compared to diesel alone.

COMBUSTION ANALYSIS:

Graph is plotted between crank angle and pressure for 50% blend of mustard with diesel. Peak pressure also studied and compared with diesel.



50% mustard oil blend

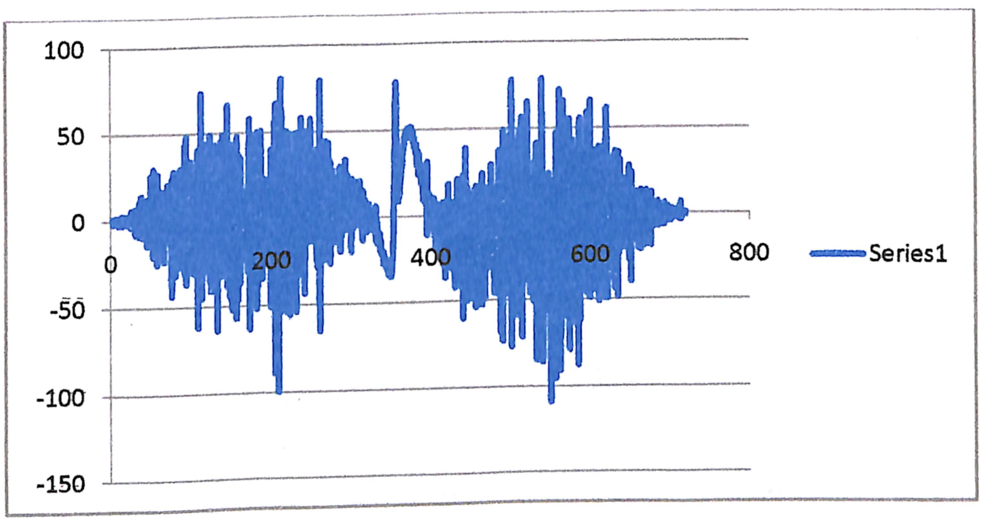
EFFECT OF BLENDS ON CYLINDER PRESSURE:

We run the engine at different blends of soyabean like 20 and 50 percent and found that the peak pressure is 63.35 bar.

EFFECT OF BLEND ON HEAT RELEASE RATE

Heat release rate indicating that the ignition delay for biodiesel and their blends was shorter than that for diesel. It can also be seen that the maximum heat release rate of biodiesel and their blends is lower than that of diesel.

Crank angle vs heat release



50% mustard oil blend

5. RESULT:

On comparing the emissions of pure diesel and bio-diesel it is found that at high loads emission of bio-diesel is less than that of diesel.

FOR PURE DIESEL:

DENSITY: .815 gm/cc
CV: 39524.13 KJ/KG

Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO %vol	.09	.06	.05	.06	.06	.07
HC ppm hex	59	34	35	36	27	31
CO2 %vol	8.7	6.8	5	4.1	2.7	2.3
NO ppm vol	1329	985	628	353	184	115
SMOKE	49.9	26.9	20.4	10.1	7.9	4.3
ROOM TEMPERATURE(C)	41.2	41.1	40.6	40.8	41	41.1
HUMIDITY %	10	10	10	10	10	10

FOR 50% BLEND OF JATROPHA OIL

DENSITY: 0.844 gm/cc

CALORIFIC VALUE: 39770.33 kJ/kg

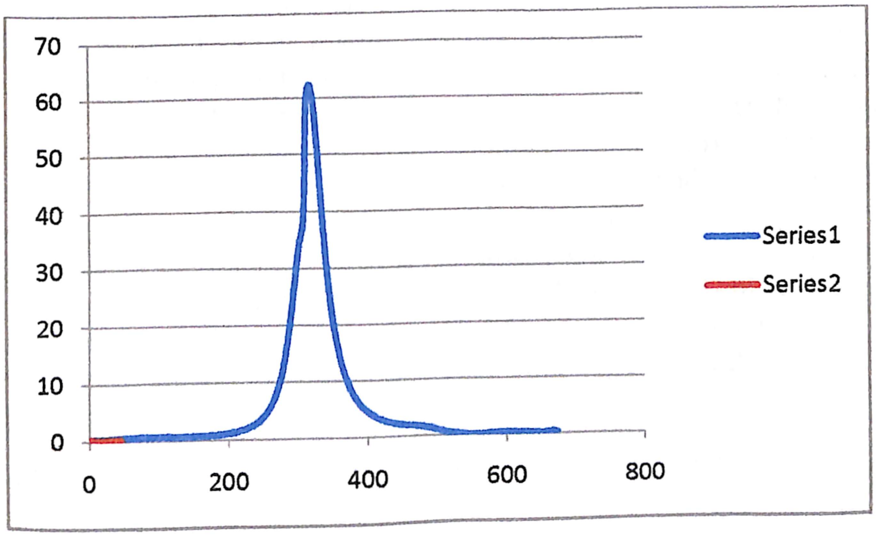
Load ->	10KG	8KG	6KG	4KG	2KG	0KG
Emission						
CO %vol	0.09	0.006	0.06	0.08	0.08	0.08
HC ppm hex	41	36	35	42	35	41
CO2 %vol	8.8	7.2	6.0	4.7	3.6	2.2
NO ppm vol	1297	1063	819	466	270	121

SMOKE	49.9	30	28.4	25.5	20.9	11.4
ROOM TEMPERATURE(C)	40.8	40.8	40.9	41	41	40.9
HUMIDITY %	10	10	10	10	10	10

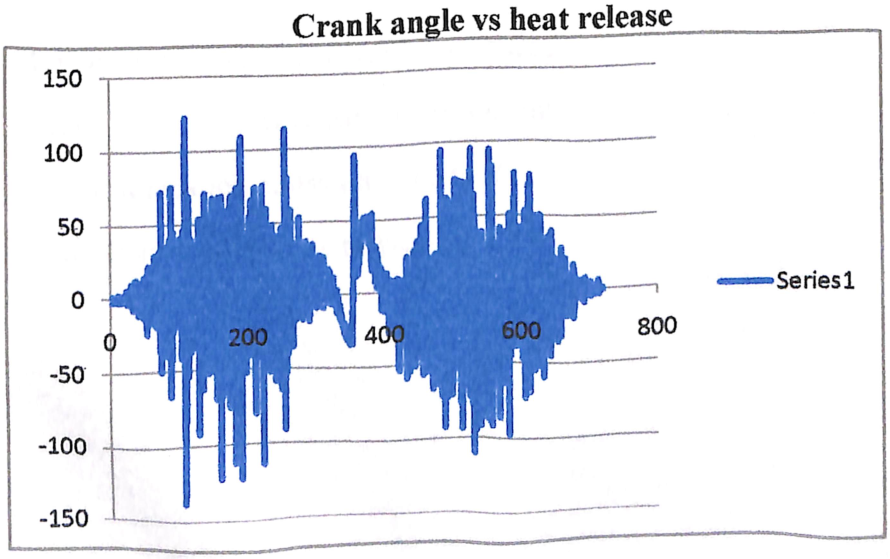
On comparing the performance of diesel and bio-diesel it is found that bio-diesel has high peak pressure and heat generation as compared to diesel. For diesel max peak pressure is 63.32bar and for bio-diesel it is 64 bar.

For diesel

Crank angle vs pressure



Crank angle vs heat release



6. CONCLUSION:

The appropriate blend necessary to ensure optimum performance, low-emission and best combustion characteristics depend upon the particular feedstock and the subsequent biodiesel formulation. The present analysis reveals that biodiesel from unrefined soyabean seed oil is quite suitable as an alternative to diesel. However, further research and development on the additional fuel property measures, long-term run and wear analysis of biodiesel fueled engine is also necessary along with injection timing and duration for better combustion of biodiesel in diesel engines.

Biodiesel, derived from vegetable oil or animal fats, is recommended for use as a substitute for petroleum-based diesel mainly because biodiesel is a renewable, domestic resource with an environmentally friendly emission profile and is readily biodegradable. The use of biodiesel has grown dramatically during the last few years. Feedstock costs account for a large percent of the direct biodiesel production costs, including capital cost and return. The amount of FFA was reduced from 93 wt % to less than 2 wt % at the end of the esterification process. The FAME was pureed by neutralization with 0.1 M sodium hydroxide in water solution at a reaction temperature of 62 °C. Condition parameters for esterification process for methanolysis of rapeseed oil were 1.8 % H2SO4 as catalyst, MeOH/oil of molar ratio 2: 0.1 and reaction temperature 62 °C, for a period of 3h. The yield of methyl ester was > 90 % in 1 h. Biodiesel has a viscosity much closer to diesel fuel than vegetable oil. The cost of biodiesel is higher than diesel fuel.

In general as discussed, biodiesel has some benefits such as:

- Cheaper fuel for consumers,

- More energy security & diversified sources,

- Higher farm incomes & rural employment,

- Significant carbon emission reduction,

- Lower Imports & energy prices

Reference

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