ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Experimental Study of 4-Stroke Cylinder Water Cooled Rope Brake Diesel Engine Using Cotton Seed Oil

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ABSTRACT:
In this experimental investigation, the various percentage of cotton seed oil are blended with diesel and the performance and emission characteristics of 4-stroke diesel engine are calculated. The optimal percentage of cso blend had derived to find out the maximum possibility of fossil fuel replacement. The addition of diethyl ether in the percentages of 0, 5, 10, 15 and 20 were done respectively and the observations are compared. The results indicated that brake thermal efficiency of CSO blends were improved than others.

Key Words: ***4-Stroke Cylinder, Vegetable Oils, Cotton Seed Oil, Biodiesel***

1.1 INTRODUCTION:

The rise in civilization may be closely tied to improvements in transportation. Our present transportation system consists of railroads, ships automobiles and planes depend on mechanical power. Practically all of this power is derived from combustion engines are divided into two general cases, external combustion engines and internal combustion engines.

Internal combustion engines are one of the important forms of prime movers, which run essentially on liquid fuels. IC engines can be divided into two main categories viz. petrol and diesel based engines otherwise called spark ignition engines and compression engines.

Compression ignition engines due to their inherit fuel economy, easiness in operation, maintenance and long life, find wide usage in the fields of transportation, marine, earth, moving machines, industries power generation and agriculture. Better part load performance and improved emission characteristics have made it popular in small automobile engines for passenger cars and light trucks. In India, the number of CI engines is so large that the bulk of available petroleum is consumed in the form of Diesel fuel.

According to the oil Co-ordination Committee, in India, the Diesel oil consumption rate was 28.3 million tons in 1994-95 and 39.3 million tons in 1999-2000 and is estimated to reach a figure of 46.5 million tons by 2004-2005, whereas during the same period, the petrol consumption is estimated to rise from 3.1 million tons. This demand is partly being met through import of diesel oil an exorbitant price.

1.2 URGENCY FOR AN ALTERNATE FUEL:

1.2.1 ALTRNATE FUELS

In the present industrialized world, the consumption of the petroleum products has an index of countries prosperity. It is increasing at a very rapid rate. Out of known reserves only a part may technically and economically feasible to expose. This I fact coupled with the present and expected consumption rates implies that these reserves may not beyond next 30 years. For India the situation could be even more difficult, over the last 15 years. The demand for the petroleum products in India has risen by an annual compound rate of 6.1%. Apart from the petroleum conservation there is a global threat through the environment due to the polluting nature of the conventional fuels.

The existing reserves are largely in countries of the Middle East, which come under OPEC (oil producing and exporting countries). The world is just as was a decade ago on oil. While new source and plateau in consumption have temporally reduced OPEC leverage, the fundamental vulnerability to reduce supply remains and the punishing economic consequences of current prices continue.

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Table 3.1 pollutants and their causes and effects:

Pollutants	Cause	Effects
CO	Incomplete combustion	Heart disorders
HC	When carbon molecule fails to burn	Drowsiness, coughing
NO	High-pressures	Morbidity, bronchitis

1.3 SCENARIO OF ALTERNATE FUELS

Research is on since interception of IC engines to find out the alternative fuels, also experimented as a dual fuel with existing fuel i.e., blended in certain proportions with existing fuel. I.I.Ps, various relevant research centers, I.I.Ts did experiments on available vehicle engines and compared the performance, stability, resources availability and economy. They classified alternate fuel into 3 categories as

- Existing fuels: diesel, petrol, blended with alcohols
- Fuels of tomorrow: CNG, LPG, vegetable oils
- Fuels of future: hydrogen, ammonia, electricity

2.1 EXISTING FUELS:

2.1.1 Ethanol

Ethanol is an alcohol typically fermented from grain. It is an octane enhancer added to motor fuel up to 10 percent. It will increase octane 2.5 to 3 points at a 10 percent concentration. Ethanol is a fuel oxygenate. Specially designed vehicles are being manufactured to run on 85 to 95 percent ethanol.

Ethanol, $C2H5OH$,(also called Ethyl alcohol) is the second member of the aliphatic alcohol series. It is a clear colorless liquid with a pleasant smell. Except for alcoholic beverages, nearly all the ethanol used industrially is a mixture of 95% ethanol and 5% water, which is known as 95% alcohol. Although pure ethyl alcohol (known as absolute alcohol) is available, it is much more expensive and is used only when definitely required.

Ethanol reduces the consumer cost of gasoline by extending supplies, providing an alternative to costly imported oil and leverage for independent gasoline marketers to compete against the larger, more powerful integrated oil companies. The ethanol tax incentive is crucial to farmer's bottom lines. Ethanol production helps boost U.S farm income by $4.5 billion.

Ethanol is only environmentally friendly, renewable fuel available for use in fuel cells. In fuel reformers, which convert the ethanol and other hydrocarbons to hydrogen, ethanol has demonstrated fewer emissions, higher efficiencies and better performance. E-diesel, a blend of 15% ethanol, 5% blending additive, and at least 80% diesel is being developed. Testing to date has proven that E-diesel can lower particulate emissions by 20-30%, reduce the sulphur content, and out-perform No.2 diesel fuel in winter conditions, all without mechanical changes or problems.

Ethanol reduces particulate emissions, especially the fine-particles that pose a health threat to children, senior citizens, and those with the respiratory ailments. A recent study by the governor's Ethanol coalition concluded that ethanol poses no threat to surface or ground water. Since the ethanol is naturally occurring substance produced during the fermentation of organic matter, it is expected to rapidly biodegrade in essentially in all environments. Ethanol, a renewable fuel made from agricultural feedstock's, is one of the best tools we have to fight air pollution.

2.2 FUELS OF FUTURE:

2.2.1 VEGETABLE OILS

The best substitutes for petroleum are the vegetable oils because they have the same base chemical structure as petroleum. Since the first crisis of 1970's various alternative fuels have been investigated with the goal of replacing conventional petroleum supplies. Some of the major oil seeds used in the world production is shown in table 4.1. The initial interest was mainly one of the fuel supply security, but recently more attention has been focused on the use of renewable fuels in order to reduce the net production of $CO2$ from the combustion sources. Ethanol and methanol are the two accepted alternate fuels, which posses the potential to be produced from the biomass sources. Neither of these fuels is well suited for use in compression ignition engines and the use of ignition improves and high compression ratios are common.

One type of fuel, which is well suited from use in compression ignition engines, is that of vegetable oils

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based fuels. They are renewable and produced easily in rural areas. The choice of the vegetable oil for compression ignition engine fuel naturally depends upon the local conditions.

A number of oils is being considered worldwide for the use as rice bran oil, cottonseed oil, sunflower oil, rapeseed oil etc. Different studies all over the world have successfully demonstrated that given the adequate availability of these oils, they can be partially or fully replace petroleum oils as engine fuels and lubricant. The usage could be in vegetable oil blends, complete sustainable to diesel.

Table 2.1 World Production of some Major oil Seeds:

S.No	CROP	PRODUCTION (million tones)	% of total production
1	Soybean	100.2	56.8
2	Cottonseed	25.7	14.6
3	Sunflower	15.5	8.8
4	Groundnut	11.9	6.7
5	Rapeseed	10.9	6.2
6	Copra	4.6	2.6
7	Linseed	3.2	1.8
8	Palm kernels	1.4	0.8
9	Castor seed	1.0	.6
10	Others	2.1	1.1
	Total	175.6	100.0

2.2.2 Composition of Vegetable oils:

Fats and oils are water insoluble hydrophobic substance primarily composed of fatty ester of glycerol (triglycerides) successfully: a triglyceride is a reaction product of one molecules of water and molecule of triglyceride.

3.0 BIODIESEL

Biodiesel is a diesel replacement fuel that is manufactured from vegetable oils, recycled cooking greases or oil or animal facts. Because plants produced oils from sunlight and air, and can do year after year on cropland, these oils are renewable. Animal facts are produced when the animal consumes plant oil and other fats, and they too are renewable. Used cooking oils are mostly made from vegetables oils but may also contain animal fats. Used cooking oils are both recycled and renewable.

The biodiesel manufacturing process converts oils and fats into chemicals called long chain mono alkyl esters, or biodiesel. These chemical are also referred to as fatty acid methyl esters are FAME. In the manufacturing process, 100 pounds of oils are fats, are reacted with 10 pounds of a short chain alcohol (usually methanol) in the presences of a catalyst (usually sodium or potassium hydroxide) to form 100 pounds of biodiesel and 10 pound of glycerin. Glycerin is a sugar, and is co-product of the biodiesel process.

The biodiesel manufactured from the cotton seed oil is used in our project as an alternate fuel. Esterification process is carried out in order to purify the oil and obtain the esterified oil. The following figure shows the cotton seeds from which the oil is extracted. In this way the waste is used to run the automobiles which in turn help in reducing the depletion of fossil fuels.

Fig 3.1: COTTON

Fig 3.2: COTTON SEEDS

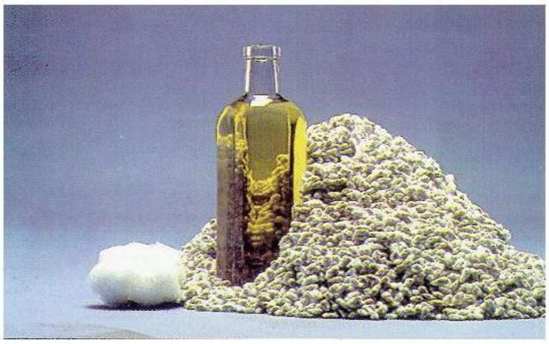

Fig 3.3: COTTON SEED OIL

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3.2 BENEFITS OF BIODIESEL USE:

Biodiesel Displaces Imported Petroleum
Biodiesel Reduces Emissions

4.0 PREPARATION OF BIODIESEL:

4.1 BIODIESEL TRANESTERIFICATION

The process of producing biodiesel is known as "Esterification". In this present work an attempt is made to produce the biodiesel in laboratory.

Biodiesel is made through a chemical process called transesterification where by glycerin is separated from the fat or vegetable oil. The process leaves behind two products-methyl esters and glycerin, a byproduct that can be used for the production of soap. This process can happen on any scale in a mason jar or in large scale production facility.

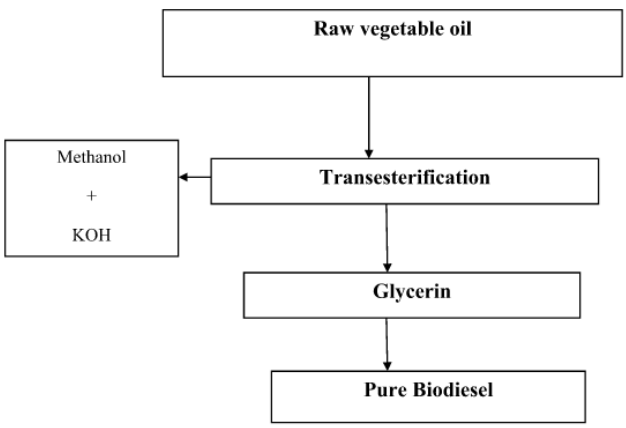
4.2 ESTERIFICATION PROCESS:

First 1.5 Kg of methanol and 0.75 Kg of Potassium Hydroxide in mass basis are taken and mixed thoroughly and then this mixture is poured in a vessel where 15 liters of crude cotton seed oil has been taken. Since temperature catalyst type and concentration ratio of alcohol to fuel and stirring rate will influences the Esterification process to greater extent; care has been taken to maintain the same.The vessel has been heated and maintained between 60 to 70 degrees centigrade. The stirrer speed is maintained at 150 rpm.

4.3 Esterification to produce biodiesel fuel

Crude Oil + Methyl Alcohol (CH 3OH) + KOH →
Bio Diesel + Glycerin

Flow Chart to Prepare the Biodiesel:



5.0 PERFORMANCE TEST

The test for study consists of two broad phases. In Phase 1 all the preliminary investigations were done to ascertain the feasibility of the use of CSO as fuel. In Phase 2 the final investigations concerning the actual running of the engine with CSO as the fuel was attempted and the performance parameters recorded.

5.1PRELIMINARY INVESTIGSTIONS:

This phase of investigation was done with utmost care, as any discrepancy in the test result would have disastrous effects on the engine without the test objectives having been fulfilled. This phase consisted of the following tests:

5.1.1 Tests for density and specific gravity determinations of the test fuel in order to ascertain its mess characteristics compared to diesel oil:

EXPERIMENTAL SET UP

The usual beam balance and flask was used to determine the density and specific gravity of the test fuel and various blends.

PROCEDURE

In this test a standard flask was taken. The test fuel was filled and weighed in a beam balance. Later the weight of the empty flask as well as the flask filled with water was weighed and observations are recorded. The procedure was repeated for blends of CSO and Diesel. The table 7.1 shows specific gravity and density of diesel and its blends.

5.1.2 Tests for determining the viscosity of the oil/blends to find its flow ability and its effect on injection pressures:

EXPERIMENTAL SET UP

The viscosity tests were conducted on Engler's Viscometer which is shown in fig 7.1 with an electrically heated water bath. A usual measuring jar was used to collect a known volume of the test fuel.

PROCEDURE

As mentioned earlier the test was filled in the inner cup of the Engler's viscometer, the cup was placed in oil bath. The time efflux of a known volume of the fuel was noted in Engler's standard seconds.

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Fig.5.1: Engler's Viscometer

6.0 RESULTS AND DISCUSSIONS

GRAPHS

The Frictional Power can be determined by plotting WILLMANS graph i.e. by taking Brake power on X-axis and mass flow rate of fuel on Y-axis.

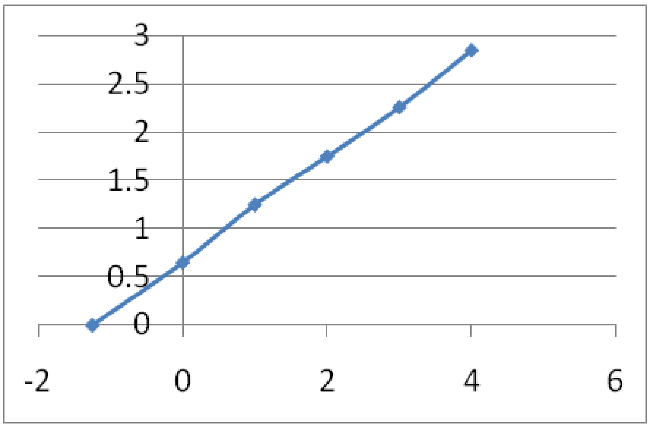

FIG 8.1 MF VS BP (DIESEL)

The above graph is for pure diesel where FP is 1.25.

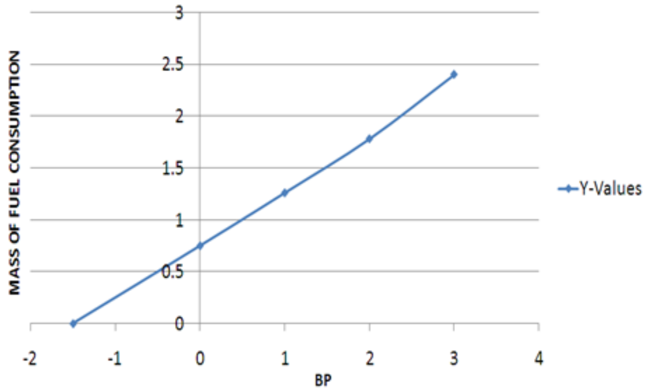

FIG 8.2 MF VS BP (B5)

The above graph is for B5 i.e. 5% SCO and 95% diesel who's FP is 1.5.

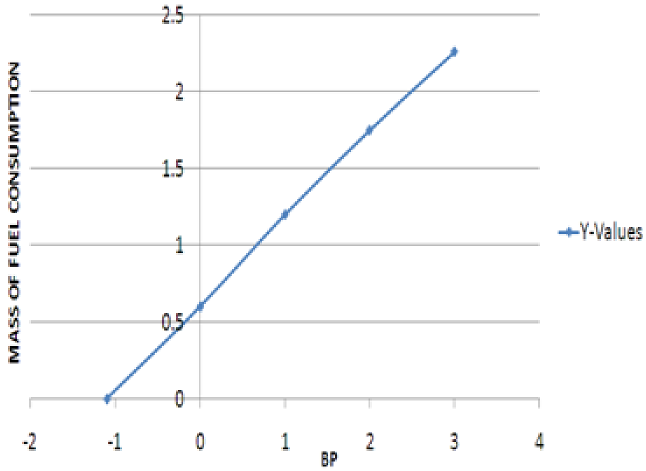

FIG 8.3 MF VS BP (B10)

The above graph is for B10 i.e. 10%CSO and 90% diesel who's FP is 1.1.

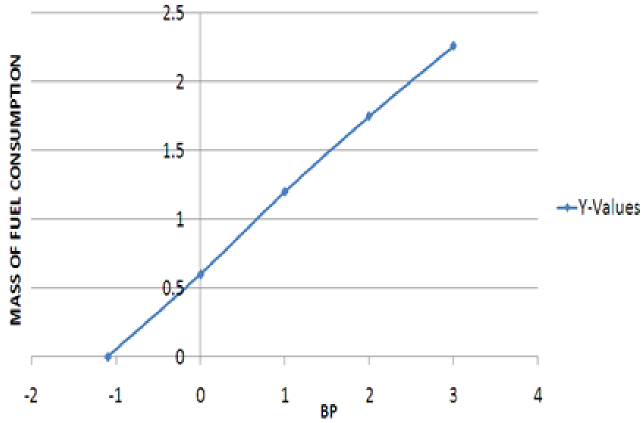

FIG 8.4 MF VS BP (B15)

The above graph is for B15 i.e. 15%CSO and 85% diesel who's FP is 0.95.

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7. CONCLUSION:

Conservation of energy had become a matter of serious concern in the past decades as petroleum resources are limited and are being consumed at alarming rates has intensified the search for alternatives to petroleum based fuels.

There are wide varieties of transportation fuels, which can be reducing dependence upon petroleum. Many of these fuels will be cost competitive with gasoline in a near future.

When performance test conducted on 4-Stroke single cylinder water cooled diesel engine using pure diesel and diesel/CSO blend the following conclusions were observed.

1. Blends of CSO and diesel have higher specific gravities, higher viscosities and higher flash and fire points. Among the blends 20% CSO and 80% diesel has the highest specific gravity, viscosity and flash & fire points.
2. The calorific value of the blends is decreasing as the percentage of CSO in the blends is increasing.
3. The Brake thermal efficiency, Indicated thermal efficiency is approximately nearer for blends and pure diesel. The values of BTH for diesel and its blends are clearly understood from the graphs i.e. for B0-33%;B5-32.14%;B10-32.4%;B15-32.9%;B20-32%. Therefore it is all similar for all the oil mixtures used.
4. Brake Specific Fuel Consumption is minimum for diesel compared to blend mixture.

Hence from the above conclusions blends of CSO/diesel can be used as alternative fuel for the diesel engine, even though there may be some fuel economy problem it can be used as substitute for diesel since the use of these blends will decreases the consumption of the diesel as there is a fear of exhaust. All the energy used does, however some negative impacts have on the environment. Therefore, whatever the fuel we use for the transportation they should be used in most efficient manner possible.

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