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Performance Evaluation of Four Stroke Single Cylinder Diesel Engine at Different Injection Pressure Using Polanga Biodiesel as a Fuel

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ABSTRACT: The demand for petroleum products in India has been increasing day to day. At the same time there is continuous pressure on emission control through periodically tightened regulations particularly for metropolitan cities. The growing concern on environmental pollution caused by the extensive use of conventional fossil fuel has led to search for more environment friendly and renewable fuels. Among various options investigated for diesel fuel, bio-diesel has been reported to be one of the strong contenders for reduction in exhaust emissions. Bio-diesel is one such initiative which is projected as an alternative to diesel fuel. Reduced emission profiles, ready usage of existing diesel engines, fuel distribution infrastructure and ecofriendly properties of bio-diesel have made many countries to implement several bio-diesel initiatives and developmental program. Polanga biodiesel is one such alternative which can be used as substitute to conventional fuels like Petrol and Diesel. The present work involves experimental investigation of Polanga bio-diesel and its blends as fuel in diesel engine. The Polanga biodiesel was triple filtered to reduce the FFA (Free Fatty Acids) value and then trans-esterified to obtain bio-diesel. The project envisaged aims at conducting performance test on diesel engine with Polanga bio-diesel blends at different injection pressure (180,190,200bars). The performance parameters including power output, fuel consumption, BTE, bsfc, air fuel ratio etc., are compared with results obtained from pure diesel. The results obtained indicate that the Polanga bio-diesel and their blends can be successfully employed as alternate fuel in diesel engines. Along with the increasing injection pressures break thermal efficiency of the engine also increases, as compared with conventional diesel fuel.

KEYWORDS: Polanga, Trans-esterification, BTE, BSFC.

I. INTRODUCTION

Biodiesel has been receiving increasing attention due to its less polluting and because it is a renewable energy resource as against the conventional diesel, which is a fossil fuel leading to a potential exhaustion. Bio diesel is made from renewable biological such as vegetable oils and animal fats. Mostly Bio diesel is prepared from oils like Soybean, Rape seed, Rice bran, Karanja, Jatropha and Rubber seed in India. However, there remain a number of other tree based oil seeds like Sal, Neem, Undi, Polanga and Simbarouba etc. These oils have great potential to make biodiesel for supplementing other conventional sources. Below data on various tree borne oil seeds which gives percentage oil present in the oils seeds.

Liquids form renewable sources are bio degradable and inexhaustible. In this regard, tree based oils (bio-fuels) or vegetable oils having their physical and combustibility characteristics close to diesel fuels may stand as immediate choice for alternative fuel for diesel fuel and the seeds can be grown and processed in rural areas. However, they suffer from some serious handicaps i.e., high viscosity (making them difficult to handle in the diesel fuel injection system) and their tendency to form harmful smoke during combustion

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II. LITERATURE REVIEW

Vegetable oils or bio fuels have many advantages as a substitute for diesel fuels. Due to wide variations in climate, soil conditions and scarcity of land, different nations have to consider different vegetable oils as potential fuels. Each country has to carefully consider the type and extent of land that it can set apart for growing vegetable oil to be used as a potential fuel, the cost of cultivation and the cost of processing the oil from the seeds etc., before taking the decision. However there is a doubt that the production of vegetable oils can be stepped up in several fold if a firm decision is taken by the government to use them as fuels. **Chincholkaret al**^[1] stated that diesel vehicles are the major source for air pollution; there is great potential for global warming due to discharge of greenhouse gases like CO₂ from vehicles. Many lung problems are connected with particulate matter emitted by diesel vehicle including dust, soot and smoke. **K.Pramanik et al**^[2] investigated the high viscosity of the jatropha cruce oil which has been considered as a potential alternative fuel for the compression ignition engine. Viscosity was decreased by blending with diesel. The blends are varying proportions of jatropha cruce oil and diesel was prepared, analyzed and compared with diesel fuel. **E.Palaniswamy et al**^[3] investigated the use of preheated jatropha and pongamia oil as fuels in single cylinder DI diesel engine. They observed that these oils have relatively high viscosity when compared to diesel fuel. **S.K.Bheleet al**^[4] investigated neat karanja oil methyl ester (KME) as well as the blend of varying proportion of karanja oil methyl ester (KME) and diesel to run a C.I engine. The use of esterified karanja oil can be effective in existing diesel engine. **Rehman et al**^[5] conducted the performance test to ascertain the possibility of use of modified karanja oil as fuel for compression ignition engine. The compression of the test fuels was made with diesel fuel. Test fuels performance analyzed for ester of karanja oil, blends of karanja oil and the diesel oil as baseline at varying loads performed at governor its influence on the engine performance with different fuels. **C.Prabhakar Reddy et al**^[6] investigated the usage of rubber seed oil as an ultimate fuel in C.I engines. It was concluded that the rubber seed oil can be used as a substitute fuel in C.I engine with 245 bar injection pressure as optimum among the tested value. 100% replacement of diesel fuel is possible by using rubber seeding oil. 80% diesel and 20% rubber seed oil blend gives marginal improvement in break thermal efficiency compared to pure diesel. **Hariharant al**^[7] conducted experiments to study the performance, emission and combustion characteristics of a DI diesel engine using sea lemon oil based fuels. It was found that from the combustion analysis, the ignition delay was slightly more for both the fuel tested compared to that of standard diesel. **J.Singhet al**^[8] studied the emission characteristic of methyl ester of refund rice bran oil diesel blend mixed in the preparation of 10:90, 20:80, 30:70, 50:50 and 100:0 the emission of carbon monoxide, oxide of nitrogen at various load on C.I. engine were compared with respect to diesel. **Malkhede et al**^[9] studied on use of ferrocene an anti-smoke additive. Jatropha oil is selected evaluating the performance of ferrocene is added to jatropha straight vegetable oil (JSVO) in various concentration and the performance is investigated each concentration of ferrocene over the whole load range of the engine. **Mahalakshmi et al**^[10] carried out engine tests with the aim of obtaining the performance, emission and combustion characteristics of a diesel engine running on methyl ester of paradise oil (MEPS) and its diesel blends. From the emission analysis it was found that there was a significant reduction in smoke and hydrocarbon emissions by 33% and 22% respectively for MEPS 50 blend and 40% and 27% reductions for MEPS 100.

from that above literature reviews all are used the different types of oils and they found the different types characteristics. But they don't use the polanga bio diesel. In this project I am envisaged aims at conducted performance test on diesel engine with Polanga bio-diesel blends at different injection pressure (180,190,200bars). The performance parameters including power output, fuel consumption, BTE, bsfc, air fuel ratio etc., are compared with results obtained from pure diesel. The results obtained indicate that the Polanga bio-diesel and their blends can be successfully employed as alternate fuel in diesel engines. Along with the increasing injection pressures break thermal efficiency of the engine also increases, as compared with conventional diesel fuel.

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III. BIO DIESEL

Introduction: Biodiesel is fuel additive or alternative combustible fuel for diesel engines. It is nontoxic, biodegradable, and virtually free of aromatic and sulfur this is because its primary components are domestic's renewable resources such as vegetable oil and animal fats. Thus, Bio diesel is the mono alkyl esters of fatty acids that are results from fats or vegetable oils. In other words, bio diesel is the end result of the chemical reaction caused by mixing vegetable oil or animal fat with an alcohol such as methanol.

Need of Biodiesel in CI engine: It has been observed that the crude vegetable oils, when used for long hours, choke the fuel filter because of the high viscosity and insoluble in crude oil. Viscosity of vegetable oils exerts a strong influence on the shape of the fuel spray. High viscosity causes poor atomization, large droplets and high spray jet penetration with high viscosities, the jet tends to be solid stream instead of spray of small droplets. As a result, the fuel is not disturbed in or mixed properly with the air required for burning. This result in poor combustion, accomplished by loss of power and economy. Most of the vegetable oil has kinematic viscosity at 40 c in the range of 35 to 50 CST. whereas for diesel oils $4 \times 10^{-6} \text{ m}^2/\text{s}$. sample esters of the fatty acids in vegetable oils have greatly reduced viscosities in the range of $2.4 \times 10^{-6} \text{ m}^2/\text{s}$ to $7.2 \times 10^{-6} \text{ m}^2/\text{s}$ at 40° c .

Properties of Bio-diesel:

- **Flash point:** The flash point of a fuel is defined as the temperature at which the fuel gives out vapors that mix with air and becomes a mixture that will ignite when exposed to a spark flame. The flash point of bio diesel has been tested and reported by various sources.
- **Toxicity:** The impact on human health is a significant criterion when consider the suitability of a fuel for commercial application. Health effects can be measured in terms of fuel toxicity to the human body or health impacts due to exhaust emissions. Test conducted by will research laboratories; Inc. investigated the acute oral toxicity of pure biodiesel fuel as well as B20 in single dose study on rates.
- **Emission reduction:** The use of biodiesel in a conventional diesel engine results in substantial reduction of unborn hydrocarbons, carbon monoxide, and particulate matter. Emission of nitrogen oxides as either slightly increased depending on the duty cycle of the engine and testing methods employed.
- **Health effects:** Evidence does exist which indicates that diesel particulate matter is a potential carcinogen. In 1988, the national institute for occupational safety and health (NIOSH) recommended that whole diesel exhaust be as "a potential occupational carcinogen," as defined in the cancer policy of the occupational safety and health administration. The use of biodiesel decreases most regulated emissions.
- **Lubricity:** In the United States the sulfur level of diesel fuel that is used for on road purpose limited to 0.05% by weight. This limit was mandated in October 1993 as a method to decrease particular matter emitted from diesel power vehicles. With the introduction of the mandated environmental agency (EPA) low sulfur fuel, fleet operates began to encounter premature wear and failure of injector pumps in increasing numbers.
- **Infrastructure:** In general, the standard storage and handling procedures used for petroleum diesel can be used for bio diesel. The fuel should be stored in a clean, dry, dark environment. Temperature extremes should be avoided. Acceptable storage tank materials include stainless steel, fluorinated polyethylene, and fluorinated polypropylene. Bio diesel has a solvent effect which may release deposits accumulated on tank walls and pipes from previous fuel storage. The release of deposits may clog filters initially and precautions should be taken

Benefits of Bio-diesel:

- It is a renewable bio based fuel and, as such, has lower life cycle CO_2 emissions than diesel derived from mineral oils.

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- Neat bio diesel contains almost no sulfur and no aromatics. In properly tuned engine this is expected to lead to lower particulate exhaust emissions.
- The material is bio degradable and nontoxic.
- Biodiesel have 17% oxygen by weight, so as an oxygen compound, it reduces the non-soluble fraction of the particles.
- The PAH content of the exhaust particles.
- In a mixture with low sulfur diesel, biodiesel can act as a lubricity improver.
- Their viscosity is far less than of virgin oils and closer to conventional diesel fuel.
- Biodiesel is environment friendly alternative to fossil fuel and it is the only alternative fuel that runs in any conventional unmodified engine.
- National security: since it is made domestically, it reduces our dependence on foreign fuel.
- National economy: using biodiesel keeps our fuel buying bollards at home instead of sending it to foreign countries. This reduces our trade deficit and crates jobs.
- Global warming potential: while it can be used in normal diesel engines it has all the ecological advantages over the mineral diesel, as it neither pollutes nor adds to the global warming.
- Greenhouse effect: using vegetable oils or animal fats as fuel for vehicles is in effect running them on solar energy. All biofuels are derived from the conversion of sunlight to energy that takes place in the green leaves of plants. Plants take up CO_2 from the atmosphere: burning plant produces in engines of releases the CO_2 up take back into the atmosphere CO_2 remains constant.

Demerits of Bio-diesel:

- Constrains on the availability of agriculture feedstock impose limits on the possible contribution of biodiesels to transport.
- The kinematic viscosity is higher than diesel fuel. This effects fuel atomization during injection and requires modified fuel injection system.
- Due to high oxygen content, it reduces relatively high NO_x levels during combustion.
- Oxidation stability is lower than that of diesel that under extend conditions it is possible to produce oxidation products that may be the vehicle components.
- Biodiesel is hygroscopic: contact with humid air must be avoided.
- Production of biodiesel is not sufficiently standardized. Biodiesel that outside European or U S standards can cause corrosion, fuel system blockage, seal failures, filter clogging and deposited at injection pumps.

IV. TRANS-ESTERIFICATION

Reaction scheme:

The reaction between the bio lipid (fat or oil) and the alcohol is a reversible reaction so the alcohol must be added in excess to drive the reaction towards the right and ensure complete conversion .Once the alcohol mixture is made it is added to the triglyceride. The reaction that follows replaces the alkyl group on the triglyceride in a series of steps.

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A reaction scheme for trans-esterification is as follows:

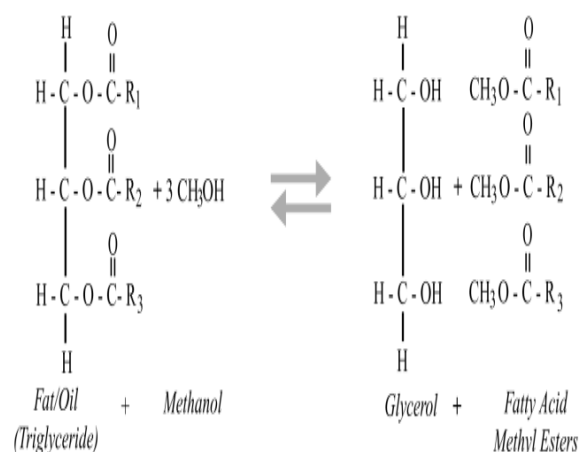


Fig: 4.1: Reaction Scheme for Trans-Esterification

- R1, R2 and R3 in this diagram represent long carbon chains that are too lengthy to include in the diagram.
- Animal and plant fats and oils are typically made of triglycerides which are esters of free fatty acid with the trihydric alcohol, glycerol.
- The alcohol reacts with fatty acids to form mono-alkyl esters (or bio diesels) and crude glycerol.
- In the trans-esterification process, the alcohol is mixed with a base to make it a stronger nucleophile. Commonly, ethanol or methanol are used. As can be seen, the reaction has no other inputs than triglyceride and the alcohol.

R1, R2 and R3 in this diagram represent long carbon chains that are too lengthy to include in the diagram. Animal and plant fats and oils are typically made of triglycerides which are esters of free fatty acids with the trihydric alcohol, glycerol. In the trans-esterification process, the alcohol is deprotonated with a base to make it a stronger nucleophile. Commonly, ethanol or methanols are used.

As can be seen, the reaction has no other inputs than a triglyceride and the alcohol. Normally, this reaction will proceed either exceedingly slowly or not at all. Heat, as well as an acid or base are used to help the reaction proceed more quickly. It is important to note that the acid or base are not consumed by the trans-esterification reaction, thus they are not reactants but catalysts.

Almost all biodiesel is produced from virgin vegetable oils using the base-catalyzed technique as it is the most economical process for treating virgin vegetable oils, requiring only low temperature and pressures and producing over 98% conversion yield (provided the starting oil is low in moisture and free fatty acids).

V. POLANGA

Introduction: Polanga (*Calophyllum inophyllum*) Kamani, Tamanu, Alexandrian Laurel, Pinnai (Tamil) is an evergreen tree which supports a dense canopy of glossy, elliptical leaves, fragrant white flowers and large round nuts. It grows along coastal areas and adjacent lowland forests; occasionally occurs on land at higher elevations. It has been widely planted throughout the tropics and is naturalized in the main Hawaiian Islands. The tree is valued for its hardiness and beauty as an ornamental tree. The tree is native to east Africa, through India and Southeast Asia to the Philippines, Taiwan, and the Marianas. Southward its range extends through Melanesia to Australia and through southern and eastern Polynesia. The habitat is primarily coastal and adjacent to lowland forests.

Polanga Plantation:

Elevation range: 0-200m (660ft) in Hawaii; up to 800m (2,000 ft) at the equator.

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Soils: The tree tolerates a wide range of soils. It grows best in sandy well-drained soils in coastal areas, but will tolerate clays, calcareous soils, and rocky soils.

Soil texture: Tree population tolerates light to medium soils (Sands, sandy loams, loams and sandy clay loams).

Soil drainage: It is that of freely draining as well as soils with impeded drainage or seasonal water logging.



Fig: 5.1 Polanga seeds



Fig: 5.2 polangatreeS

Soil acidity: Neutral to acid soils (pH 7.4-4.0).

Special soil tolerances: are shallow and saline soils.

Tolerances: It is a hardy tree of tropical coastal areas that tolerates wind, salt spray, drought, and brief periods of waterlogged soils. It does not tolerate much shade nor cold weather.

Drought: It can tolerate 4-5 months of drought in its natural littoral and riparian environments.

Salt spray and wind: Tree grows in areas subject to sea breezes and salt spray.

Abilities: The trees drop large amounts of fruit and wildings, which may often be found under mother trees, though growth is slow relative to many weed species. It regrows dependably but slowly after pruning. The branches can be pruned back every 2-3 years and they will regrow.

Growth and Development: The seedlings start out growing erect and with few branches. Growth slows after the first few years and the trees branch out, often developing multiple stems.

Growth rate: Young trees may grow up to 1 m (3.3 ft) in height per year for the first few years, but after that the growth rate slows. In Malaysia it is reported one stand of trees attained a diameter of 50cm (20in).

Flowering and fruiting: The tree flowers twice a year in the northern hemisphere, in the late spring/early summer and late fall. In northern Australia, it flowers in January and June. Young trees begin flowering after 7 or 8 years in peninsular India.

Rooting habit: The tree has a non-aggressive root system.

Reaction to competition: The tree is only slightly shade tolerant and will not grow under dense forest canopies. It grows slowly in height and may be overwhelmed by weeds in young plantations.

Propagation It is moderately easy to propagate by seed and local seed sources are easily found. Germination and initial growth is slow and seedlings should be started six months before they are required. Once out planted, seedlings are hardy but slow growing. They prefer full sun and tolerate wind, salt spray, and drought.

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Seed collection: Ripe fruits are most easily collected from the ground under trees. Fruits fall twice a year in most location.

Seed storage: Seed storage is intermediate. In other words, fresh seeds may keep for a few months stored cool and dry. Usually with the husk removed.

Pre-planting treatments: Seed germination is slow if the entire fruit is planted. Ripe fruits (Skin is yellow or brown and wrinkled) may be soaked overnight to remove skin. Just prior to planting it is best to crack shells or shell seeds entirely using a mallet, pliers, or hammer, No additional treatments are required.

Growing area: Plants may be started in containers at least 6 cm (2.4in) in diameter, of sufficient size to accommodate the fairly large seeds. Hot areas. Seedlings should be grown in full sun after 1-2 months.

Germination: Seeds germinate gradually and shelled seeds germinate faster than seeds in their shells. One study found average germination items of 22 days for seeds fully shelled, 38 days for seeds in cracked shells, and 57 days for seeds still in their shells. Germination rates for fresh seed are greater than 90%.

VI. POLANGA BIO-DIESEL EXTRACTION

Processing of Polanga Bio-Diesel:

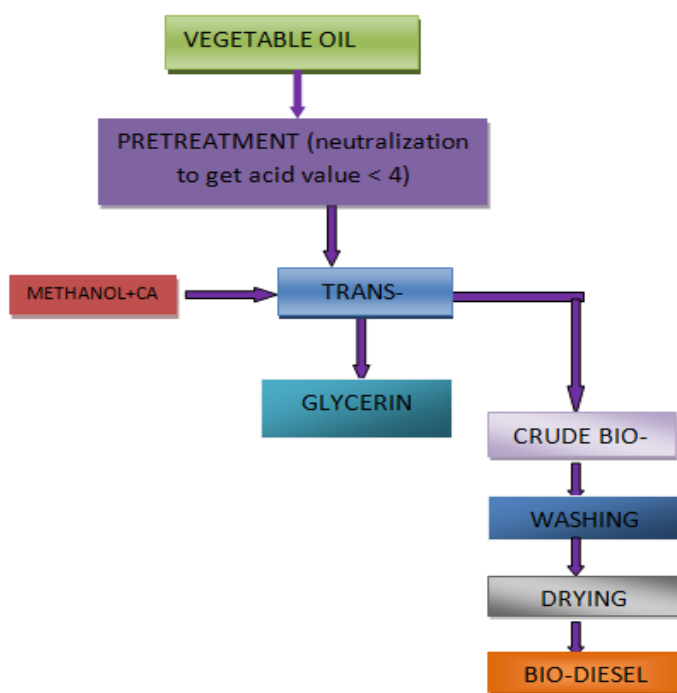


Fig: 6.1 Extraction of Polanga Bio-Diesel

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Trans-esterification unit:

The main trans-esterification reaction takes place in a 265-liter, stainless steel reaction tank with a 0.37 kW explosion-proof mixer, which has a fixed speed of 1750 rpm. A load cell mounted on one leg of the reaction tank measures the reactant amounts.

To ensure accurate weight measurements, all connections to the tank are flexible and the load cell output has been calibrated by adding known amounts of water to the tank. Methanol is added to the reaction tank using the air-operated pump.

After preparing the alcohol solution with the catalyst, it is added to the reaction tank. The reactants are agitated for 8 hours, and then the mixture is transferred to a 492-liter cone bottom tank for glycerin separation and ester washing. A load cell measures the glycerin amount, the washing water amount, and the amount of ester produced.

Methods of purification:

The glycerin obtained as a by-product from the three processes noted above contains impurities and must undergo further processing to purify and concentrate it.

Commercially, there are two known processes in use:

1. The conventional method of purification of the spent soap lye or sweet water by acid–alum or ferric chloride treatment followed by evaporation, distillation, deodorization, and bleaching.
2. The ion exchange method of purification followed by evaporation and polishing. Conventional Method. The conventional method is widely popular. Basically, the steps used to produce high-grade glycerin with up to 99% purity are essentially the same. The spent soap lye, or sweet water, is acidified with mineral acid to split any dissolved soap and release it as fatty acid, which is skimmed off.

The pH is adjusted, and alum or ferric chloride as a flocculent is then added to entrap the impurities, after which the mixture is filtered. The filtered lye is adjusted to a pH of 6.5 or higher before it is fed to the evaporator. The type of evaporator, either single or multiple effects, depends on the volume of materials to be processed. The crude glycerin obtained after evaporation has a concentration of 80–88% and undergoes further processing. Salt, which separates out during the evaporation of treated glycerin soap lye, accumulates in a salt pot positioned underneath the evaporator.

Ion exchange method: The Ion Exchange method of glycerin purifications gaining wide acceptance because of the simplicity of operations and low energy consumption. This method is made possible by the availability of suitable ion exchange resins and is particularly suitable for refining of glycerin obtained from fat splitting or from trans-esterification, which is practically salt free.

When salt is high, as in the spent lye from saponification, pretreatment to remove the salt is necessary. Purification by ion exchange involves the passage of the pre filtered material through successive beds of a strong cat ion, a weak anion, and a mixed bed of strong cat ion- anion resins.

The ion exchange units operate efficiently with dilute solutions containing 25–40% glycerin. Several resins are available commercially. Passage through the resin beds eliminates traces of free fatty acids, colour, odor bodies, and other mineral impurities present. Subsequent concentration of the purified glycerin solution is through evaporation using multiple effect evaporators to produce glycerin with a purity of more than 99%.

Conventional method Vs Ion exchange method:

The Conventional method offers greater flexibility but uses more energy, considering that much water must be

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evaporated and that the glycerin is distilled at a higher temperature. The ion exchange method requires less energy but cannot be used for sweet water containing high chlorides. Chlorides foul up the ion exchange resin.

VII. FLASH POINT

Fuel oils are classified according to their flash point from the point of view of safety. There are two points at which the fuel ignites called the flash and fire points. For conditions of storage and use and in transportation of oils. Knowledge of flash and fire point is mandatory. Oils whose flash point is below 23 (gasoline OR Petrol) are regarded as highly inflammable and dangerous and above 66 C are regarded as safe.

Flash point: Flash point is minimum temperature of oil at which, on the application of a flame over the surface of the oil causes a momentary flash with blue colour.

The flash point depends on the volatility of the oil, the design of the apparatus and the barometric pressure. The flash and fire points can be obtained under closed cup and open cup condition. The closed cup condition give the lower value of the flash point in comparison with the open cup condition as the vapour is not escape into atmosphere. Cleveland's apparatus is one of the apparatus used for this purpose

Experimental procedure:

- Clean the metal cup and fill it with the given sample of oil up to the groove level marked in the cup.
- Place the cup in the groove provided in the asbestos sheet.
- Fix the thermometers in the fixture, so that the bulb should not touch the bottom of the cup.
- Connect the power line to the power supply and check the heating circuit for the proper working.
- Switch on, the power supply and adjust the regulator so that a slow and steady heating may be obtained.
- Stir the oil gently and continuously with a small external stirrer.
- When the temperature of the oil is about 5°C and 10°C below the expected Flash temperature start introduction of a test flame.
- Apply the test flame at every 0.5°C to 1°C rise in temperature.
- Record the minimum temperature at which a distinct flash is obtained on the given sample of oil. This is the flash point.
- Continue heating and apply test flame on the surface of the oil and record the minimum temperature at which the oil burns with continuous flame on the surface for a minimum of 5 seconds and record it as fire point temperature.

Flash point (39°C) for Pure Diesel



Flashpoint (130°C) for Polanga oil



Fig: 7.2: Flash point determination

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VIII. FUEL INJECTION PRESSURE

Fuel Injector: Diesel engine plays a dominant role in the field of power, propulsion and energy. The diesel engine is a type of internal combustion engine, more specifically it is a compression ignition engine, in which the fuel is ignited solely by the high temperature created by compression of the air-fuel mixture. The engine operates using the diesel cycle. The engine is more efficient than the petrol engine, since the spark-ignition engine consumes more fuel than the compression-ignition engine. The fuel injection system is the most vital component in the working of CI engine.

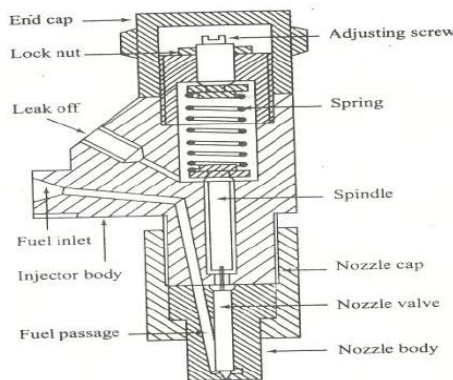


Fig: 8.1: Components of Fuel Injector

When the fuel is supplied by the injection pump it exerts sufficient force against the spring to lift the nozzle valve, fuel is sprayed into the combustion chamber in finely atomized particles. After fuel from the delivery pump gets exhausted; the spring pressure pushes the nozzle-valve back on its seat. For proper lubrication between nozzle valve and its guide a small quantity of fuel is allowed to leak through the clearance between them and then drained back to fuel tank through leak of connection.

IX. PRESENT WORK

Objective: To measure the performance characteristics of Single cylinder four stroke diesel engine when Polanga Biodiesel is blended with pure diesel in the ratio 20:80 (B20) at different injector pressures (180 bar, 190 bar and 200 bar).

Methodology: Various performance characteristics of the engine at different pressures are determined. To do this injector pressure is modified a bit, Diesel oil which is blended with Polanga oil (B20) is used as a fuel for this project.

Significance of this work:

Use of Biofuel alone is not much economical. So, Conventional fuel like Diesel is blended with Polanga Biofuel to measure improved characteristics of the engine.

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X. SINGLE CYLINDER FOUR STROKE DIESEL ENGINE

Description:



Fig: 10.1 Single Cylinder Four Stroke Diesel Engines

The 4-stroke diesel (CI) engine operates on diesel cycle. The cycle of operation is completed in 4-strokes of the piston or in two revolutions of the crankshaft. The 4-strokes of the piston in proper sequence are

1. Suction stroke
2. Compression stroke
3. Expansion stroke
4. Exhaust stroke

Experimental procedure:

- Check the level of the diesel oil.
- Check the lubricant oil level of the engine for safe valve and open the diesel tank out let valve.
- Open the 3-way cock so that the fuel flows in to the engine and see that there is no load on the engine.
- Crank the engine with the help of the handle by keeping the decompression lever in the vertical Position. In this position the exhaust valve will be in the open condition. After attaining sufficient momentum, lower the decompression lever and remove the crank handle from the shaft. Repeat the above procedure till the engine starts.
- Supply the cooling water through the inlet pipe in to the jackets of the engine and in to the exhaust gas calorimeter.
- Allow the engine to run at no load condition for few minutes and Note down the readings
- Engine speed.
- Mechanical loading.
- Time for 10 cc of fuel consumption.
- Manometer reading (h1, h2).
- Load the engine by keeping the dead weights gently on hook plate and .adjust break drum through rope

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XI. RESULTS

Table of observation for B20 oil at 180 bar pressure:

SNO	SPEED N (rpm)	Load W(kg)	Spring Weight (kg)	Time (Sec)	Nanometer Reading		Exhaust gas Temperature after calorimeter (T _G) ⁰ C
					(mm)		
					h1	h2	
1	1478	0	0	65	55	112	75
2	1450	5	1	63	51	111	97
3	1445	10	2	44	50	110	152
4	1444	15	3	34	55	115	156
5	1443	20	4	32	63	120	166

TYPE OF FUEL : 20% PB+80% Diesel

INJECTION PRESSURE : 180 bar

SNO	LOAD W-S(kg)	BP (KW)	m _f (kg/hr)	Bsfc (kg/KW- hr)	η _v (%)	BTE (%)	AIR- FUEL ratio
1	0	0	0.46	-	87.2	0	55.44
2	4	1.06	0.48	0.45	91.18	18.9	54.5
3	8	2.23	0.69	0.3	89.6	25.96	37.91
4	12	3.31	0.89	0.28	90.6	28.78	29.39
5	16	3.48	0.95	0.27	88.71	30.12	26.85

Table of observation for B20 oil at 190 bar pressure:

SNO	SPEED N (rpm)	Load W(kg)	Spring Weight (kg)	Time (Sec)	Nanometer Reading		Exhaust gas Temperature after calorimeter (T _G) ⁰ C
					(mm)		
					h1	h2	
1	1480	0	0	78.34	51	111	120
2	1468	5	1	67.53	56	111	122
3	1457	10	2	43	56	109	130
4	1444	15	3	59.1	59	109	134
5	1432	20	4	44.3	58	103	142

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TYPE OF FUEL : 20% PB+80% Diesel							
INJECTION PRESSURE : 180 bar							
SNO	LOAD W-S(kg)	BP (KW)	m _f (kg/hr)	Bsfc (kg/KW-hr)	η _v (%)	BTE (%)	AIR- FUEL ratio
1	0	0	0.38	-	89.3	0	67.77
2	4	1.09	0.46	0.42	86.5	19.1	54.56
3	8	2.23	0.7	0.31	85.3	26.97	35.12
4	12	3.31	0.94	0.28	83.7	29.78	25.14
5	16	3.48	0.95	0.26	79.9	30.89	24.1

SNO	SPEED N (rpm)	Load W(kg)	SPRING LOAD(S) (kg)	Time (Sec)	Nanometer Reading (mm)		Exhaust gas Temperature after calorimeter (T _G) ⁰ C
					h1	h2	
1	1490	0	0	62	55	110	71
2	1482	50	1	59	58	112	92
3	1478	10	2	43	62	115	124
4	1465	15020	3	30	70	118	172
5	1444		4	23	77	121	198

Table of observation for B20 oil at 200 bar pressure:

SNO	SPEED N (rpm)	Load W(kg)	Spring Weight (kg)	Time (Sec)	Nanometer Reading (mm)		Exhaust gas Temperature after calorimeter (T _G) ⁰ C
					h1	h2	
1	1478	0	0	80.32	55	112	118
2	1460	5	1	65	53	113	126
3	1452	10	2	62.21	52	113	135
4	1223	15	3	30.8	52	113	141
5	1380	20	4	31	55	112	147

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SNO	Load W(kg)	BP(KW)	Mf _c (kg/hr)	Bsfc(kg/kw hr)	η_{vol} (%)	BTHE (%)	Air fuel ratio
1	0	0	0.42	-	93.6	-	52.31
2	4	1.06	0.51	0.48	92.5	17.2	50.13
3	8	2.12	0.68	0.31	91.2	24.1	35.84
4	12	3.15	0.99	0.32	90.4	27.3	27.02
5	16	3.38	1.29	0.39	88.8	29.7	20.27

TYPE OF FUEL : 20% PB+80% Diesel							
INJECTION PRESSURE : 200 bar							
SNO	LOAD W-S(kg)	BP (KW)	m _r (kg/hr)	Bsfc (kg/KW-hr)	η_v (%)	BTE (%)	AIR-FUEL ratio
1	0	0	0.37	-	87.2	0	67.83
2	4	1.05	0.46	0.42	90.6	17.9	56.87
3	8	2.08	0.74	0.35	91.7	24.75	35.66
4	12	3.04	0.98	0.32	90.2	27.8	26.92
5	16	3.39	0.99	0.28	92.7	29.6	26.16

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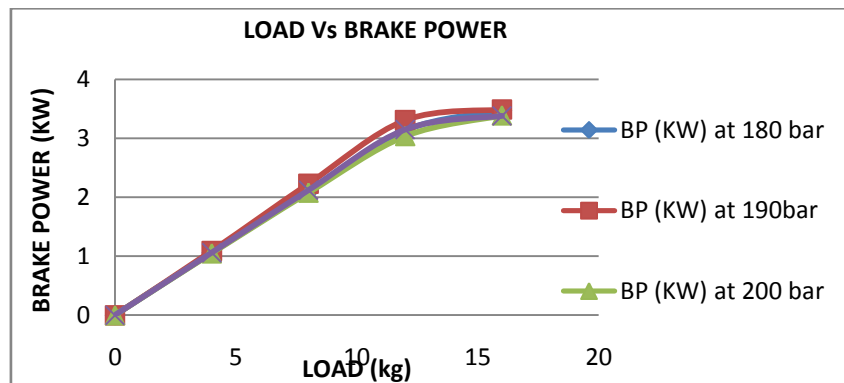
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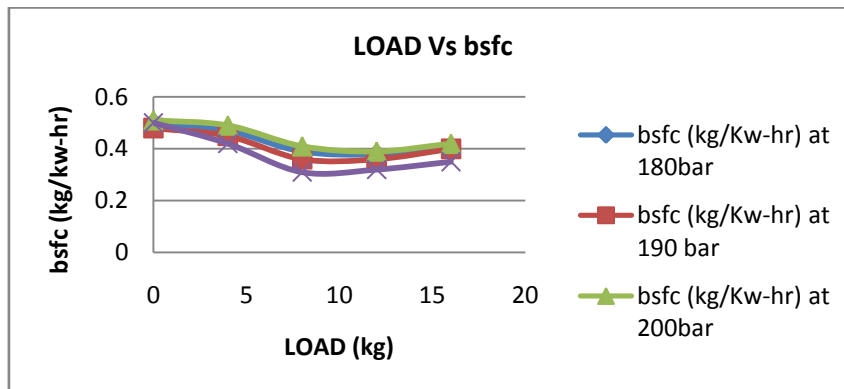
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GRAPHS

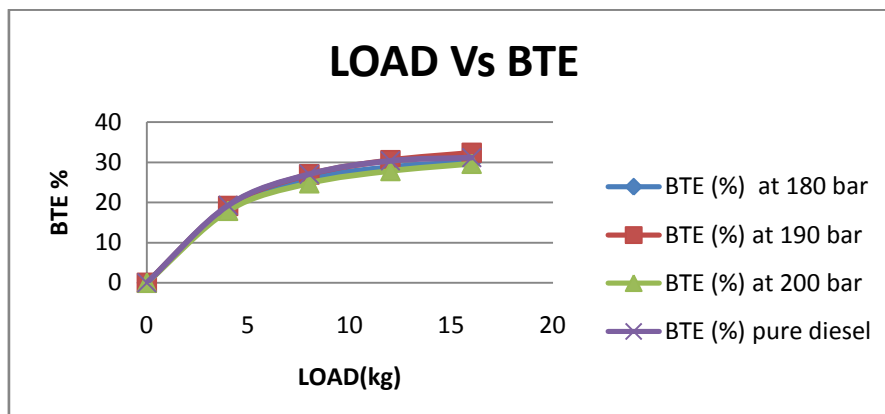
12.1 Load Vs Brake Power:



12.2 Load Vs Brake Specific fuel consumption:



12.3 Load Vs Brake thermal efficiency:



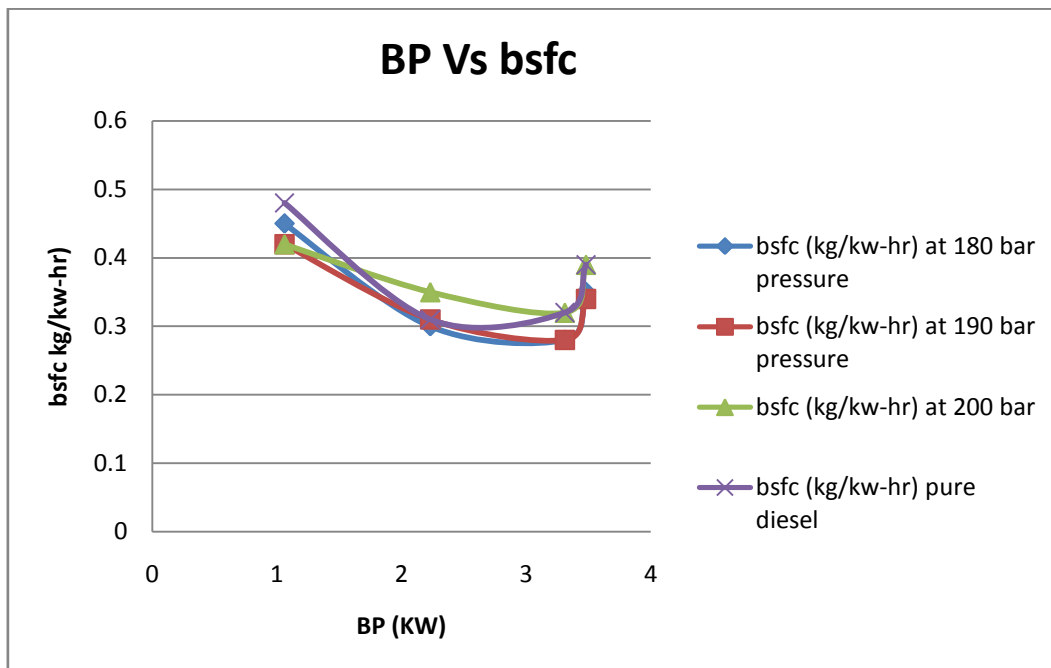
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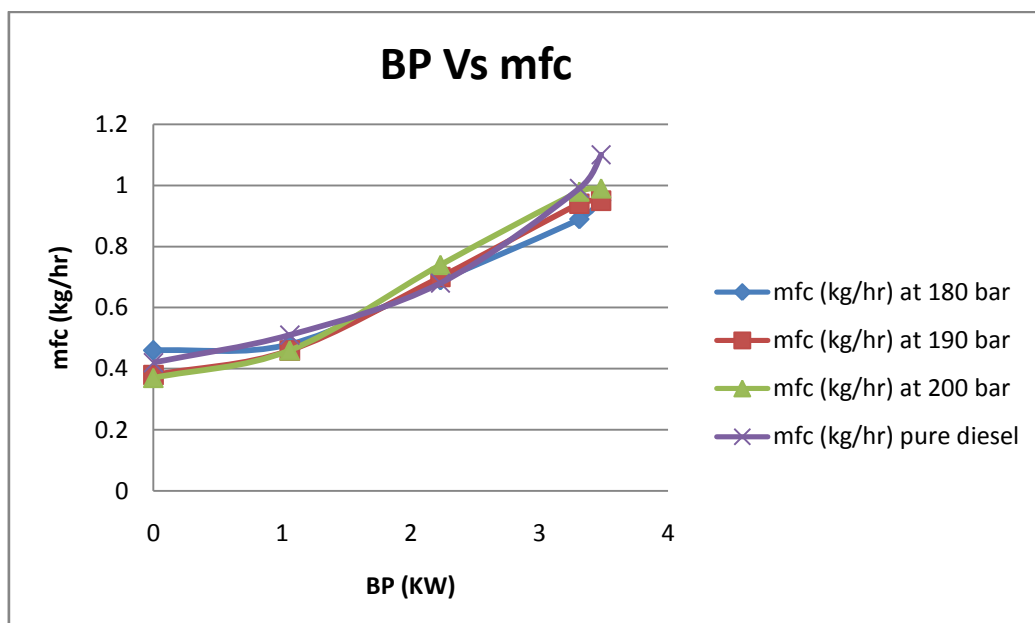
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12.4 Brake Power Vs Brake Specific fuel consumption:



12.5 Brake Power Vs Mass of fuel consumed



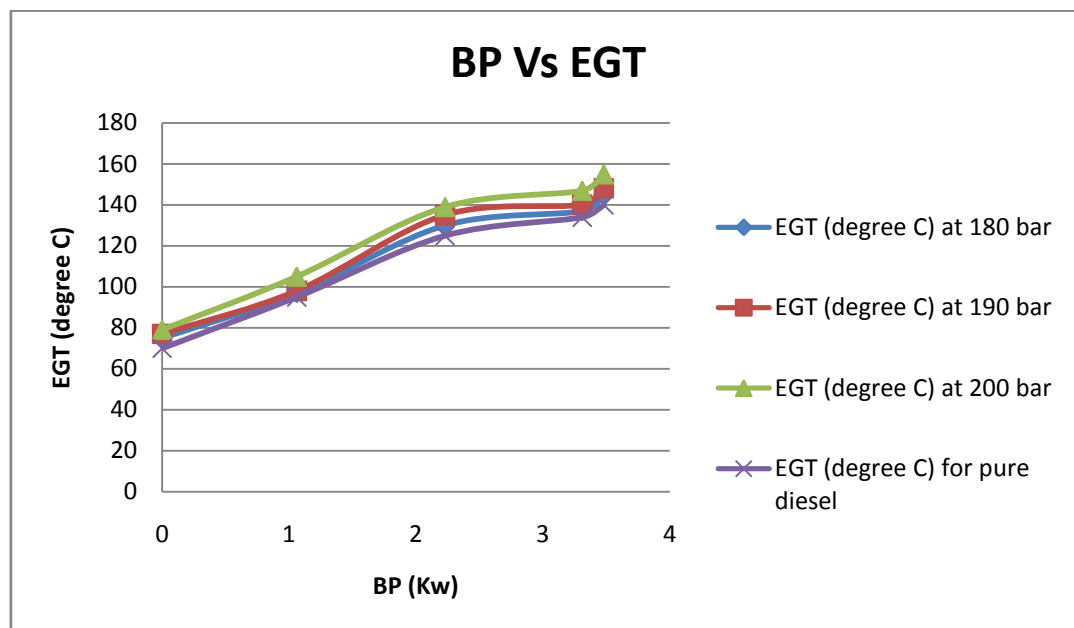
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12.6 Brake Power Vs Exhaust gas temperature



XIII. CONCLUSION AND SCOPE FOR FUTURE WORK

13.1 Conclusion

- The present analysis reveals that biodiesel from unrefined Polanga seed oil is quite suitable as an alternative to diesel. It is concluded that Polanga biodiesel (B20) which results in is the optimum fuel blend.
- Polanga biodiesel blend can be used as an alternative fuel in existing diesel engine without any modification of basic engine.
- It is observed from the graph 12.1 that around 20% of Polanga blend at 190 bar pressure gives much brake power when compared to 180bar, 200 bar and also diesel at standard pressure (180 bar).
- From the graph 12.2 bsfc for B20 at injection pressure 190 bar is lower than remaining two injection pressures while the diesel is lower than B20.
- It is observed from the graph 12.3 that around 20% of Polanga blend at 190 bar pressure gives better brake thermal efficiency when compared to other injection pressures and also diesel at standard pressure.
- Referring the graph 12.6 the exhaust gas temperature for B20 at 200 bar was higher when compared to B20 at remaining pressures, diesel at standard operating injection pressure.
- Polanga biodiesel blend may give additional lubricating effect if it is smaller in quantity.

13.2 Scope for future work

- Experimentation can be carried out on multi cylinder engines to study the behavior of this fuel to ascertain the usage in the practical engines.
- The study of performance and combustion characteristics can be done by computer simulation of the engine using Mat lab software which can be validated with the experimental evaluation.

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- Preheated fuel can be used in order to get the reduction in viscosity which will result in similar characteristics as that of esterified fuel. the heat energy required for preheating of fuel can be obtained by utilizing the heat of exhaust gases.
- A semi adiabatic engine can be further converted into an adiabatic engine by insulating piston crown, cylinder liner, cylinder head and exhaust valve so that the complete combustion can be ensured

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