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INVESTIGATION ON PERFORMANCE CHARACTERISTICS OF DIESEL ENGINE USING PEANUT OIL AS BIODIESEL

A Project report submitted in partial fulfilment of the requirements for the Award of the Degree of

BACHELOR OF TECHNOLOGY (2018-2022)

In

MECHANICAL ENGINEERING

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ACKNOWLEDGEMENT

We express immensely our deep sense of gratitude to **Mr. G. Naresh**, Assistant Professor, Department of Mechanical Engineering, Anil Neerukonda Institute of Technology & Sciences, Sangivalasa, Bheemunipatnam Mandal, Visakhapatnam district for his valuable guidance and encouragement at every stage of work for the successful fulfilment of students.

We are also very thankful to **Prof. T.Hanumanthrao**, Principal and **Prof. B. Naga Raju,** Head of the Department, Mechanical Engineering, Anil Neerukonda Institute of Technology & Sciences for their valuable suggestions.

We express our sincere thanks to **Mr. Rayalu,** lab technician, Department of Mechanical Engineering, Anil Neerukonda Institute of Technology & Sciences for his valuable support throughout the project.

We express our sincere thanks to the non-teaching staff of Mechanical Engineering Department for their kind co-operation and support to carry on work.

Last but not the least, we like to convey our thanks to all who have contributed directly or indirectly for the completion of our work.

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ABSTRACT

Increase in energy demand, stringent emission norms and depletion of resources led to the discovery of alternative fuels for internal combustion engines. Many alternative fuels like alcohols, Bio diesel, liquid petroleum gas (LPG), compressed natural gas (CNG), etc. Have been already commercialized in the transport sector. In the present work, peanut oil is blended with diesel and used as an alternate fuel for CI engines. The peanut oil can be converted into bio diesel using a chemical process called trans-etherification.

Different proportions of fuel blends have been produced by the process of blending. The fuel properties of each blend are determined. The load test of four stroke diesel engine using the blends of peanut oil with diesel done. The performance parameters such Power, Specific fuel consumption, Thermal efficiencies, Mechanical efficiency and mean effective pressure are calculated based on the experimental observations of the engine and compared for different blends. The comparative graphs are drawn at different loads. The sustainability of using alternative fuels in Diesel engines, especially the potential use of peanut oil as bio-diesel have been brought to the fore through this work. B5 blend containing 5% of biodiesel and 95% of diesel giving the best output but not economical.

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CHAPTER - I

1. INTRODUCTION

1.1 Fossil Fuels:

The term fossil is used to describe the broad setoff fuels "formed in the Earth from plant or in the earth from plant or animal remains" that have been transformed into raw energy sources over the course of many years as a result of geological processes. In effect, fossil fuels are the repositories of millions of years of energy that has been accumulated and shaped into a concentrated form.

Fossil fuels come in three main forms: petroleum or crude oil, coal and natural gas. All have many uses, but each serves one main purpose. In 2011, fossil fuels accounted for approximately 82 percent of world's primary energy use but this is expected to fall to 78 percent by 2040, meaning that the use of fossil fuels is expected to be on a decline due to use of alternative fuels. Yet fossil fuels are finite resources and they can also irreparably harm the environment. According to Environmental Protection Agency, the burning of fossil fuels was responsible for 79 percent of U.S. greenhouse gas emissions in 2010. Oil is the world's primary fuel source for transportation. Most oil is pumped out of underground reservoirs, but it can also be found imbedded in shale and tar sands. Once extracted, crude oil is processed in oil refineries to create fuel oil, gasoline, liquefied petroleum gas, and other non-fuel products such as pesticides, fertilizers, pharmaceuticals and plastics.

1.2 Alternative fuels:

Alternative fuels, known as non- conventional or advance fuels, are any materials or substances that can be used as fuels, other than conventional fuels. Some well-known alternative fuels include biodiesel, bio alcohol (methanol, ethanol, and butanol), chemically stored electricity (batteries and fuel cells), hydrogen, non-fossil methane, non-fossil natural gas, vegetable oil, propane, oil from waste tyres, plastic and other biomass sources. These alternative fuels are economical when compared to diesel. So, these are most suitable for automobiles and they can meet the growing demand for fuels in the future.

1.3 Need for Shifting Towards Alternative Fuels:

Probably in this century, it is believed that crude oil and petroleum products will become very scarce and costly to find and produce. Although fuel economy of engines is greatly improved, increase in the number of automobiles alone dictates that there will be a great demand for fuel in the near future. Alternative fuel technology, availability, and use must and will become more common in the coming decades. Another reason motivating the development of alternative fuels for the IC-engine is concerned over the emission problems of gasoline engines. Combined with air polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. A third reason for alternative fuel development is the fact that a large percentage of crude oil must be imported from other countries which control the larger oil fields.

1.4 Biodiesel:

Biodiesel is a clean burning alternative fuel produced from domestic, renewable resources. The fuel is a mixture of fatty acid alkyl esters made from vegetable oils, animal fats or recycled greases. Where available, biodiesel can be used in compression-ignition (diesel) engines in its pure form with little or no modifications.

Biodiesel is simple to use, biodegradable, nontoxic and essentially free of sulphur and aromatics. It is usually used as a petroleum diesel additive to reduce levels of particulates, carbon monoxide, hydrocarbons and toxics from diesel-powered vehicles. When used as an additive, the resulting diesel fuel may be called B5, B10 or B20, representing the percentage of the biodiesel that is blended with petroleum diesel.

Biodiesel is produced through a process in which organically derived oils are combined with alcohol (ethanol or methanol) in the presence of a catalyst to form ethyl or methyl ester. The biomass-derived ethyl or methyl esters can be blended with conventional diesel fuel or used as a neat fuel (100% biodiesel). Biodiesel can be made from any vegetable oil, animal fats, waste vegetable oils, or microalgae oils. There are three basic routes to biodiesel production from oils and fats:

1) Base catalysed trans-esterification of the oil.
2) Direct acid catalysed trans-esterification of the oil.
3) Conversion of the oil to its fatty acids and then to biodiesel.

There are varieties of oils that are used to produce biodiesel, the most common ones being soybean, rapeseed, and palm oil which make up the majority of worldwide biodiesel production. Other feedstock can come from waste vegetable oil, Jatropha, mustard, flax, sunflower, palm oil or hemp. Animal fats including tallow, lard, yellow grease, chicken fat and fish oil by-products may contribute a small percentage to biodiesel production in the future, but it is limited in supply and inefficient to raise animals for their fat. Jatropha is a small pest and drought resistant shrub that is capable of being grown on marginal/degraded land and produces seeds that yield several times more oil per acre than soybeans.

Biodiesel can be blended in any proportion with mineral diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, biodiesel operates in the compression ignition (diesel) engine, and essentially requires very little or no engine modifications because the biodiesel has properties similar to mineral diesel. It can be stored just like mineral diesel and hence does not require separate infrastructure. The use of biodiesel in conventional diesel engines results in substantial reduction in the emission of unburned hydrocarbons, carbon monoxide, and particulates. There are currently a large number of existing biodiesel production plants globally, and a large number under construction or planned to supply the growing global demand.

1.5 Advantages of Biodiesel:

Biodiesel fuel is a renewable energy source unlike petroleum based diesel.

An excessive production of soybeans in the world makes it an economic way to utilize this surplus for manufacturing the biodiesel fuel.

One of the main biodiesel fuel advantages is that it is less polluting than petroleum diesel.

The lack of sulphur in 100% biodiesel extends the life of catalytic convertors.

Another of the advantages of biodiesel fuel is that it can also be blended with other energy resources and oil.

Biodiesel fuel can also be used in existing oil heating systems and diesel engines without making any alterations.

It can also be distributed through existing diesel fuel pumps, which is another biodiesel fuel advantages over other alternative fuels.

CHAPTER - II

2. LITERATURE REVIEW

Before going with the project, a brief study on papers related to Performance Analysis of Compression Ignition Engine using Biodiesel was done. Many authors portrayed different ideas related to their works on Biodiesel. The different papers reviewed are listed below:

Santos capareda and capunitan et al. Investigated on performance and emission characteristics of diesel engine using peanut oil as biodiesel by trans- esterification process. It shows that when we are using peanut oil as biodiesel and its blends giving better results than the reference diesel by lowering the content of carbon monoxide (co) and carbon dioxide (co2).The methods in the paper included the ASTM characterization and engine performance and exhaust emissions testing and also trans-esterification . using small percentage of fuel blends, such as B5 and B20, resulted in significant changes in peak power and BSFC as compared to that of pure diesel fuel.

Canan Kaya and Akin Baysal et al. The peanut seed oil was extracted from the seeds of the peanut that grows in SEAnatolia of Turkey. Oil was obtained in 50 wt/ wt.%, by solvent extraction. Peanut seed oil was investigated as an alternative feed stock for the production of a bio diesel fuel. Bio diesel was prepared from peanut by transesterification of the crude oil with methanol in the presence of NaOH as catalyst. A maximum oil to ester conversion was 89%. The viscosity of biodiesel oil is nearer to that of petroleum diesel and the calorific value is about 6% less than that of diesel. Peanut seed oil have about 8.3% less heating value than that of diesel oil due to the oxygen content in their molecules. Bio diesel was obtained at laboratory scale from transesterification of crude peanut seed oil with methanol, using sodium hydroxide as a catalyst, in a batch process.

Thu Nguyen and David A. Sabatini et al. The goal of this research is to demonstrate the feasibility of producing this biodiesel fuel via vegetable oil extraction using diesel-based reverse micellar micro emulsions as an extraction solvent. In this extraction technique, peanut oil is directly extracted into the oil phase of the micro emulsion based on the “likes dissolve likes” principle and the product of the extraction process is peanut oil/diesel blend. The extracted peanut oil/diesel blend has the peanut oil fraction, viscosity, cloud point and pour point that meet the requirements for biodiesel fuel. An extraction efficiency of 95% was achieved at room temperature and short extraction time of 10 min in just a single extraction step.

Avinash Kumar Agarwal and K. Rajamanoharan et al. An experimental investigation has been carried out to analyze the performance and emission characteristics of a compression ignition engine fuelled with Karanja oil and its blends (10%, 20%, 50% and 75%) visa-vis mineral diesel. .The performance parameters evaluated include thermal efficiency, brake specific fuel consumption (BSFC), brake specific energy consumption (BSEC), and exhaust gas temperature whereas exhaust emissions include mass emissions of CO, HC, NO and smoke opacity. Thermal efficiency of the engine with preheated oil blends is nearly 30% and for lower blends (unheated) such as K10, K20 and K50, it was 24–27%. The brake specific fuel consumption and brake specific energy consumption of the engine with preheated lower blends showed an improved trend.

Mushtaq Ahmad and Sofia Rashid et al. Bio diesel was tested for fuel properties according to ASTM Standards. This paper is confined to the production and physio chemical characterization of peanut oil bio diesel (POB). An optimum conversion of POB from triglycerides (TD) was achieved by using 1:6 molar ratio (methanol : oil) at 60 C. Fuel properties of POB were determined and compared with ASTM (American Standard Testing Material). The kinematic viscosity at 40 C (eta) of POB (100%) was 5.908, specific gravity 0.918, density at 40 C (Rho) 0.0992, flash point (FP) 192, pour point (PP) 3 C, cloud point (CP) 6 C, and sulfur contents 0.0087. The engine performance by using POB in terms of consumption, efficiency and power output was quite comparable with petro-diesel (PD). It is concluded that most important factors affecting the fatty acid methyl esters (FAME) yield during transesterification are molar ratio of methanol to oil and reaction temperature.

Anand A, Nithyananda B. S et al. A single step process i.e., Transesterification is carried out for the mixed pongamia and coconut oil which contained low percentage of FFA to obtain the bio diesel. It was observed that the obtained bio diesel has very high density and viscosity which made it not possible to use in its pure form but it can be blended with diesel to obtain properties almost similar to that of diesel. The blends were prepared with bio diesel percentages of 10, 20, 30, 40 and 50 and the conclusions were drawn from this investigation.

R Anand and GR Kannan et al. A methyl ester of cottonseed oil was prepared and blended with diesel in four different compositions varying from 5% to 20% in steps of 5%. Tests were conducted in a single cylinder variable compression ratio diesel engine at a constant speed of 1500 rpm. Highest brake thermal efficiency and lowest specific fuel consumption were observed for 5% bio diesel blend for compression ratio of 15 and 17 and 20% bio diesel blend for compression ratio of 19. The 20% bio diesel blend at a compression ratio of 17 had maximum nitric oxide emission as

205 ppm, while it was 155 ppm for diesel. Substantial reduction in Carbon monoxide emissions and smoke in the full range of compression ratio and loads was observed. Improved heat release characteristics were observed for the prepared bio diesels. The results reveal that the bio diesels can be used safely without any modification to the engine.

Deepak Agarwal and Avinash Kumar Agarwal et al. In the present research, experiments were designed to study the effect of reducing Jatropha oil's viscosity by increasing the fuel temperature (using waste heat of the exhaust gases) and thereby eliminating its effect on combustion and emission characteristics of the engine. Experiments were also conducted using various blends of Jatropha oil with mineral diesel to study the effect of reduced blend viscosity on emissions and performance of diesel engine. A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine typically used in agricultural sector was used for the experiments. The acquired data were analyzed for various parameters such as thermal efficiency, brake specific fuel consumption (BSFC), smoke opacity, CO2, CO and HC emissions.

Chatpalliwarl et al. described the brief overview of the Bio-diesel production plant. Various issues- sources, opportunities, challenges, plant design, and evaluation etc. are discussed related to the Biodiesel production. The contribution of the work is that it discusses the important issues concerned with the Biodiesel production plant design, the fundamental details required for the formulation of Biodiesel plant and also it presents possible approach for the mathematical model to evaluate the Biodiesel plant design.

From the above literature survey, the authors have identified some of the gaps in the areas of Biodiesel. Hence the authors have embarked to study the influence of Alternative Fuels. In this work, the Performance of Compression Ignition Engine using peanut oil as Biodiesel is carried out by following the experimental procedure.

CHAPTER - III

3. SYNTHESIS OF PEANUT OIL & BIODIESEL

Biodiesel is produced through a process known as Trans-Esterification of triglycerides to methyl esters with methanol, a balanced and catalysed reaction. An excess of Methanol is required to obtain a higher degree of conversion. Jatropha and Rubber seed oils are among the some of the best for biodiesel uses.

The conventional catalyst in natural oil transesterification processes is selected among basis such as alkaline or alkaline earth hydroxides or alkoxides. However, transesterification could also be performed using acid catalysts such as hydrochloric, sulphuric and sulfonic acid, or using metallic base catalysts such as titanium alcoholates or oxides of tin, magnesium or zinc. All these catalysts act as homogeneous catalysts and need to be removed from the products after methanolysis step.

3.1 Peanut Oil as a Biodiesel:

Biodiesel from peanut oil is compatible with fossil fuel-based biodiesel and can be mixed in any combination. Compared to fossil-based biodiesel, there will likely be a 2 percent to 5 percent reduction in miles per gallon with either soy or peanut oil-based fuel, according Daniel Geller, a UG research engineer. Geller, who began working with peanut oil several years back, contends this is not significant and can likely be overcome by tweaking diesel engines.

In tests in his UG lab, Geller says peanut biodiesel is less toxic to the atmosphere and has a cleaning effect on diesel engines. He says peanut diesel can gel in the engine at temperatures as high as 50 degrees F, but the problem is easily fixed, and not likely to be a limiting factor in commercial use.

Peanuts and biodiesel go way back — to the beginning of diesel engines. German scientist Rudolph Diesel received a patent for his engine design in 1893. At the 1900 World's Fair, Diesel demonstrated his new engine powered by peanut biodiessel.

Diesel noted at the World Fair demonstration that his vision was that fuel for his engine would be grown in the area where the diesel powered vehicles would be used.

3.1 Methods of Extraction of Peanut Oil:

The extraction process can be classified based on combination of phases (solid, liquid, gas, supercritical fluid). For solid – liquid, this extraction is useful for the isolation and purification of naturally occurring sources while liquid – liquid is a more common method depending on solubility properties of components. Various solvents are used for extraction such as organic solvents and inorganic solvents where, organic solvents are less dense than water while inorganic solvents are denser than water. Commonly used organic solvents are diethyl ether, toluene, hexane, ethyl acetate, ethanol, and inorganic solvents are dichloromethane, chloroform and carbon tetrachloride. The most oil content of Jatropha is in the seed of the plant where it has about 40% of oil.

Traditional Method: these methods by which the oil is extracted from the seeds by hand using simple implements are till practiced in rural and le developed areas.

Mechanical Extraction: Mechanical pressing is the oldest and simplest method for oil extraction. Continuous screw-presses replaced the conventional hydraulic press equipment. Mechanical extraction of the oil is accomplished by exerting sufficient force on confined seed. Under this condition pressure is high enough to rupture the cells and force oil from the seed to escape. Extraction is accomplished by compressing the material in a container that has small perforations, either round or slotted, that allow the liquid component to leave.

Oil Expellers: these are used for the purpose of jatropha oil extraction. The most commonly used ones are the Shayari oil expeller and the komet expeller. The raw materials are squeezed under high pressure in a single step. The machine uses friction and continuous pressure from the screw drive to move and compress the seed material. The oil seeps through small openings that do not allow seed fiber solids to pass.

Hot Oil Extraction: Extraction of oil is done at high pressure. Hot oil extraction leads to the oil flow more quickly due to higher viscosity. The press cake that remains after extraction has less content, which is about 3 to 7%. During the oil extraction method, many stuffing of seeds converts them into gum like substances and some non-organic element. These are unwanted products, and they have to be refined.

Ultrasonic Assisted Extraction: Oil extraction is based on ultrasound waves. Ultrasound is used for the extraction of intra-cellular compounds through disintegration of cell structures which is also known as lysis ofthe cell. The process of extraction oil through this method is known as cavitation. Cavitation's occur when vapor bubbles of a liquid form in an area where pressure of the liquid is lower than its vapor pressure.

3.2 Methodology of Trans-Esterification Process of Peanut Oil:

The use of vegetable oils as alternative fuels has been around for one hundred years when the inventor of the diesel engine redolph Diesel first tested peanut oil, in his compression-ignition Engine. Biodiesel is better for the environment because it is made from renewable resources and has lower emissions compared to petroleum diesel. It is less toxic than table salt and biodegradable as fast as sugar.

Its use decreases dependence on foreign oil and contributes to one’s own country's economy. Biodiesel is made through a chemical process called transesterification where glycerin is separated from the fat or vegetable oil. Oils and fats typically contain monoglycerides, diglycerides, triglycerides, unsaponified lipids and free fatty acids. Since viscosity of vegetable oils is higher, engines designed to burn diesel fuel may not operate efficiently with high viscous and poor volatile vegetable oils. Vegetable oils get solidified at lower temperatures and do not support fuel injection system of engine.

So, transesterification is adapted to convert triglycerides to fatty acid methyl esters. Free fatty acids react to form glycerin (soap) which ultimately reduces the yield of biodiesel .

There are four basic routes to biodiesel production from oils and fats.

1. Base catalyzed transesterification
2. Direct acid catalyzed transesterification
3. Conversion of oil into its fatty acids and then into biodiesel
4. Non - catalytic transesterification of oils and fats

Base catalyzed transesterification

Esters in the presence of base such as an alcoholate anion form an anionic intermediate which can dissolve back to the original ester or form the new ester. The most useful basic transesterifying agents are sodium or potassium methoxide in anhydrous methanol . The main advantage of base catalyzed transesterification over acid one is that it is fast and can be conducted at low temperatures(303-308K) and pressure (0.1 MPa).

Acid catalyzed transesterification

Carboxylic acids can be esterified by alcohols in the presence of suitable acidic catalyst in water free conditions. The most frequently cited reagent for the preparation of methyl esters is 5%anhydrous hydrogen chloride in methanol. In a typical esterification procedure, using methanolic hydrogen chloride, the lipid sample is dissolved in at least a 100-fold excess of the reagent and the solution is refluxed for about two hours or is held at 50o C overnight (30 minutes at 50oC will suffice for free acids alone). Free fatty acids in the oil were reduced by using acid catalyst. Free fatty acids reduce the yield of biodiesel by saponification, hence acid catalyzed transesterification has an advantage of more yield. However, the reaction is slow that one run can take more than a day.

Lipase mediated transesterification

Chemical production of biodiesel by transesterification is cost effective and highly efficient but its problem is with downstream processing which includes separation of catalyst, unreacted methanol, glycerol recovery, removal of inorganic salts. There may be a risk of free acid or water contamination along with soap formation makes separation process difficult . Enzymatic approach seems to be a promising alternative production pathway. Because it not only decreases the operation cost but also over comes problems associated with chemical production of biodiesel.Enzymatic approach produces high purity product and enables easy separation from byproduct, glycerol. Lipases (triacyl glycerol acyl hydrolase EC 3.1.1.3) are hydrolytic enzymes that catalyze the hydrolysis and synthesis of variety of acylgecerols at interface of lipid and water. Lipases are produced by Pseudomanas aeruginosa, P. flurescens, Candida antarctica, Rhizopus oryzae, Thermomyces lanuginosa. Transesterification reaction mixture consisted of oil, lipase and methanol. 86.2% conversion of fatty acids to fatty acid methyl ester (FAME) within 36 hours at 45oC by using 7.5 % (w/v) lipases, molar ration of oil to methanol is 1:4 .

Microwave assisted transesterification

In conventional transesterification process heating of material takes place by conduction. Whereas microwaves heat by means of thermal radiation and it is very efficient mode of heat transfer. In microwave assisted continuous transesterification, vegetable oil and methanolic NaOH solution were fed separately via 2 pumps and mixed at the tee connector at the inlet of modified house hold microwave oven (800W). Reaction time and molar ratio of the oil to alcohol were controlled via a combination of flow control valves of the pumps. Instantaneous heating of oil mixture by microwave is more advantageous than conventional prolonged heating of 2 hours. The reaction temperature attained during the transesterification in microwave oven (800 W) is around 65 to 800oC. Microwave energy is delivered directly to the reacting molecules which undergo chemical reaction. Reaction time was reduced to 60 seconds with palm oil, 5 to 10 minutes in case of non-edible oils of Honge and Jatropha where their respective conversion in conventional method was 1 hour and 1 to 2 hours. Biodiesel produced by microwave assisted transesterification has reduced performance due to their comparatively high viscosity. Also smoke opacity, HC and CO emissions increased with such oils .

Ultra sonically assisted transesterification

Transesterification is a chemical reaction between triglycerides (oil /fats) and methanol, which form immiscible phases when they are in a reaction vessel, the reaction takes place at contact surface between oil and methanol .Ultrasonic reactor drastically reduces the amount of catalyst, molar ratio of oil to methanol 1:6, reaction time, reaction temperature, mass transfer resistance elimination and energy input for production of biodiesel. Low frequency ultra sound (28 and 40 kHz) were found to be more efficient, at higher frequencies the collapse of cavitations bubbles are not strong enough to impinge one liquid to the other . Transesterification reaction takes place at interfacial region of two immiscible phases (oil and methanol), which may be achieved by vigorous mixing using ultra sonic waves and produces pure fuel with highest possible conversion percentage. Previous reports shown the smaller reaction time (20-40 minutes) with 2-3times lower amounts of catalyst requirements in case of ultrasonic assisted transesterification when compared to mechanical agitation . The reaction rate constants were evaluated and found that rate constants are 3-5 times higher than that of mechanical agitation. Acoustic and hydrodynamic cavitation found effective tool for intensification of esterification of fatty acids with acid catalyst (H_2SO_4) 99.4 % conversion soybean oil to FAME (fatty acid methyl ester) was achieved in about 15 minutes at 40 oC and molar ratio of 6:1 methanol to oil with 20kHz ultrasonic frequency. Lipase catalyzed transesterification activity enhanced with ultrasonic irradiation. With 8% enzyme (Novozyme 435), 3:1 molar ratio of propanol to oil, power of ultrasonic assistant 100 W, frequency of 28 kHz, temperature 40 to 45 oC for 50 minutes yielded 94.86% of propyl oleate, which is 10.43% higher than mechanical agitation mediated transesterification,also ultrasonic assisted transesterification reduced amounts of lipase and reaction time. Yields of biodiesel were always higher when ultrasound was used.

3.4 Trans-esterification Reaction:

The transesterification process was widely used in bio-diesel production from different biomass materials. The process consists of two steps namely, acid esterification and alkali transesterification:

Step 1: Acid esterification: Acid esterification reduces the FFA value of un-refined oil using an acid catalyst.

Step 2: Alkali trans-esterification: After removing the impurities of the product from the step 1, it is trans-esterified to monoesters of fatty acids using an alkali catalyst.

Fig 3.1: Trans-Esterification Process

3.5 Draining of Glycerol Peanut oil as a bio-diesel:

After the transesterification reaction, we must wait for the glycerol to settle to the bottom of the container when kept in a separating funnel. This happens because Glycerol is heavier than biodiesel. The settling will begin immediately, but the mixture should be left a minimum of eight hours to make sure all of the Glycerol has settled out. The Glycerol volume should be approximately 20% of the original oil volume. The objective is to remove only the Glycerol and stop when the biodiesel is reached. Glycerol looks very dark compared to the biodiesel as shown in Fig 3.2. The viscosity difference is large enough between the two liquids that the difference in flow from the drain can be seen.

Fig 3.2: Separation of Glycerol and Esters

The Methyl esters thus obtained from trans-esterification of jatropha seed oil is referred as Biodiesel in this work. The Biodiesel is mixed with

Petroleum Diesel by the process of Blending with varying proportions to obtain various fuel blends.

CHAPTER - IV

4. EXPERIMENTAL SETUP:

4.1 Basic Theory:

Engine: Engine is a device or a machine used to convert one form of energy to mechanical energy.

Heat Engine: It converts chemical energy of the fuel into heat energy which is used to do work. They are classified into two categories:

1. Internal Combustion engine (ICE): ICE is a heat engine where the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber.

2. External Combustion engine (ECE): ECE is heat engine where a working fluid, contained internally, is heated by combustion in an external source, through the engine wall or a heat exchanger.

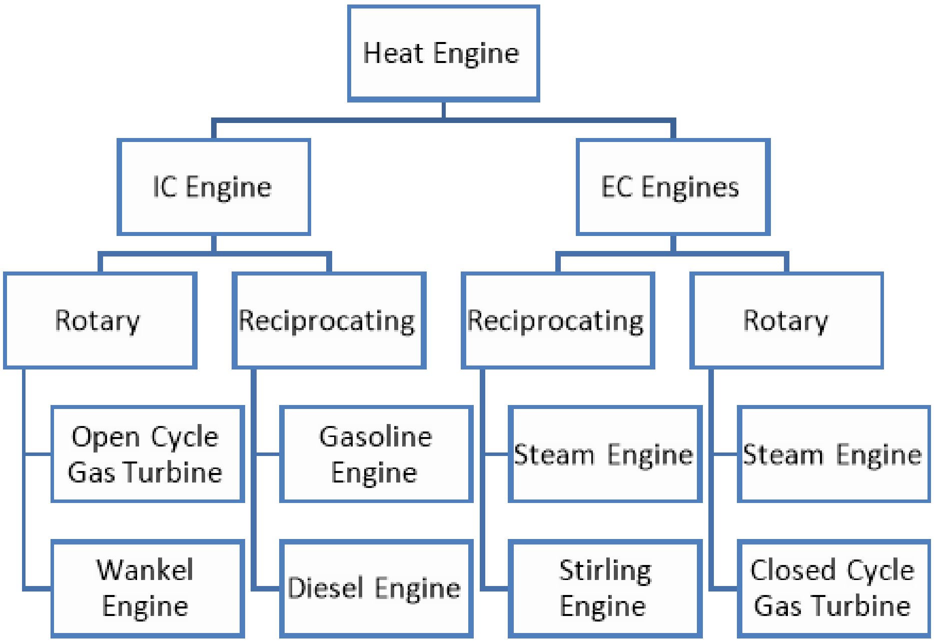


Fig 4.1: Classification of Heat Engine

4.2 IC Engines Classification:

There are several possible ways of to classify IC engines

Reciprocating:

By number of strokes

1. Two stroke engines
2. Four stroke engines

3. Six stroke engines

By type of ignition

1. Compression-Ignition Engine
2. Spark-Ignition Engine

Rotary:

Gas turbines

1. Turbojet
2. Turbofan
3. Turboprop

Ramjet

Rocket engine

Reasons for Selection of Diesel Engine over Petrol Engine:

1. Diesel Engines are More Efficient: As of now diesel engines convert 45-50% of the energy whereas gasoline engines convert only 30% of energy.
2. More Reliable: Because it doesn't require high voltage ignition system so they don't emit RF (radio frequency) issues with vehicle electronic system. As long as good maintenance is done, vehicles life would be around 5,00,000 miles with advancements in turbo technology some drawbacks are minimized.
3. Fuel Cost is Significantly Lower: Overall cost for kilowatt for diesel fuel runs between 30 to 50% lower than gasoline powered engines. Moreover, diesel require work to refine than gasoline.
4. Diesel is Much Safer: Higher flash and fire point makes diesel much safer than gasoline and vaporization loses are less compared to petrol engines.

4.3 Diesel Engine:

Diesel engine (also known as compression ignition engine) named after **Rudolf Diesel**, is an internal combustion engine in which fuel ignition is caused by elevated temperature of air due to adiabatic compression in the cylinder. In this fuel injectors are used to inject the fuel into the cylinder in the form of small droplets which atomizes the fuel with compressed air.

Fig 4.2: Four Stroke, Single Cylinder, Vertical Diesel Engine

4.4 Diesel Cycle:

Unlike Otto cycle, here the heat addition process takes place at constant pressure because the fuel is injected after the compressed air reaches the temperature higher than the self-ignition temperature of the fuel. So, this is also known as Constant Pressure Cycle but is better to avoid this term as it creates confusion with Joule's cycle.

The following process takes place during the cycle

Suction: Here, air enters through inlet valve opening due to creation of low pressure inside the cylinder till the crank angle reaches 180 degrees in four stroke engine and 90 degrees in two stroke engines.

Isentropic compression: In this process, air in the cylinder gets compressed through the movement of piston from bottom dead center (BDC) to top dead center (TDC). Since this process takes place in the short period of interval it can be assumed as adiabatic compression process. The compression ratios are higher in order for the air in the cylinder to achieve self-ignition temperature of the fuel.

Constant pressure heat addition: At the end of the compression process, when the piston is nearer to TDC the fuel injection starts injecting fuel into cylinder in the form of small droplets due to high temperature and pressure present in the cylinder the fuel vaporizes instantaneously and combustion starts taking place. The fuel is added till the initial part of the power stroke so the air-fuel mixture is allowed to expand during the heat addition.

Isentropic expansion: After the heat addition is done the power stroke takes place till the BDC and work is transferred to the crank shaft through connecting rod. Since the heat addition done at constant pressure the amount of torque generated can be controlled with the change in fuel addition.

Constant volume heat rejection: When the piston reaches BDC this process starts with the opening of exhaust valve. Here all the burnt and un-burnt gases escape due to the pressure difference inside the cylinder and exhaust manifold.

Exhaust: The remaining exhaust gases are pushed out with the movement of piston from BDC and the exhaust valve closes simultaneously when the piston reaches TDC. Thus finishes one ideal diesel cycle process.

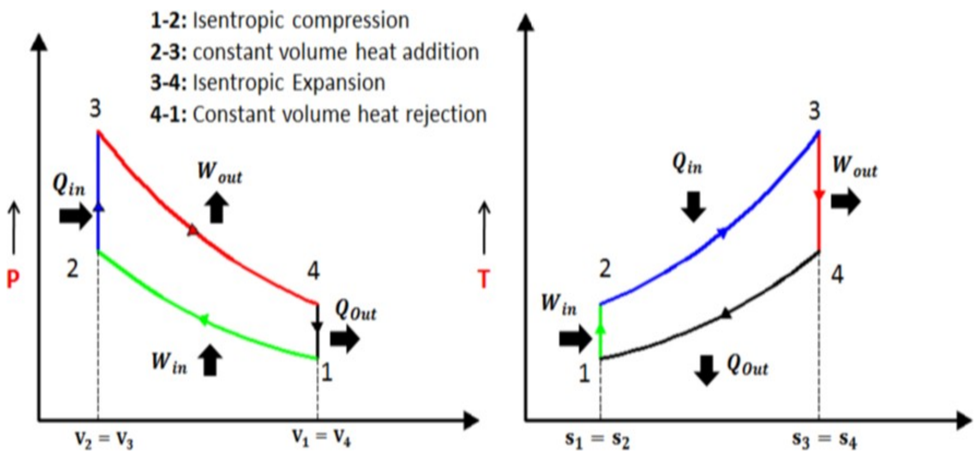


Fig4.3: P-V and T-S Diagram of Otto Cycle

4.5 Types of Diesel Engine:

1. **Two stroke diesel engines:** In this the cycle is completed in one revolution of the crankshaft. The major difference is method of filling the fresh charge and removing the burnt gases from the cylinder. During the expansion stroke, the charge from the inlet uncovers the exhaust port, due to the decrease of pressure to atmospheric value exhaust products leave the cylinder. Further movement uncovers the transfer ports, permitting slightly compressed charge into the cylinder. To eliminate mixing of

charges provisions are made on the cylinder which pushes the fresh charge to top portion and allows the burnt gases to leave from cylinder. Now, during the compression stroke charge in cylinder is compressed and fresh charge is introduced using spring loaded valve into the crankcase. This is the basic working process of the two-stroke engine.

2. Four **stroke diesel engines:** The working of this cycle is similar as explained in the above diesel cycle

Advantages of Four stroke Engine over Two Stroke Engine:

1. Less noise: 4 stroke engines make less noise and mixture remains only in the combustion chamber.
2. More torque: In general, 4 stroke engines always make extra torque than 2 stroke engines at low RPM. Although 2 stroked ones give higher torque at higher RPM but it has a lot to do with fuel efficiency.
3. More fuel efficiency: 4 stroke engines have greater fuel efficiency than 2 stroke ones because fuel is consumed once every 4 strokes.
4. Less pollution: As power is generated once every 4 strokes and as no oil or lubricant is added to the fuel so 4 stroke engine produces less pollution.
5. More durability: We all know that more the engine runs, quicker it wears out. 2 stroke engines are designed for high RPM. If a 4-stroke engine with 100 rpm will run for 100 minutes than the other 2 stroke engine which has a higher rpm of 500 and will run for only 20 minutes.
6. No extra addition of oil: Only the moving parts need lubrication intermediately. No extra oil or lubricant is added to fuel.

Limitations of Four Stroke Engine:

1. Complicated design: A 4 stroke engine has complex valve mechanisms

operated & controlled by gears & chain. Also, there are many parts to worry about which makes it harder to troubleshoot.

2. Less powerful: As power gets delivered once every 2 rotations of crankshaft (4 strokes), hence 4 stroke is less powerful.

3. Expensive: A four stroke engine has much more parts than 2 stroke engines. So, they often require repairs which lead to greater expense.

Combustion Processes in Diesel Cycle:

Unlike in SI engines, combustion process mainly happens with high compression ratios and heterogeneous mixture combustion takes places due to fuel injection.

Stages of Combustion in CI Engines:

Ignition Delay Period: At the instant of injection of fuel droplets the mixture doesn't ignite immediately so some time is taken up by the cycle to build up pressure inside the chamber which has huge effect on combustion rate, knocking, engine start ability and presence of smoke in exhaust. This period is known as ignition delay period.

It mainly divided into two parts

1. Physical delay: It is the time between the injection and attainment of chemical reaction conditions. During this the fuel gets atomized, vaporized, mixed with air and reaches self-ignition temperature. It mainly depends on type of fuel used.
2. Chemical delay: In this the reactions starts slowly and accelerate until ignition takes place. Generally, it takes lager time but it depends on temperature of surroundings and at high temperatures it takes shorter time than physical delay.

Period of Rapid Combustion: After the delay period, most of the fuel admitted would have evaporated and forms a combustible mixture with air. The period of rapid combustion starts from end of delay period to the point of attainment of maximum pressure in the cylinder. The rate of heat release is also maximum and it depends on duration of delay period.

Period of Controlled Combustion

Period of After-Burning

4.6 Engine Description:

After the diesel preparation and blending has been done proper type of diesel engine is to be selected which is a crucial step in determining the main conclusions in the project. By conducting survey on the available engines in our locality, based on merits Kirloskar make, four stroke, single speed, water cooled vertical diesel engine test-rig in ANITS college laboratory. The engine is provided with burette, graduations duly marked and three-way valve for fuel flow measurement. Along with-it provisions are made for applying load with the help of spring balance on the brake drum. So, from the above experimental set we can conduct load test on the four-stroke diesel engine and performance characteristics for different blends of bio-diesel can be determined.

Table 4.1: Specifications of Diesel Engine

Single Cylinder Four Stroke Diesel Engine Test Rig:	
Engine Make	M/S Kirloskar
Cylinder Position	Vertical
Brake Power	5 HP
Speed	1500 RPM
Bore	80 mm
Stroke	110 mm
Compression ratio	17.5:1
Air Box Orifice Diameter	20 mm
Cooling	Water Cooled
Starting	Hand Cranking
Dynamometer	Rope Brake

4.7 Viscometer:

Viscosity is the measure of resistance offered by the fluid in the form of layers due to gradual deformation by shear stress or tensile stress. In general, it corresponds to the informal concept of "thickness". For example, oil takes more time to fill than water.

A viscometer (also called viscosimeter) is a device used to measure the viscosity of a fluid which is an important property for determining the characteristics of the bio-diesel. For liquids viscosities which vary with flow conditions, an instrument called rheometer is used. Viscometers only measure under one flow condition. There are different types of viscometers such as Ostwald viscometers or glass capillary viscometers, Falling-sphere viscometers, vibrational viscometers based on different principle of operations.

At 20.00 degrees Celsius the viscosity of water is 1.002mPa and its kinematic viscosity (ratio of viscosity to density) is 1.0038 mm2/s. These values are used for calibrating certain types of viscometers. Redwood viscometer determines the viscosity in terms of seconds. Here, initially time for collection of 50 cc fluid through a small orifice which is uniformly heated in terms of seconds is noted from this value by calculations viscosity can be determined. Redwood viscometers are of two types:

1. Redwood viscometer No.1 (for fluids having viscosity corresponds to redwood seconds less than 2000)
2. Redwood viscometer No.2 (for fluids having viscosity corresponds to redwood seconds greater than 2000)

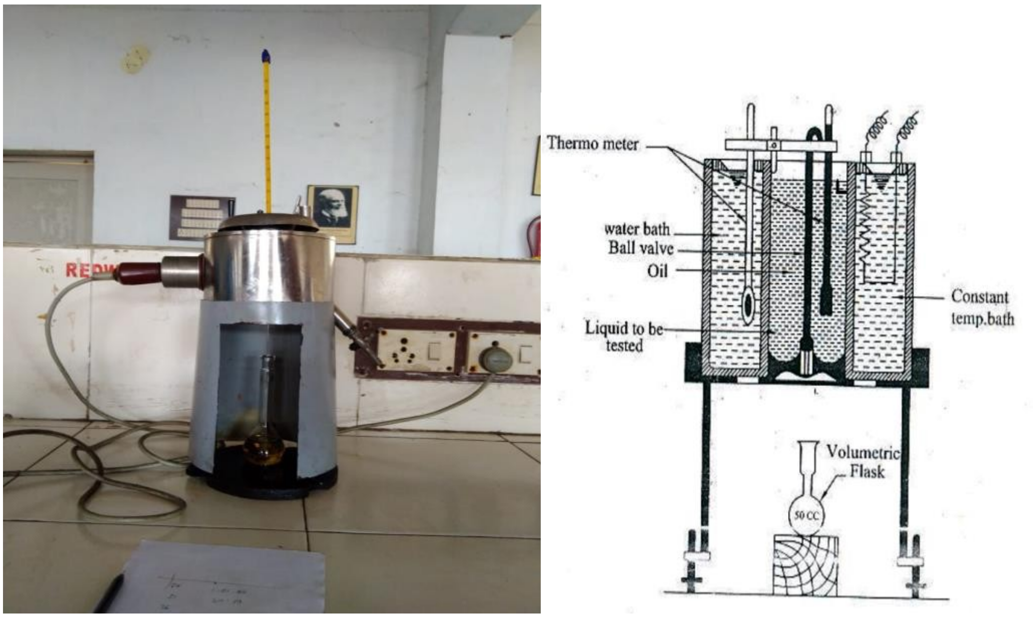


Fig 4.4: Viscometer Apparatus

CHAPTER - V

5. EXPERIMENTAL PROCEDURE:

5.1 Biodiesel preparation:

1. First the oil is manufactured from the peanutoil.
2. Removal of impurities and particulate matter from the oil through filter.
3. Removal of water particles by heating the oil up to 100 degrees centigrade.
4. Now allow the oil to cool then methanol is added in required quantities.
5. Place the mixture on the heating machine and with the help magnetic stirrer heating and stirring is done simultaneously.
6. In the second stage KaoH billets are added to methanol solution and stirred until the billets gets melted completely. Then this solution is added to the main mixture.
7. Again, the process of heating and stirring is done around 52-55 degrees centigrade until the separation is visible.
8. Now the solution is allowed for sedimentation until clear separation of two layers.
9. One layer contains biodiesel and other glycerol. Glycerol is allowed to solidify and the biodiesel is separated.
10. With the help of distilled water any further impurities are removed from the biodiesel.

Precautions:

1. Make sure that the apparatus is free from impurities and water particles.
2. The oil should not contain any other proportions of chemicals.

5.2 Blending:

It is the main process involved for preparation of biodiesels by using a magnetic stirrer mixing is done with different oils to obtain the required properties.

This process involves:

a. Taking proportions of biodiesel.

b. Mixing biodiesel with petroleum diesel in the mixer.

Fig 5.1: Blending of Oils using Magnetic Stirrer

5.3 Blending of oils:

In general terminology to indicate the composition of biodiesel is as B5, B10, B15 etc., where "B" represents the percentage of blend.

For example: 10% biodiesel, 90% diesel is represented as B10.

Table 5.1: Oil Proportion in Fuel Blends

Blends	**Diesel (ml)**	**Peanut Oil(ml)**
B 5	950	50
B 10	900	100
B 15	850	150
B 20	800	200

Table 5.2: Properties of Oil Blends

	B5	B10	B15	B20	B25
Specific Gravity (gm/cc)	0.8324	0.8360	0.8378	0.8394	0.8422
Calorific Value (kJ/kg)	44406.3	44204.2	44080.6	43608.1	43441.9

5.5 Testing procedure:

1. Check the fuel and lubricating oil systems before staring the engine.
2. Connect the water supply to the engine and brake drum and remove all load on the brake drum.
3. Keep 3-way cock in horizontal position so that fuel flows from the tank to the engine filling the burette.
4. Start the engine by hand cranking and allow the engine to pick up the rated speed.
5. Allow the engine to run for some time in idle condition.
6. Pull the 3-way cock in vertical position and measure the fuel consumption rate by noting the time for 10cc of fuel flow.
7. Experiment repeated at different loads.
8. Engine is stopped after detaching load from the engine.

CHAPTER - VI

6. RESULTS AND DISCUSSION:

In this chapter, the observations are evaluated from the basic formulae to obtain the required results and graphs. The observations and results are tabulated which are also mentioned in this chapter. The results were analysed and the conclusions have been derived.

6.1 Basic Data for Calculations:

1. Rated brake power of the engine B.P = 5 H.P =3.77KW
2. Speed of the engine N = 1500RPM
3. Effective radius of the brake drum R=0.213 m.
4. Stroke length L =110×10^{-3} m
5. Diameter of cylinder bore D = 80×10^{-3} m
6. Time taken for 10cc fuel consumption is't' sec

6.2 Basic Formulae for Calculations:

$$\text{Maximum load} = \frac{Rated\ B.P \times 60000}{2\pi NR \times 9.81}$$

$$= \frac{3.7 \times 60000}{2\pi \times 1500 \times 0.213 \times 9.81}$$

$$=11.27 \text{ kg}$$

$$\text{Brake Power (B.P)} = \frac{2\pi N(W-S) \times 9.81 \times R}{60000}$$

$$\text{Fuel Consumption (F.C)} = \frac{10}{t} \times \frac{specific\ gravity \times 3600}{1000}$$

kg/hr Indicated Power (I.P) = B.P + F.P

Where F.P is the Frictional Power obtained from the graph drawn between Brake

Power and Fuel Consumption. The linear portion of the graph is extended to cut the negative of the x-axis on which B.P. is taken. The length of intercept point from zero gives Frictional Power. This method of determining F.P. is known is known as Willian line Method.

CALCULATIONS:

1. Specific fuel consumption (SFC) = $\frac{F.C}{B.P}$kg/KW.hr

2. Brake Thermal efficiency η Bth = $\frac{B.P \times 3600}{FC \times CV}$

3. Indicated thermal efficiency η Ith = $\frac{I.P \times 3600}{FC \times CV}$

4. Mechanical efficiency η mech $\frac{B.P}{I.P}$=

5. Indicated mean effective pressure (IMEP) = $\frac{I.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

6. Brake mean effective pressure (BMEP) = $\frac{B.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

6.3 Model Calculations:

Considering pure diesel at 3.4 kgf load:

Specific gravity is 0.853

gm/cc Calorific value is

45000 KJ/kg

Brake Power (B.P) = $\frac{2\pi N(W - S) \times 9.81 \times R}{60000}$

$$= \frac{2\pi * 1500 * (2-0.3) * 9.81 * 0.213}{60000}$$

=0.55kw

Fuel Consumption (F.C) = $\frac{10}{t} \times \frac{specific\ gravity \times 3600}{1000}$ kg/hr

=(10/65) *((0.8*3600)/1000)

=0.443 kg/hr

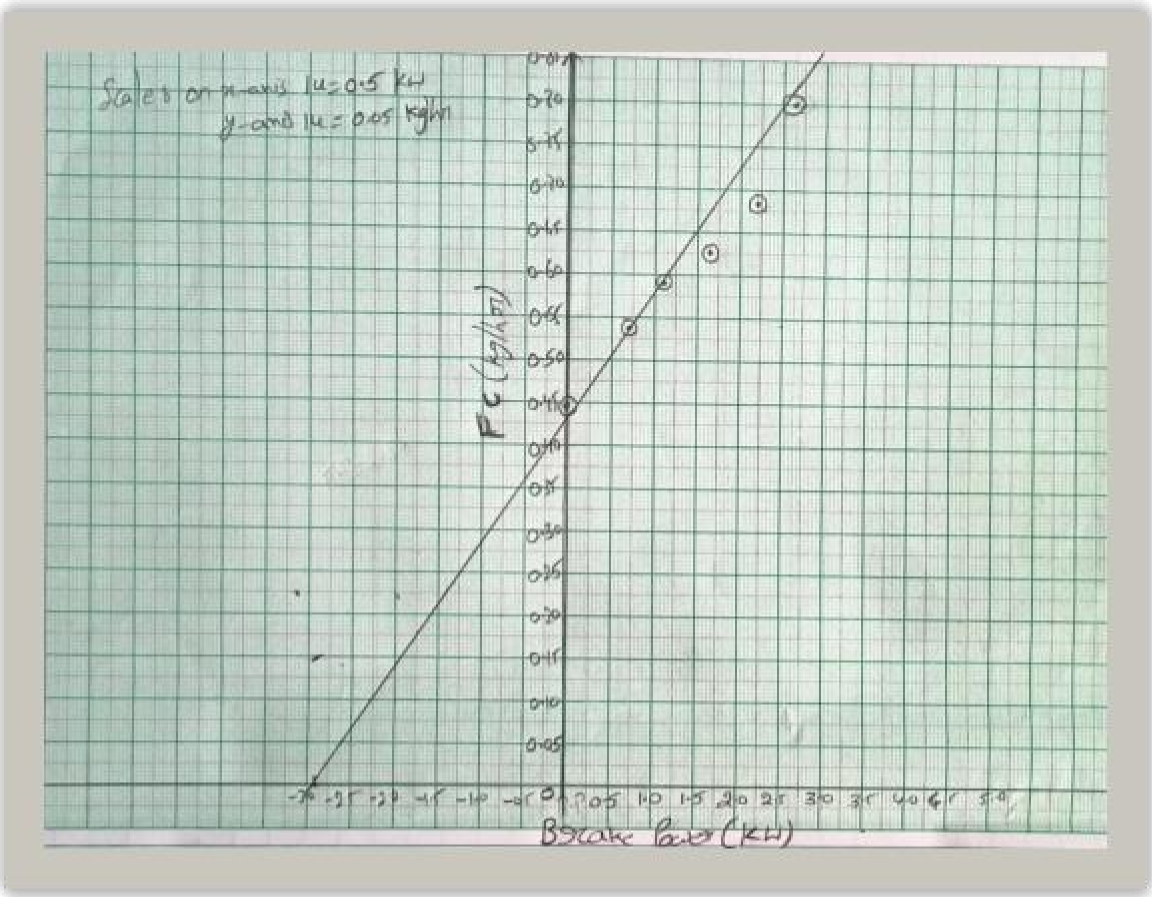
Frictional Power from graph (F.P) =2.8

KW Indicated power (I.P) = B.P +F. P

=0.55+2.8

=3.3 KW

Where F.P is the frictional power obtained from the graph drawn between Brake Power and Fuel Consumption. The linear portion of the graph is extended to cut the negative of the x-axis on which B.P is taken. The length of intercept point from zero gives frictional power. This method of determining F.P. is known as Willan's line method.



Specific fuel consumption (SFC)= $\frac{F.C}{B.P}$kg/KW.hr

= (0.443/0.558)

=0.79 kg/KW hr

Brake thermal efficiency ηBth $\frac{B.P \times 3600}{FC \ \times CV}$

=(0.558*3600)/(0.443*45000)

$$=0.1007$$

=10.007%

Indicated thermal efficiency $\eta_I \frac{I.P \times 3600}{FC \times CV}$

=(3.3*3600)/(0.443*45000)

=0.59

=59%

Mechanical efficiency η_{mech} $\frac{B.P}{I.P}$

=(0.558/3.3)

=0.17

=17%

Indicated mean effective pressure (IMEP) =$\frac{I.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

$=\frac{3.956 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4}(80 \times 10^{-3})^2 \times \frac{1500}{2}}$

=4.77bar

Brake mean effective pressure (BMEP) = $\frac{B.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

$=\frac{1.1159 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4}(80 \times 10^{-3})^2 \times \frac{1500}{2}}$

=0.87bar

TABLES

FLASH POINT AND FIRE POINT

BIODIESEL BLENDS	FLASH POINT	FIRE POINT
B5	47	49
B10	48	50
B15	49	52
B20	52	54
B25	54	56
B30	56	58

VISCOSITY RESULTS

FOR B5

SNO	TEMPERATURE	TIME FOR 50CC OF OIL	A*TIME	B/TIME	KINEMATIC VISCOSITY	Ln(V)	ABSOLUTE VISCOSITY
1	34	35	0.0924	0.054	0.0384	-3.26	0.035

SNO	TEMPERATURE	TIME FOR 50CC OF OIL	A*TIME	B/TIME	KINEMATIC VISCOSITY	Ln(V)	ABSOLUTE VISCOSITY
2	39	33	0.087	0.057	0.030	-3.50	0.027
3	44	31	0.081	0.061	0.020	-3.91	0.018

FOR B10

SNO	TEMPERATURE	TIME FOR 50CC OF OIL	A*TIME	B/TIME	KINEMATIC VISCOSITY	Ln(V)	ABSOLUTE VISCOSITY
1	34	40	0.105	0.04	0.057	-2.86	0.052
2	39	38	0.10	0.05	0.050	-2.99	0.046
3	44	34	0.089	0.05	0.034	-3.38	0.031

FOR B15

SNO	TEMPERATURE	TIME FOR 50CC OF OIL	A*TIME	B/TIME	KINEMATIC VISCOSITY	Ln(V)	ABSOLUTE VISCOSITY
1	34	42	0.110	0.045	0.065	-2.73	0.056
2	39	39	0.102	0.048	0.054	-2.91	0.050
3	44	36	0.095	0.052	0.043	-3.14	0.040

FOR B20

SNO	TEMPERATURE	TIME FOR 50CC OF OIL	A*TIME	B/TIME	KINEMATIC VISCOSITY	Ln(V)	ABSOLUTE VISCOSITY
1	34	44	0.116	0.043	0.073	-2.61	0.066

2	39	40	0.105	0.047	0.058	-2.84	0.053
3	44	37	0.09	0.051	0.045	-3.08	0.041

Table 6.1: Observations for Pure Diesel

S. No	Load on brake drum(W-S)kgf	Time for 10cc fuel consumption (Sec)	F.C. (Kg/hr)	Brake power (kW)	Indicated power (kW)	Specific fuel consumption (Kg/kW-hr)	Brake thermal efficiency (%)	Indicated thermal efficiency (%)	Mechanical efficiency (%)	I.M.E.P (bar)	B.M.E.P (bar)

1.	0	75	0.384	0	2.8	0	0	0.58	0	4.05	0
2.	2-0.3	65	0.443	0.558	3.3	0.79	0.1007	0.59	0.17	4.77	0.87
3.	4-0.5	56	0.514	1.14	3.9	0.44	0.178	0.60	0.29	5.64	1.66
4.	6-0.9	49	0.587	1.67	4.4	0.35	0.228	0.59	0.38	6.30	2.42
5.	8-1.1	42	0.685	2.26	5.0	0.30	0.264	0.58	0.44	7.23	3.26
6.	10-1.1	36	0.80	2.92	5.7	0.27	0.29	0.57	0.51	8.24	4.22

Table 6.2: Observations for B5 Blend

S. No	Load on brake drum(W - S)kgf	Time for 10cc fuel consumption (Sec)	F.C. (Kg/hr)	Brake power (kW)	Indicated power (kW)	Specific fuel consumption (Kg/kW-hr)	Brake thermal efficiency (%)	Indicated thermal efficiency (%)	Mechanical efficiency (%)	I.M.E.P (bar)	B.M.E.P (bar)
1.	0	83	0.346	0	2.8	0	0	0.58	0	4.05	0
2.	2-0.3	67	0.429	0.558	3.3	0.79	0.1007	0.59	0.17	4.77	0.87
3.	4-0.5	61	0.472	1.148	3.9	0.44	0.178	0.60	0.29	5.64	1.66
4.	6-0.9	50	0.576	1.674	4.4	0.35	0.228	0.59	0.38	6.36	2.42
5.	8-1.2	43	0.669	2.26	5.06	0.303	0.264	0.58	0.44	7.23	3.26
6.	10-1.5	38	0.757	2.92	5.7	0.27	0.29	0.57	0.512	8.24	4.22

Table 6.3: Observations for B10 Blend

S. No	Load on brake drum(W-S) kgf	Time for 10cc fuel consumption (Sec)	F.C. (Kg/hr)	Brake power (kW)	Indicated power (kW)	Specific fuel consumption (Kg/kW-hr)	Brake thermal efficiency (%)	Indicated thermal efficiency (%)	Mechanical efficiency (%)	I.M.E.P (bar)	B.M.E.P (bar)
1.	0	84	0.34	0	2.25	0	0	0.58	0	3.75	0
2.	2-0.3	68	0.42	0.55	2.28	0.77	0.11	0.48	0.24	4.05	0.79
3.	4-0.5	65	0.44	1.14	3.39	0.38	0.22	0.68	0.33	4.90	1.64
4.	6-1.1	50	0.57	1.60	3.85	0.36	0.24	0.59	0.41	5.57	2.31
5.	8-1.3	42	0.68	2.19	4.44	0.31	0.28	0.57	0.49	6.42	3.16
6.	10-1.7	38	0.75	2.72	4.97	0.27	0.32	0.58	0.54	6.46	3.93

Table 6.4: Observations for B15 Blend

S. No	Load on brake drum(W-S) kgf	Time for 10cc fuel consumption (Sec)	F.C. (Kg/hr)	Brake power (kW)	Indicated power (kW)	Specific fuel consumption (Kg/kW-hr)	Brake thermal efficiency (%)	Indicated thermal efficiency (%)	Mechanical efficiency (%)	I.M.E.P (bar)	B.M.E.P (bar)
1.	0	82	0.35	0	2.35	0	0	0.63	0	3.40	0
2.	2-0.3	68	0.42	0.55	2.90	0.76	0.12	0.65	0.18	4.09	0.79
3.	4-0.5	56	0.51	1.14	3.49	0.44	0.21	0.65	0.32	5.05	1.64
4.	6-0.9	50	0.57	1.67	4.02	0.34	0.27	0.67	0.41	5.81	2.41
5.	8-1.3	43	0.66	2.19	4.54	0.30	0.31	0.65	0.48	6.57	3.16
6.	10-1.4	38	0.75	2.82	5.17	0.26	0.35	0.66	0.54	7.48	4.08

Table 6.5: Observations for B20 Blend

S. No	Load on brake drum(W - S) kg f	Time for 10cc fuel consumption (Sec)	F.C. (Kg/hr)	Brake power (kW)	Indicated power (kW)	Specific fuel consumption (Kg/kW-hr)	Brake thermal efficiency (%)	Indicated thermal efficiency (%)	Mechanical efficiency (%)	I.M.E.P (bar)	B.M.E.P (bar)
1.	0	82	0.35	0	2.5	0	0	0.72	0	3.61	0
2.	2-0.3	67	0.42	0.55	3.05	0.76	0.13	0.73	0.18	4.41	0.79
3.	4-0.5	55	0.52	1.14	3.64	0.45	0.22	0.71	0.31	5.26	1.64
4.	6-0.9	49	0.58	1.67	4.17	0.35	0.29	0.73	0.38	6.03	2.41
5.	8-1.3	41	0.70	2.19	4.69	0.31	0.31	0.68	0.46	6.73	3.16
6.	10-1.5	37	0.77	2.78	5.28	0.27	0.36	0.69	0.52	7.64	4.02

The Frictional Power in case of each blend is determined through the Willian's Line Method as described earlier. The Willian Line for each blend is obtained from the graphs for Diesel, B5, B10, B15, B20, B25 respectively.

The Frictional Power obtained from the Willan's line method for each fuel blend is as follows:

For Diesel F.P = 2.84 KW

For B5, F.P = 2.25 KW

For B10, F.P= 2.25 KW

For B15, F.P = 2.35 KW

For B20, F.P = 2.50KW

6.4 Performance Characteristics:

The values of brake power, mechanical efficiency, specific fuel consumptions, indicated thermal efficiency, brake thermal efficiency are set to be the parameters of performance of the engine. By comparing of different blend characteristics values are made to all combinations of conditions.

Engine performance is an indication of the degree of success with which it is doing its assigned job, i.e., the conversion of the chemical energy contained in the fuel into the useful mechanical work.

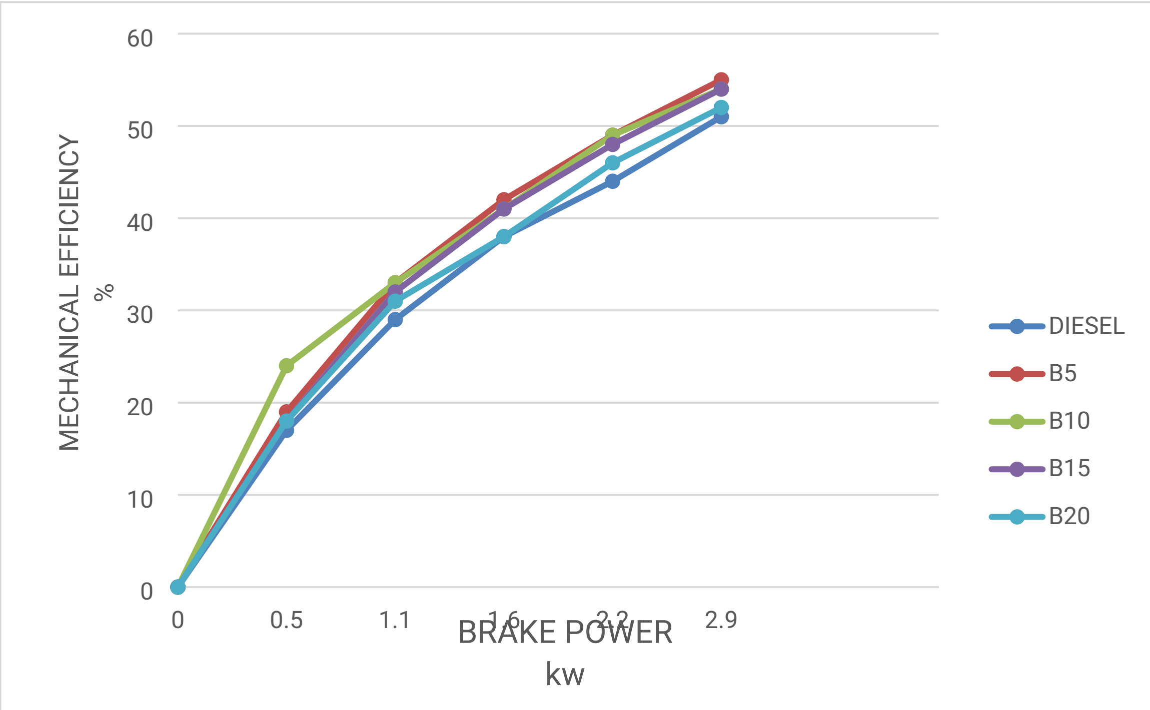
The degree of success is compared on the basis of the following:

1. Specific fuel consumption
2. Brake mean effective pressure
3. Brake thermal efficiency
4. Indicated thermal efficiency
5. Mechanical efficiency

6. Indicated mean effective pressure

Fig 6.1: Brake Power Vs Mechanical Efficiency

Mechanical efficiency indicates how good an engine is inverting the indicated power to useful power. The values of Mechanical Efficiency at



different Brake Powers are plotted as shown in Fig 6.1. B5 blend offers the best Mechanical Efficiency of all the mixtures and therefore seems to be the best mixture with regards to the minimum Frictional Power. Diesel gives the least Mechanical Efficiency.

6.4.2 Comparison of Brake Thermal Efficiency:

Brake Thermal Efficiency is defined as Brake Power of a heat engine as a function of the thermal input from the fuel. It is used to evaluate how well an engine converts the heat from a fuel to mechanical energy. The values of Brake Thermal Efficiency at different brake powers are plotted. B5 offers least Brake Thermal Efficiency.

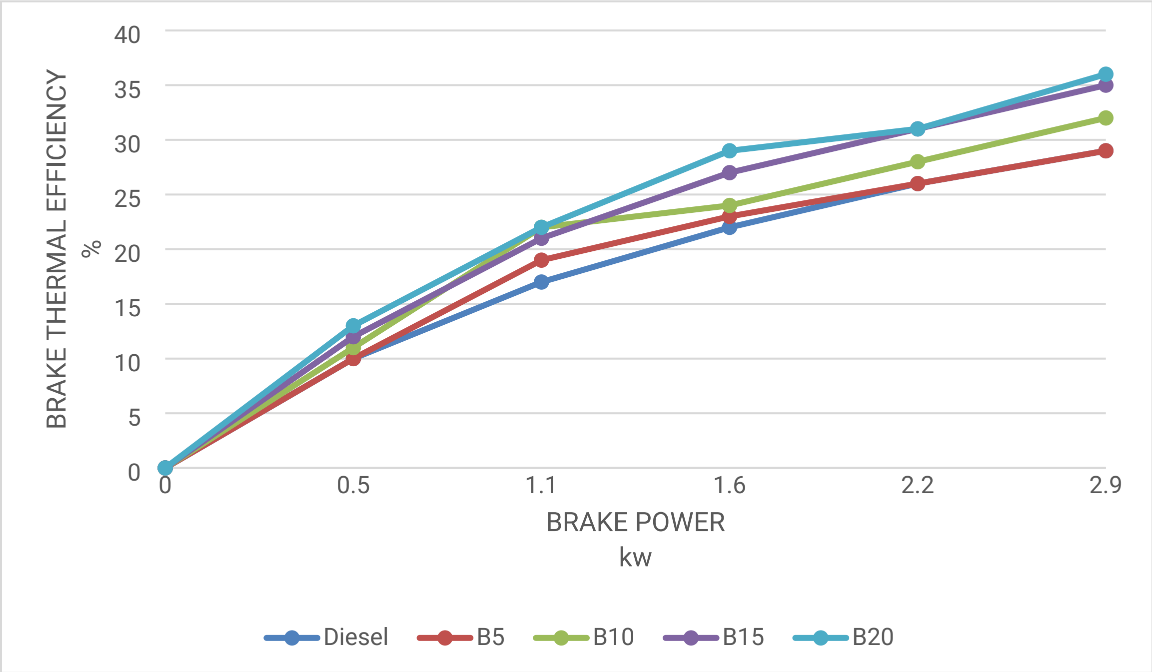
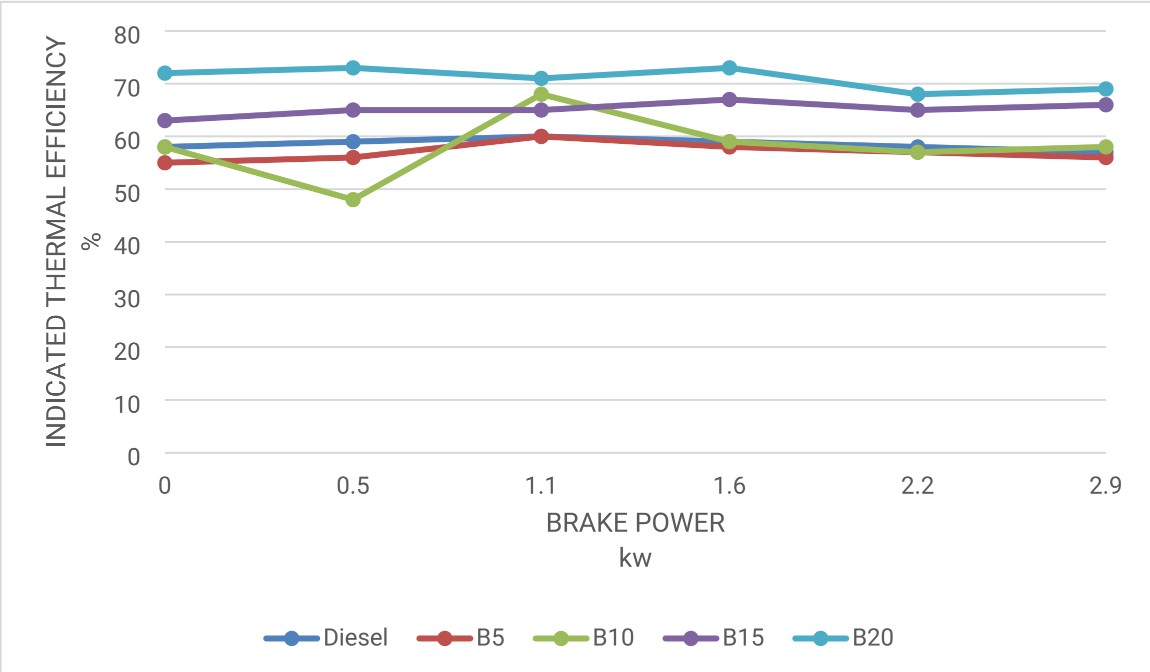


Fig.6.2.BP VS BTE

6.4.3 Comparison of Indicated Thermal Efficiency:

The values of Indicated Thermal Efficiency at different brake powers are plotted. B20 blend offers the maximum Indicated Thermal Efficiency of all the mixtures and it seems to be the best mixture, while B5 offers the minimum Indicated Thermal Efficiency.



6.4.4 Comparison of Specific Fuel Consumption:

Specific fuel consumption is a measure of the fuel efficiency of any prime mover that burns fuel and produces rotational, or shaft power. It is typically used for comparing the efficiency of IC engines with a shaft output. It is a rate of Fuel consumption with respect to power produced. The variations of Specific Fuel consumption with respect to Brake Power for different fuel blends are plotted. B10 blend offers the least Specific Fuel Consumption of all the mixtures while Diesel has the maximum Specific Fuel Consumption.

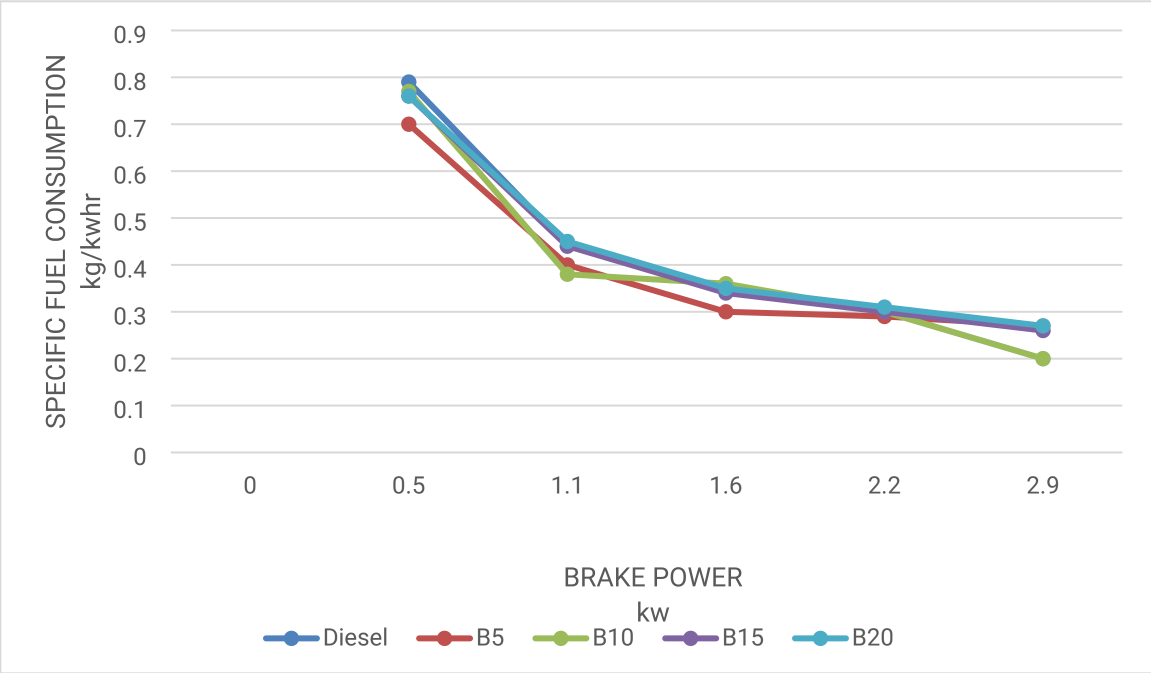


Fig.6. 4.BP VS SFC

6.4.5 Comparison of Indicated Mean Effective Pressure:

Indicated Mean Effective Pressure is defined as the average pressure produced in the combustion chambers during the operation cycle. IMEP is equal to the brake mean effective pressure plus friction mean effective pressure. The variations of Indicated Mean Effective Pressure with respect to Brake Power for different fuel blends and Diesel are shown. B10blend offers the minimum Indicated Mean Effective Pressure of all the mixtures and it seems to be the best mixture with regards to minimum Frictional Power while B15 offers the maximum Indicated Mean Effective Pressure.

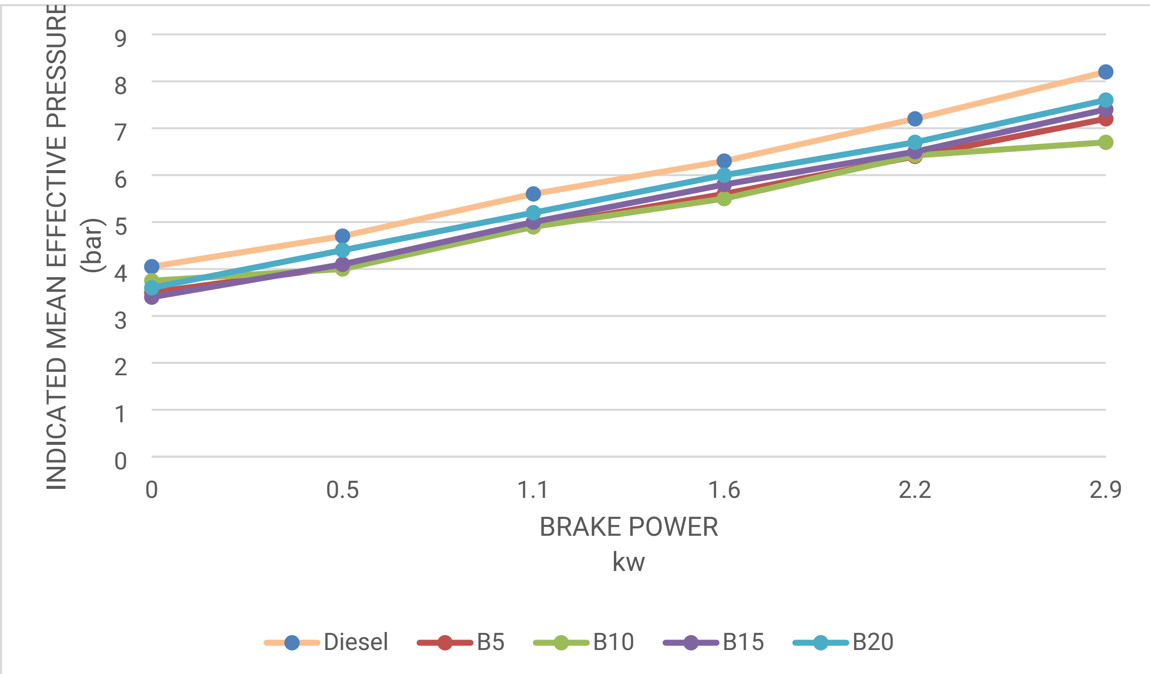


Fig.6.5.BP VS IMEP

6.4.6 Comparison of Break Mean Effective Pressure:

Brake mean effective pressure is a calculation of the engine cylinder pressure that would give the measured brake horsepower. Brake mean effective pressure is an indication of engine efficiency regardless of capacity or engine speed. The more efficient it is, the higher the average pressure or BMEP. Pressure increases by compression alone can-do wonders to a stock engine, it is, by factory choice, usually a low number.

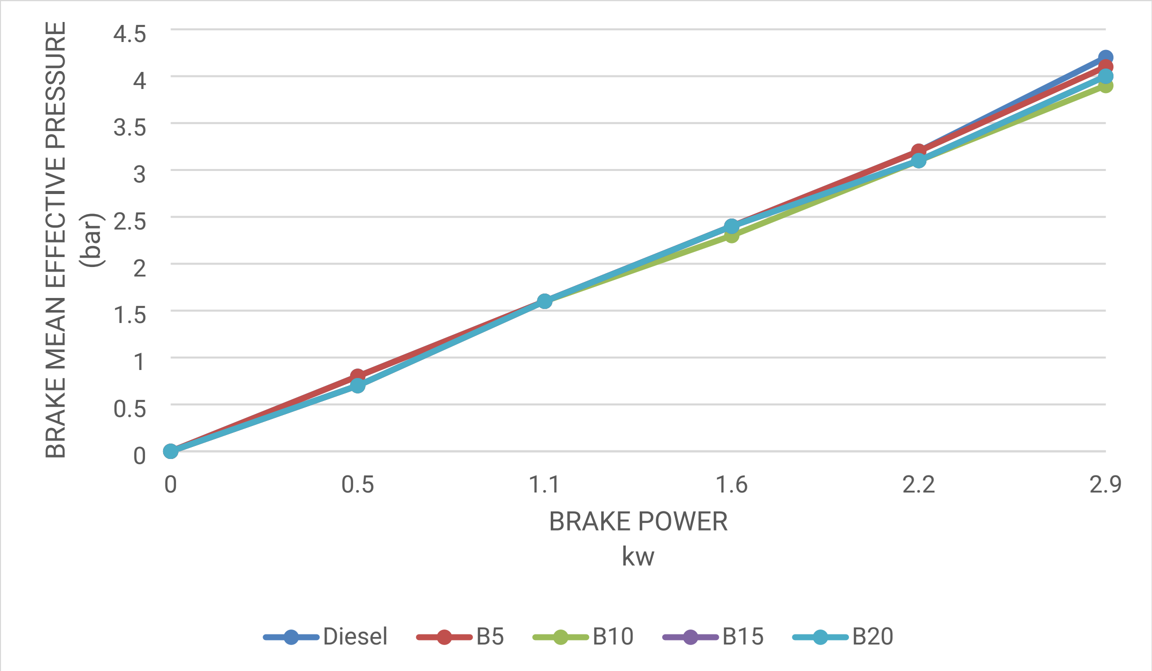


Fig 6.6: BRAKE POWER vs BMEP

CHAPTER - VII

7. CONCLUSIONS

An experimental study is conducted to evaluate and compare the use of peanut oil as a full or partial supplement to conventional diesel fuel in IC engine.

A series of tests were conducted using each of the fuels in various proportions with the engine working under the constant speed of 1500 rpm, and at different loads ranging from no load to full load. For each test performed, the performance gauging parameters such as fuel consumption, thermal efficiency, mechanical efficiency, mean effective pressure etc. were computed. Further the performance characteristics were also plotted.

Based on the experimental results, the following conclusions have been drawn:

Comparing the mechanical efficiencies at different loads for all blends, it can be inferred that B5 offers the highest mechanical efficiency.

Comparing the specific fuel consumption for each particular blend, it was observed that B10 has least specific fuel consumption.

B20 blend offers the maximum Indicated Thermal Efficiency of all the mixtures and it seems to be the best mixture, while B5 offers the minimum Indicated Thermal Efficiency

B10 blend offers the minimum Indicated Mean Effective Pressure of all the mixtures and it seems to be the best mixture with regards to minimum Frictional Power while B15 offers the maximum Indicated Mean Effective Pressure.

It can therefore be concluded that B5 blend containing 95 % diesel and 5 % peanut oil is the best blend but not economical.

Future scope:

The present-day demand can't be reached by the existing reserves of fossil fuels and efficiency of conversion of this fuel energy to maximum extent is still in the development stages and lot of interest is being created for the topic of alternatives fuels. This substitute for these fossil fuels should have the following features:

Shouldn’t deplete the existing resources at faster rate and make them available for our future generations.

Usage of this substitute should have less environmental impacts than present fuels.

The production of these fuels should be on large scale to meet our present needs efficiently.
Since biofuels burn faster and cleaner than fossil fuels, it will release greenhouse gases at a lower and slower rate.

REFERENCES

[1] A.S. Chatpalliwar "Issues in Biodiesel Production", International Journal of Industrial Engineering, Volume 24, Issue 3, September 2013, Pages 189-206.

[2] Taymaz I, Sengil M. Performance and emission characteristics of a diesel engine using esters of palm olein/soybean oil blends. Int J Vehicle Design 2010; 54:177e89.

[3] Labeckas G, Slavinskas S. The effect of rapeseed oil methyl ester on direct injection diesel engine performance and exhaust emissions. Energy Convers Manage 2006; 47:1954e67.

[4] Piyanuch Nakpong "Biodiesel production from mixtures of vegetable oil and used cooking oil", Asian Journal on Energy and Environment, Volume 10, Issue 04, August 2009, Pages 221-229.

[5] S L Sinha & R K Yadav "Performance of diesel engine using blends of conventional diesel and Jatropha biodiesel as alternative fuel for clean environment", International Journal of Enhanced Research in Emerging Science &Technology, Volume 2, Issue 2, February 2015, Pages 8-15.

[6] Avinash Kumar Agarwal "Effect of Straight Vegetable oil Utilization on carbon deposits and wear of CI Engine components", International Journal for Research in Applied Science &Engineering Technology, Volume 4, Issue 1, January 2016, Pages 113-119.

[7] Sahoo, P.K., Das, L.M., Babu, M.K.G., Arora, P., Singh, V.P., Kumar, N.R., Varyani, T.S.,2009. Comparative evaluation of performance and emission characteristics of jatropha, karanja and polanga based biodiesel as fuel in a tractor engine. Fuel 88, 1698–1707.

[8] Manickam, M., Kadambamattam, M., Abraham, M., 2009. Combustion

characteristics and optimization of neat biodiesel on high-speed common rail diesel engine powered SUV. SAE Technical Paper 2009-01-2786.

[9] Chauhan, B.S., Kumar, N., Cho, H.M., 2012. A study on the performance and emission of a diesel engine fueled with jatropha biodiesel oil and its blends. Energy 37, 616e622.

[10] Pramanik K. Properties and use of jatropha curcas oil and diesel fuel blends in CI engines. Renewable energy 2003.Hashimoto N., Nishida H. And Ozawa Y. 2014 Fundamental combustion characteristics of Jatropha oil as alternative fuel for gas turbines Fuel 126 194-201.

[11] Liu Y. Et al 2012 Biodiesel Production from Crude Jatropha curcas L. Oil with Trace Acid Catalyst Chinese of Chemical Engineering 20 740-746

[12] Abedin M.J. et al 2014 Performance, emissions, and heat losses of palm and jatropha biodiesel blends in a diesel engine Industrial Crops and Products 59 96-104

[13] W. M. J. Achten, J. Almeida, V. Fobelets et al., "Life cycle assessment of Jatropha biodiesel as transportation fuel in rural India," Applied Energy, vol. 87, no. 12, pp. 3652– 3660, 2010.

[14] G. Reinhardt, S. O. Gärtner, N. Rettenmaier et al., "Screening life cycle assessment of jatropha biodiesel," Tech. Rep., IFEU, Heidelberg, Germany, 2007

[15] K. Prueksakorn and S. H. Gheewala, "Energy and greenhouse gas implications of biodiesel production from Jatropha curcas L.," in Proceedings of the 2nd Joint International Conference on Sustainable Energy and Environment, Bangkok, Thailand, 2006

[16] J. Tobin and D. Fulford, Life Cycle Assessment of the production of biodiesel from Jatropha [Ph.D. thesis], School of Construction Management and Engineering, The University of Reading, 2005.

[17] M. Withaker and G. Heath, "Life Cycle Assessment of the use of Jatropha biodiesel in Indian locomotives," Tech. Rep. NREL/TP-6A2-44428, National

Renewable Energy Laboratory, Golden, Colorado, 2009.

[18] S. M. Gmünder, R. Zah, S. Bhatacharjee, M. Classen, P. Mukherjee, and R. Widmer, “Life cycle assessment of village electrification based on straight jatropha oil in Chhattisgarh, India,” Biomass and Bioenergy, vol. 34, no. 3, pp. 347–355, 2010.

[19] M. K. Lam, K. T. Lee, and A. Rahmanmohamed, "Life cycle assessment for the production of biodiesel: a case study in Malaysia for palm oil versus jatropha oil," Biofuels, Bioproducts and Biorefining, vol. 3, no. 6, pp. 601–612, 2009.

[20] G. Reinhardt, K. Becker, D. R. Chaudhary et al., "Basic data for Jatropha production and use," Tech. Rep., Ifreu, Heidelberg, Germany, 2008.

[21] K. Becker and H. P. S. Makkar, "Jatropha curcas: a potential source for tomorrow's oil and biodiesel," Lipid Technology, vol. 20, no. 5, pp. 104–107, 2008.

[22] S. Jain and M. P. Sharma, "Prospects of biodiesel from Jatropha in India: a review,"
Renewable and Sustainable Energy Reviews, vol. 14, no. 2, pp. 763–771, 2010

[23] P. Ariza-Montobbio and S. Lele, "Jatropha plantations for biodiesel in Tamil Nadu, India: viability, livelihood trade-offs, and latent conflict," Ecological Economics, vol. 70, no. 2, pp. 189–195, 2010.

[24] P. Kumar Biswas, S. Pohit, and R. Kumar, "Biodiesel from jatropha: can India meet the 20% blending target?" Energy Policy, vol. 38, no. 3, pp. 1477–1484, 2010.

[25] Thanachayan, T; Krishnakumar, G; Pushpraj, M; Ajay, SPA; Karunja, S (2013) Biodiesel Production from Jatropha oil and castor oil by Transesterification Reaction- Experimental and Kinetic studies. Int'l Journal of Chem Tech Research, 5: 1107-1112.

[26] Wang, R; Hanna, MA; Zhou, WW; Bhadury, PS; Chen, Q; Song, B.A;Yang, S (2011) Production And selected fuel properties of biodiesel from Promising

nonedible oils: Euphorbia lathyris L., Sapiumsebiferum L. And Jatropha curcas L, Bioresource Technology, 102: 1194-1199.

ANITS

CERTIFICATE

This is to certify that this report entitled **"INVESTIGATION ON PERFORMANCE CHARACTERISTICS OF DIESEL ENGINE USING PEANUT OIL AS BIODIESEL"** has been carried out by **M. SAINIVAS (318126520188), SHAIK NAZIYAKHATUN (318126520201), M. JASWANTH (319126520L46), P. VAMSI VARMA (319126520L52)** under the esteemed guidance of **Mr. G. NARESH, ME (PhD*)** Asst Prof, in partial fulfilment of the requirements of Degree of Bachelor of Mechanical Engineering of Andhra University, Visakhapatnam.

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