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# EXPERIMENT AND ANALYSIS OF EMISSION CHARACTERSTICS BIO FUEL USING DIESEL ENGINE WITH ALEXANDRIAN LAUREL SEED OIL

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***Abstract: Biodiesel, a light to dark yellow liquid, is biodegradable, non-toxic and has significantly fewer emissions than petroleum-based diesel. It is practically immiscible with water, has a high boiling point and low vapour pressure. Biodiesel is produced from a wide range of feedstock, including fresh soybean oil, mustard seed oil, waste vegetable oil, palm oil, rapeseed, sunflower, soybean and jatropha, copra, palm, groundnut and cotton seed.In the present years, population of vehicles increased enormously which increases the demand of fossil fuel, The availability of conservative fuels decreased continuously, these reasons makes to find the alternative fuels especially biofuels . The use of biodiesel considerably reduced emission and increase the performance of the engine.Now a days researchers have reported the possibility for the production of biodiesel from non edible oil jatropha curcus , pongamia pinnata etc. There is a best source of raw material that is Alexandrian laurel seed oil for biodiesel production. In present study Alexandrian laurel seed oil is used as fuel in C.I engine. The main objective of the present study was to use the non-edible Alexandrian laurel seed oil as biodiesel in ci engine. to reduce the viscosity of neat Alexandrian laurel, transesterification was done to bring it close to that of conventional diesel. In order to obtain a basis for comparison, Various blends are used such as (B10, B20,B30,B100) from this blends B20 shows best results compared to the diesel. Observe the brake thermal efficiency, Brake powder, Break mean effective pressure, Specific fuel consumption at various loads.To improve the performance characteristics Isobutanol additive added in the B20 in the concentration of 10% and 15%. Observe the which blend gives the good result in single cylinder operation based on the result.***

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## INTRODUCTION

### ALEXANDRIAN LAUREL

The Alexandrian Laurel has derived its generic name from the Greek terms ‘kalos’ denoting beautiful and ‘phullon’ meaning leaf. In other words, the generic name of this species means the beautiful-leafed tree in Greek. Similarly, the precise nickname (epithet) of this tree also has its origin in two Greek words – ‘is’ meaning fiber and ‘phullon’ denoting leaf that refers to the prominent veins on the underside of the leaves of the Alexandrian Laurel.The tree is cultivated for providing shade as well as reforestation and afforestation – an initiative to reclaim soil. In many places, tree is also planted along the shores because it has proved to be effective in preventing soil erosion by the sea. While the growth of the tree is very sluggish, it is very popular as a roadside plantation in India. Additionally, it is also an attractive ornamental plant, as it has young foliage that is crimson in color. Even the flowers are very aromatic.

**Figure 1ALEXANDRIAN LAUREL LEAFS AND SEEDS**

**HISTORY:**

As early as 1863, the Frenchman Etienne Lenoir had test-driven a vehicle which was powered by a gas engine which he had developed. However, this drive plant proved to be unsuitable for installing in and driving vehicles. It was not until Nikolaus August Otto's four-stroke engine with magneto ignition that operation with liquid fuel and thereby mobile application were made possible. But the efficiency of these engines was low. A diesel engine is an internal combustion engine. • It converts gasoline into motion • It is the most common car engine type • It is relatively efficient •

**Figure 2A train running on bio-diesel.**

It is relatively possibility for the production of biodiesel from non edible oil jatropha curcus , pongamia pinnata etc. There is a best source of raw material that is Alexandrian laurel seed oil for biodiesel production. In present study Alexandrian laurel seed oil is used as fuel in C.I engine. The main objective of the present study was to use the non-edible Alexandrian laurel seed oil as biodiesel in ci engine. to reduce the viscosity of neat Alexandrian laurel, transesterification was done to bring it close to that of conventional diesel. In order to obtain a basis for comparison, Various blends are used such as (B10, B20,B30,B100) from this blends B20 shows best results compared to the diesel. Observe the brake thermal efficiency, Brake powder, Break mean effective pressure, Specific fuel consumption at various loads.

**NEED FOR BIO-DIESEL IN INDIA:**

One of the most important ingrdients in the recipe of 21st century growth is energy. And to surmount the challenge of availing such energy without compromising the government's progress towards other targets – including climate change – India launched the National Biofuel Policy (NBP) in 2008. One motivation was that 10 million litres of E10 biofuel could save Rs 28 crore in forex and around 20,000 tonnes of carbon dioxide emissions. Biofuel is the product of blending a fossil fuel with a certain percentage of ethanol. This ethanol is generally extracted from crops, oilseeds and waste, and mixed in a ratio that doesn't affect the properties of the fossil fuel while reducing the amount of greenhouse gases it emits when combusted. In 2008, the NBP targeted an ethanol fraction of 20% in both petrol and diesel by 2017.However, by 2017, the government had achieved only a 2% blend with petrol and about 0.1% with diesel.

Some of the reasons need bio-diesel in India:

Lack of crude oil (conventional) resources.

For reducing pollutant products to fulfil the aim of 'SWACHH BHARAT '.

Utilizing the sources available in forest areas.

To reduce the amount of imported fuels from other countries.

By introducing the bio diesel into the agricultural sector can become a great revolution for reducing diesel usage in locomotive engines.

**SCOPE FOR PRODUCTION OF BIO DIESEL IN INDIA:**

The economic development of any country depends upon the source of energy. India being a developing country requires much higher level of energy to sustain its rate of progress. The dependency on energy resources of India is of similar pattern to other developing country. Coal and oil, the major fossil resources are on the driver seat. The rapid mechanization in agriculture sector and other unorganized small scale industrial sector needs more and more oil and electricity in future. As per the current estimates, oil reserves in India will exhaust in next few years. It is estimated that oil demand and supply almost quadruple during the last quarter century. At present, India is enabling to produce about one-third of the total petroleum fuels required. However, the remaining being imported which consume major share of foreign exchange earn by the country. The development and promotion of appropriate technology for utilizing non- traditional energy resources is coming up strategically as an emerging solution to the present energy and environmental crises.

**INTERNAL COMBUSTION ENGINE & ALTERNATEFUELS:**

The fuels of both SI and CI engines are commonly fossil based and have uncertain future because of their limited reserve and environmental impact. Hence to meet the international standard for both fuel consumption and exhaust emission, several proven options are being available starting from expensive engine hardware modification to cheaper alternative fuels. In Indian context, the use of existing IC engines with little or no modifications is a promising and viable solution which can only be possible through the route of alternative fuels. In general, two broad types of IC engines are spark ignition (SI) engine and compression

ignition (CI) engine which are popular in the society as petrol and diesel engine respectively. SI engine uses fuels with high auto ignition temperature like petrol, alcohol and gaseous fuels. The combustion in this engine is initiated at a single location by a spark and the developed flame thenpropagates in to the pre-mixed fuel air mixture in a progressive manner.

## PROCESS OF UTILIZATION OF VEGETABLE OIL AS DIESEL ENGINE FUEL

The vegetable oil can be used in different ways during diesel engine operation as follows:

Neat form

Partially substitution (blending and micro-emulsification)

Trans esterification

**Blending:**

Blending is the method of direct mixing of two completely miscible fluids. An appropriate proportion of vegetable oil with conventional diesel fuel blend runs the engine without any modification.

Figure 3 Blending

**Micro-emulsification:**

MEs refer to monophasic, optically isotropic, thermodynamically stable, and clear dispersions formulated from oil, water, surfactant, and a cosurfactant. The term microemulsion, which was first used in 1943 by Hoar and Schulman, is ambiguous because it is not clear from the term that several phases and structures can be present. Water or oily droplets and bicontinuous structures can form even within the microemulsion domains. Microemulsions are effective drug delivery vehicles since they are simple to prepare (an external energy source is not required) and are thermodynamically stable (ME phases do not easily separate over time and a majority of microemulsions are stable for many years). It is stabilized by the addition of a surfactant and co- surfactant. This phenomenon deals with the equilibrium dispersion of optically isotropic fluid micro structures.

## ADVANTAGES & DISADVANTAGES OF BIO-DIESEL:

**ADVANTAGES:**

High energy return and displace petroleum based fuels.

- Reduces life-cycle Greenhouse emission.
- Reduces pollution.
- Improves air quality and positive impact on human health.
- Utilizing bio diesel where the conventional fuels are not available.

**DISADVANTAGES:**

- Conversion of raw oil into bio-diesel is difficult
- Time taken process.
- NOx from the emission of bio-diesel is high when compared conventionalfuels.
- Some bio-diesels requires engine modifications.
- Bio-diesel having low calorific value & high viscosity.

**OBJECTIVES OF PRESENT WORK:**

Collection of Alexandrian laurel seeds from different source sand extracting oil.Collecting requirements for the present work based on standard journals.Converting raw oil into bio-diesel.Make ready the computerized MFVCR engine.Conducting base line test using diesel. the properties of bio-diesel and component with the base line value.Checking the performance. Combustion analysis of the Alexandrian laurel seed bio-diesel with additives.

## LITERATURE REVIEW

The main purpose of this literature review is to provide background information on the issues to be considered in this work and to emphasize the relevance of the present study. An intensive literature survey has been carried out from bio-diesel and its blends in diesel engine.The chapter contains the information we have got from different papers:

**BIO-DIESEL:**

In the present years non edible oils are easily obtained because of the availability. In the paper stated that potential Alexandrian laurel seed oil as a most promising feed stock for biodiesel production In this paper, several aspects such as physical and chemical properties of crude Alexandrian laurel seed oil and methyl ester, fatty acid composition, Transesterification blending and engine performance and emissions of Alexandrian laurel methyl ester were studied. Overall, Alexandrian laurel seed oil appears to be an acceptable feedstock for future biodiesel production.T.M.M. Marso et al. studied the production of biodiesel from Alexandrian laurel seed. In this biodiesel production raw oil is prepared and then the viscosity of the oil is reduced by the transesterification process.

Sahid at el studied the use of biodiesel in CI engine by using edible oils such as soybean oil, sunflower oil, cotton seed oil. It can reduce the emission reduced in the engine but it has one limitation for the use edible oil as biodiesel i.e.

edible oils are used as the food crops in daily life due to its unavailability non edible oils are used as biodiesel. Soo-young No studied the scope non edible oils in the present generation. Due to the unavailability of edible oils non edible oils are preferred. Non edible oil such as jatropha, Karanja, linseed, rubber are used as fuels. In this jatropha is used as biodiesel in CI engine and the results were obtained concluded that NOx emissions increased by the use of bio diesel and reduced CO and HC emissions compared to diesel. B.AshokK.Nanda gopal, D.shakthi Vignesh stated Alexandrian laurel is a source of bio-diesel in India. The Alexandrian laurel trees in India can reduce the dependency on petroleum products. In present study different types of blends such as B100,B30,B60 are used for engine testing and comparing this results with conventional fuel. The results obtained by the engine shows performance characteristics increased by using Alexandrian laurel bio-diesel with out any modification.

**BIODIESEL ADDITIVES:**

B.Ashok,k.Nanda gopal in the present study anti oxidant additives are used in Alexandrian laurel seed bio-diesel to improve the performance of the engine. Anti oxidant additives such as Ethanox and Butylated hydroxytoluene are added to the Alexandrian laurel seed biodiesel in different concentrations. Experimentation conducted then results are compared. Ethanox has better performance compared to the Butylated hydroxytoluene.

N. Yilmaz et al studied the effect of butanol additive on the performance and emission characteristics on the diesel engine. Additives are added to the biodiesel to improve the characteristics. Results are concluded that the reduced the NOx emissions and slight increase in the CO and HC emissions by the addition butanol in the concentration of 5% and 10%. Al-Hasan studied the effect of Isobutanol addition to the diesel engine and the results are concluded that decrease brake thermal efficiency and increase the specific fuel consumption with the addition of Isobutanol compared to dieselengine.

The knowledge we have got from the studying the above papers:

- Different sources of production of bio-diesel inIndia
- How to convert the raw oil into bio-diesel (transesterification)
- Modifications required for engine.
- Different parameters that have been considered while the test is conducting.
- Pollutants from the bio-diesel and base line.
- Improving the performance of the diesel engine by adding additives.

**PREPARATION OF BIO-DIESEL:**

Preparation of bio diesel involves following process.

Collection of seeds from the sources and converting into raw oil.

- Pre-treatment
- Acid-test
- Esterification.
- Transesterification.
- Settling & separation
- Water washing.
- Post-treatment.

**Collection of seeds from the sources and converting into raw oil:**

The dry & cleaned Alexandrian laurel fruits from the different sources are collected sufficiently. By peeling the Alexandrian laurel dry fruits seeds has been extracted. The seeds are now used for producing raw oil. The seeds are gently cleaned and crushed in an oil mill. In the oil mill the seeds are fed into hopper and crushed by using helical grooves, due to high pressure, the seeds are crushed then raw oil & oil cake are the by products from this sources. The oil recovery was calculated to be near about 27%.We extracted (200 – 250) ml of oil by grinding 1kg of Alexandrian laurel seeds.

**Figure 4 Alexandrian laurel tree, seeds**

**PRE-TREATMENT:**

The pre-treatment involves following processes.

- Removing all dust particles by using filter papers.
- Heating the raw oil up to above the boiling temperature of the water toremove water content
- Keep that oil in an air tight seal bottle.

**ACID TESTING:**

The acid value of the fuel represents corrosive resistance of the engine with increase in the acid value of the fuel the engine parts become corroded.

**PROCEDURE:**

The acid number is a measure of the amount of carboxylic acid groups in a chemical compound,such as fatty acid.

Chemicals required:

- Conical flask.
- Measuring jar.
- Weighing machine.
- Burette.
- Heater.
- Ethanol (99% pure).
- Phenolphthalein indicator.
- Potassium hydroxide (KOH).

Figure 5 Oil sample

The oil sample of 2.5 gm is taken in a conical flask and added 20 ml of ethanol. Now the flask is placed on a hot plate, heat the solution up to formation of bubbles. Next the flask is taken out from the hot plate and subjected to rapid cooling. After cooling 2-3 drops of phenolphthalein indicator is added as a colour indicator. Then the solution is titrated with 1% of KOH solution until the colour changes to pale pink.

Burette reading: 11.5

Acid value = 25.76 mg of KOH/gm.

FFA value = 12.88 mg of KOH/gm.

ESTERIFICATION:

The Alexandrian laurel crude oil was first heated to 45-50 °C and 1% (by wt.) sulphuric acid was to be added to oil. Then methyl alcohol about (22-25)% (by wt.) was added. Methyl alcohol was added in excess amount to speed up the reaction. This reaction was proceed with stirring at 700 rpm and temperature was controlled at 55- 60oC for 90 min with regular analysis of FFA every after 25-30 min. When the FFA was reduced up to 1%, the reaction was stopped. The major obstacle to acid catalysed esterification for FFA is the water formation. Water can prevent the conversion reaction of FFA to esters from going to completion. After dewatering the esterified oil, it was fed to the transesterification process.

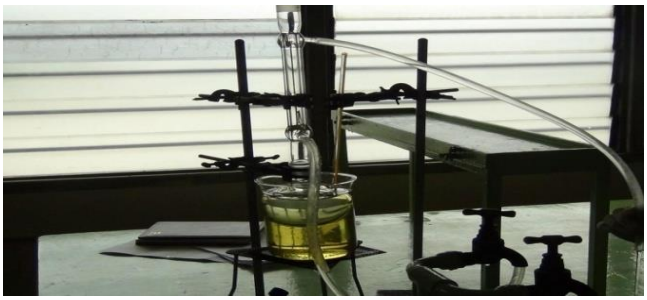

Figure 6 Esterification

**TRANSESTIRIFICATION:**

The conversion of straight vegetable oils into bio-diesel by the process called transesterification to overcome the usual problems encountered by using straight vegetable oils.However the transesterification procedure involves costly chemicals like ethyl / methyl alcohol and the suitable catalyst and also the controlled temperature and stirring equipment. It is difficult for a lay man to prepare bio-diesel from transesterification process. Especially Indian farmers are not well equipped and they do not have the time and patience to undertake this kind of complicated procedure.

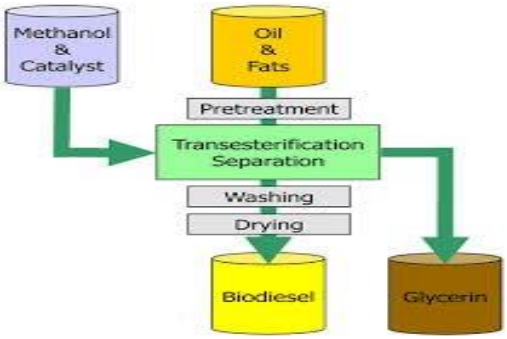


Figure 7 Transesterification

**SETTLING & SEPARATION:**

In the settling & separation process the solution is poured in separating funnel and fitted in a funnel stand. The settling time is required for the Alexandrian laurel seed oil is minimum 24 hours. After 24 hours the glycerine is settle downdue to density variation and due to gravity. In this stage we will clearly observe the glycerine and bio-diesel. The glycerine is separated by operating the knob available in separating funnel, bio diesel is taken out. Now bio-diesel is moved to water washing.

Equipment required:

- Separating funnel.
- Funnel.

- Stands.
- Clean cloth.

**WATERWASHING:**

In the water washing process the de-ionized water is initially heated up to 45-50 C. Now the 100ml of warm water is taken in a flask and equal amount of bio-diesel is mixed. Now the jar is closed with friction cap and shacked well. The solution appear in cream colour, this solution is poured in a separating funnel and allowed to settle down up to 30 min. After 30 min. the water, white milky layer and bio-diesel is separately appear in separating funnel. The water and white milky layer is separated from separating funnel by operating knob. In this stage partially cleaned bio-diesel is obtained. The white milky layer contains some impure particles and glycerine. This will be separated, and this process is continued by 3-5 times to get the pure bio-diesel. Now we are having the BIO-DIESEL.

Figure 8 water washing

***Applications:***

- It is used as paint solvent and varnish remover.
- It is used as paint additive, to reduce viscosity, improve brush flow
- It is used as fuel additive , to reduce pollutants and improve performance.
- It is used as automotive polish additive and paint cleaner additive.

**PROPERTIES OF PREPARED BIO-DIESEL.**

**Properties of bio-diesel:**

- Calorific value(CV)
- Flash point.
- Fire point
- Cloud point.
- Pour point.
- Cetane number.
- Acid value.
- Density.
- Viscosity.

**CLOUD POINT: (ASTM D2500)**

The cloud point is defined as "the temperature at which solidification of solution starts". At cloud point the bio-diesel will start the solidification and the liquid phase is converted into solid phase.

**POUR POINT:(ASTM D 97)**

The pour point is defined as "the temperature at which the completediesel is solidified". At pour point the bio-diesel is completely converted into solid phase and losses the flowable properties. At this temperature the diesel is not able to flow.

In the measuring of cloud and pour point initially 10 ml of bio-diesel is taken in a measuring jar, A beaker of 1000 ml is taken and filled with ice cubes and pour the Cacl2on ice to reduce the formation of water. After waiting some time the formation of fog will occur from this stage the temperature is measured in certain intervals. The temperature at which solidification will occur that is cloud point and the temperature at which the bio-diesel is completely solidified.

***CALCULATIONS:***

Kinematic viscosity (ν) = $At - \frac{B}{}$ centistoke

Absolute viscosity (μ) = ν ∗ ρcentipoise

**ACID VALUE: (ASTM D 6584)**

The acid value of the fuel represents corrosive resistance of the engine withincrease in the acid value of the fuel the engine parts become corroded.

The oil sample of 2.5 gm is taken in a conical flask and added 20 ml of ethanol. Now the flask is placed on a hot plate, heat the solution up to formation of bubbles. Next the flask is taken out from the hot plate and subjected to rapid cooling. After cooling 2-3 drops of phenolphthalein indicator is added as a colour indicator. Then the solution is titrated with 1% of KOH solution until the colour changes to pale pink.

$$\text{Formula} = \left(\frac{te\ reading}{oil\ sample\ weight}\right) * 5.6$$

Acid value = 2.016 mg of KOH/gm.

Figure 9 Acid testing

***EXPERIMENTAL SETUP DETAILS OF TEST RIG AND IT'S SPECIFICATIONS:***

The MFVCR engine test rig is a computer based analysis engine by using different sensors and thermocouples. The sensors are used in the present test rig that are used to find the speed, torque, fuel consumption etc., k-type thermocouples are used in the test rig to measure the temperature atvarious points.

***ENGINE SPECIFICATIONS:***

- *Engine: 4 stroke computerized variable compression ratio*
- Make: TECH-ED
- Basic engine: Kirloskar
- Rated power: 5 HP (DIESEL)
- Rated power: Up to 3 HP (PETROL)
- Bore diameter: 80mm
- Stroke length: 110mm
- Connecting rod length: 234mm
- Swept volume: 551cc
- Compression ratio: 5:1 to 20:1
- Rated speed: 1500 rpm

Figure 10 Experimental setup

**SPEED MEASURING SENSOR:**

Speed sensor is a electronic device that convert speed of the engine into digital form. The speed sensor is placed near the flywheel, based on the fly wheel revolutions it will convert that into digital form. By using this sensor no need any manual speed measuring devices like tachometer etc..

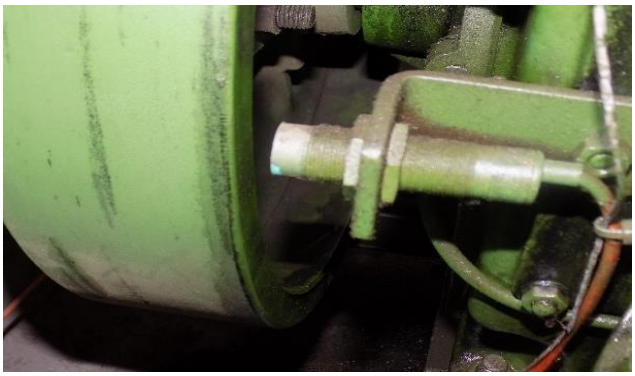

Figure 11 speed measuring sensor

**PERFORMANCE PARAMETERS**

The present project is completed by computerized and software based engine.To check the error of the software we are done the calculations manually for PGM-LPG

**RESULTS & ANALYSIS**

**PERFORMANCE ANALYSIS:**

***BP v/s LOAD:***

The BP v/s load graph will gives the information about the engine condition at different loads with respective to the BP is high at higher loads will ensure the use of that combination fuel the main consideration when working with any fuel BP and load are very more important.

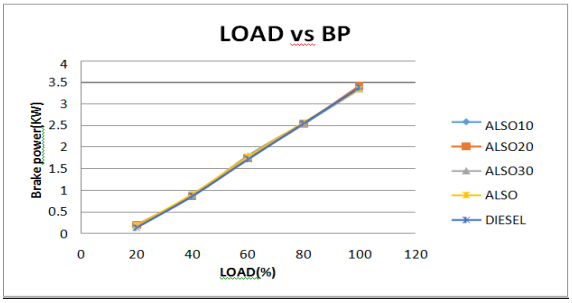


Figure 12 LOAD v/s BP diagram

**BP vs SFC:**

***Importance:***

Specific fuel consumption consideration is mainly for economic purposeat higher loads condition at which fuel will give low SFC value

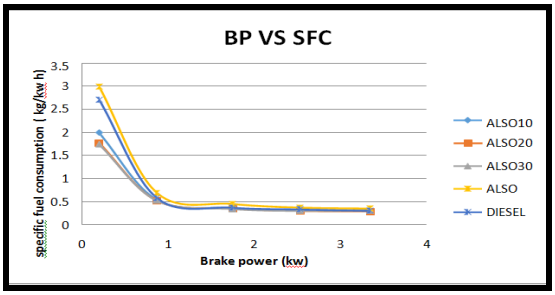


Figure 13BP v/s SFC diagram

## CONCLUSION

The main objective of the present study was to use the non-edible Alexandrian laurel seed oil as biodiesel in CI engine. To reduce the viscosity of neat Alexandrian laurel, transesterification was done to bring it close to that of conventional diesel. In order to obtain a basis for comparison, Various blends are used such as (B10,B20,B30,B100) from this blends B20 shows best results compared to the diesel. To improve the performance characteristics Isobutanol additive added in the B20 in the concentration of 10% and 15%. Finally we conclude that by observing performance, combustion and emission analysis the combination of ALSO20+ISO15 gives better results compared to conventional diesel fuel. At full load condition the ALSO20+ISO15 will produce maximum B.P. so, this combination is recommendable for the stationary engine.

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