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Assessment of Engine Performance Parameters of Biodiesel of Sunflower Oil & Peanut Oil

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Abstract

This paper presents the comparative testing results of a four stroke, four cylinder multi-fuel diesel engine and its 5%, 10% and 15% sunflower oil and peanut oil blends with Diesel fuel. This paper aims at providing a comparative analysis on the engine performance parameters like brake power, indicated power frictional power, BMEP, MEP, brake thermal efficiency, indicated thermal efficiency Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance.

Introduction

During the last years, the consumption of energy has increased a lot due to the change in the life style and the significant growth of population. This increase of energy demand has been supplied by the use of fossil resources, which caused the crises of the fossil fuel depletion, the increase in its price and the serious environmental impacts as global warming, acidification, deforestation, ozone depletion. As fossil fuels are limited sources of energy, this increasing demand for energy has led to a search for alternative sources of energy that would be economically efficient, socially equitable, and environmentally sound. Two of the main contributors of this increase of energy demand have been the transportation and the basic industry sectors, being the largest energy consumers. With a worldwide increasing number of vehicles and a rising demand of emerging economies, demand will probably rise even harder. Transport fuel demand is traditionally satisfied by fossil fuel demand. However, resources of these fuels are running out, prices of fossil fuels are expected to rise and the combustion of fossil fuels has detrimental effects on the climate. Bio-fuels appear to be a solution to substitute fossil fuels because, resources for it will not run out (as fresh supplies can be re-grown), they are becoming cost wise competitive with fossil fuels, they appear to be more environmental friendly and they are rather accessible to distribute and use as applicable infrastructure and technologies exists and are readily available. Bio-fuels appear to be more environment friendly in comparison to fossil fuels considering the emission of greenhouse gasses when consumed. Examples of those gasses are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Biodiesel is an alternative fuel for diesel engines that is produced by chemically reacting a vegetable oil or animal fat with an alcohol such as methanol. The reaction requires a catalyst, usually a strong base, such as sodium or potassium hydroxide, and produces new chemical compounds called methyl esters. It is these esters that have come to be known as biodiesel. To overcome problems of high viscosity associated with neat vegetable oils (triglycerides) as bio fuels, the oil or fat is either cracked, blended with low viscosity solvents or converted to methyl esters. Such methyl ester fuels are already in commercial production in Europe, with rapeseed and sunflower oils being the major feedstock, and to a limited extent in the USA, with soybean oil being the major feedstock. In India also some of the companies like Naturol (Kakinada, A.P, India), Southern on line, (Hyderabad, A.P, India) are using Palm oil and Fish oil respectively for the production of bio diesel. The driving forces behind the search for bio diesel fuels in the United States and Europe are mainly environmental concerns. Vegetable oil and animal fat based bio diesel fuels, as methyl esters, have the following advantages and disadvantages over diesel fuel.

Advantages:

As a neat fuel or in blends with diesel fuel they produce less smoke and particulates.

1. Have higher cetane numbers.
2. Produce lower carbon monoxide and hydrocarbon emissions.
3. They are biodegradable and non-toxic.
4. They provide engine lubricity compared to low sulfur diesel fuels.

Disadvantages:

1. Low volatility.
2. High pour points, cloud points and cold filter plugging.
3. Higher NOx emissions at elevated temperatures.
4. Incomplete combustion.

A detailed literature survey has been conducted which includes the study of different edible and non - edible oils, their properties and the suitability as a fuel for IC engine.In the present study, the sunflower seed oil, an edible type vegetable oil is chosen as a potential alternative for producing biodiesel and use as fuel in compression ignition engines. Its technical name is helianthus annuus. The viscosity of crude sunflower oil is much greater, about 15 times larger than that of diesel oil. While it becomes very near to diesel once it is transesterfied. Fatty acid composition of the oil contains mostly oleic (44.05%), linoleic (10.72%), palmitic (38.60%), and stearic (4.65%) acids.Sunflower is a high oil content seed and average yields can produce 600 pounds of oil per acre, considerably more than soybeans. There is a great deal of interest from local areas for construction of small processing facilities for sunflower biodiesel production. It is most important that processing equipment be investigated very prudently for small 'press' only facilities. In most cases a major portion of the oil is left in the by-product meal thereby dropping economic efficiency.

CHEMICAL CONVERSION

Vegetable oils are generally called as Tri-Glycerides. These Glycerides are long chain of fatty acids. The composition of fatty acids must be ensured before conversion. The amount of fatty acids affects the quality of oil, longer the chain of fatty acids oil will be more viscous in nature. The FFA (Free Fatty Acid test) test determines the composition by titrating the oil with base with known normality. Initially FFA test is carried out by taking 10g of oil, 50ml of isopropyl alcohol and 2 to 3 drops of 0.1N NaOH which is a base catalyst is added to a conical flask which is then heated up to 60°C, shake the mixture and allow it to cool up to room temperature. After that add 2 to 3 drops of phenolphthalein indicator to the mixture which speed up the reaction. Titrate the mixture against 0.1N NaOH through burette until faint pink colour appears. Note down volume of NaOH consumed from burette and calculate the FFA using the formula FFA (%) = 0.282V If amount of FFA is less than 4% single stage Transesterification Process is Preferred and If amount of FFA is greater 4% Double stage is Preferred.

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CONVERSION PROCESS

The Transesterification is the process used for preparation of Bio-Diesel using vegetable oils. Bio-Diesel is a mono-alkyl esters of long chain fatty acids derived from vegetable oils. It is chemically called Free Fatty Acid-Alkyl Ester. Even though, "diesel" is part of its name, there is no petroleum or other fossil fuels in biodiesel. Biodiesel refers to the pure fuel before blending with diesel fuel. The Reaction is as follows. Bio-diesel is a substitute fuel for Compression-Ignition internal combustion engines. It is produced by the transesterification of waste or vegetable oils and animal oils, or fats with lower alcohols. Bio-diesel is a clean burning fuel made from vegetable oils. Bio-diesel is made up of almost 10% oxygen, making it a naturally "oxygenated" fuel. It is obtained by reaction of vegetable oil with alcohol in presence of catalyst.

Literature Review

Robert et al. [1] conducted experiments on a diesel engine using thermally cracked soybean oil. The experimental results revealed that thermally cracked soybean oil produced low NOx emissions and less power compared to diesel fuel operation. **Machacon Herchel T.C et al. [2]** evaluated performance and emission characteristics of coconut oil diesel fuel blends without any engine modifications. Increased coconut oil percentage in diesel fuel resulted in increased brake specific fuel consumption and decreased brake mean effective pressure. Lower smoke and NOx levels were observed with coconut oil blend operation compared to diesel fuel operation. **Yusuf Ali and Hanna [3]** review the suitability of vegetable oils and animal fats as diesel fuel. The fuel properties of bio diesel produced by various methods like trans esterification, pyrolysis, dilution and microemulsion are discussed. The esterification process is costly and to reduce the cost of bio diesel the plant capacities are to be enhanced. **Knothe[4]** elaborately discusses the analytical methods used in production of bio diesel from vegetable oil, animal fats or used (waste) vegetable oils and the fuel quality assessment for successful commercialization of bio diesel. The methods adopted to determine the quality of bio diesel like Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Nuclear Magnetic Resonance (NMR), viscometry and enzymatic methods are well explained. He expresses the need to determine the bio diesel blend levels with conventional diesel fuel. **Klopfenstein and walker [5]** tested lauric, myristic palmitic, stearic, linoleic and linolenic acids, Ethyl and butyl Esters of Oleic acid as fuels in a diesel engine. The test results suggest that a vegetable oil having high content of oleic acid or short chain saturated acid subjected to transesterification produces a better fuel to be used as a diesel substitute to be used in diesel engines.

Fangrui and Milford [6] reviewed the bio diesel production and expresses that the cost is the main hurdle for commercialization of the biodiesel. Pyrolysis produces more biogasoline than biodiesel fuel. The commonly accepted molar ratio of alcohol to glycerides is 6:1. The cost of raw materials accounts for 60 to 75% of the total cost of biodiesel fuel. **Hamasaki et al. [7]** conducted experiments with methyl esters of waste vegetable oils and emulsions of methyl esters of waste vegetable oil with water. The waste methyl ester with 15% water emulsions reduced 18% NOx emissions and improved combustion characteristics.

Yasufumi Yoshimoto and Hiroya Tamaki [8] observed 4% increase in brake specific energy consumption and reduced NOx emissions with exhaust gas recirculation while using water emulsified bio diesel and diesel fuel blends. **Masjuki et al. [9**] added palm oil Methyl Esters as lubricant additive in a small diesel engine to evaluate the lubrication characteristics of SAE 40 oil. The addition of palm oil Methyl Ester to SAE 40 oil enhances anti wear characteristics of the lubricating oil. **Masjuki et al. [10]** used preheated palm oil Methyl esters in a diesel engine and observed diesel like performance and reduced exhaust emissions with preheating of the palm oil Methyl esters to 100 °C.**Duran et al. [11]**

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studied the impact of bio diesel chemical structure, especially fatty acid composition on particulate matter formation, on the retention of hydrocarbons by soot due to the scrubbing effect and absorption processes. The specific emissions of diesel particulate matter (DPM) in milligrams (mg) have been traditionally calculated from the addition of smoke opacity and total hydrocarbons (THC). **Vara Prasad C.M [12]** conducted experiments with bio diesel derived from Jatropha. The test results revealed that 100% bio-diesel can be used satisfactorily which produces less NOx emissions and higher smoke emissions.

Mushtaq Ahmad [12] confined to the production and physico-chemical characterization of peanut oil biodiesel (POB). An optimum conversion of POB from triglycerides (TD) was achieved by using 1:6 molar ratio (methanol: oil) at 60oC. Fuel properties of POB were determined and compared with ASTM (American Standard Testing Material). The kinemetic viscosity at 40oC (eta) of POB (100%) was 5.908, specific gravity 0.918, density at 40oC (Rho) 0.0992, flash point (FP) 192, pour point (PP) 3oC, cloud point (CP) 6oC, 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. A comparative experimental investigation was conducted to evaluate the performance and exhaust emissions of an agricultural tractor engine when fueled with sunflower oil, rapeseed oil, and cottonseed oil and their blends with diesel fuel (20/80, 40/60 and 70/30 volumetrically). Tests were also carried out with diesel fuel to be used as a reference point. Engine power, torque, BSFC, thermal efficiency, NOx and CO2 were recorded for each tested fuel. All vegetable oils resulted in normal operation without problems during the short-term experiments. The 20/80 blends showed unstable results, in comparison to higher oil content fuels Power, Torque and BSFC were higher as oil content was increased in the fuel. Rapeseed oil fuels showed increased power, torque and thermal efficiency with simultaneous lower BSFC in comparison to the other two vegetable oils. Cottonseed oil fuels gave better engine performance than sunflower oil fuels. In all oil types, NOx emissions were augmented when fuel oil percentage was increased. Cottonseed oil fuels led to higher NOx emission increase compared to rapeseed oil fuels. CO2 emissions showed a tendency to be increased as the oil content was evolved. The highest CO2 emissions were given by cottonseed oil fuels, followed by rapeseed and sunflower oil.

Jacobus et al. [13] conducted trials on four vegetable oils, namely sunflower, cottonseed, soyabean oil and peanut oil blend with diesel. They compared the engine performance and emission characteristics and reported that all the oils provided almost similar characteristics. **Swarup Kumar Nayak et al. [14]** conducted the experiment on diesel engine at constant speed of engine i.e. at 1500 rpm under varying load conditions with different ratio of blend of Mahua biodiesel. This was a probing investigation to determine the effect of fuel on the engine performance parameters and structure required to use this fuel.

Saswat Rath et al. [15] for taking measurement under various speed and loading condition and checked various parameters such as brake power, brake thermal efficiency, brake specific fuel consumption and exhaust gas temperature. They use various ratios of blends like B-0, B-10, B-20, to B-100. B represent Karanja biodiesel and 10, 20 represent the percentage of biodiesel blends. **Stewart et al.[16]** The vegetable oils include soyabean oil, cottonseed oil, sunflower oil, rapeseed oil, palm oil, linseed oil, jatropha oil, neem oil and mahua oil. There are more than 350 oil bearing crops identified whose cetane number and calorific value are comparable with those of diesel fuels and are compatible with material vehicle fuel system. Vegetable oil is of special interest because it has shown to significantly reduce particulate emission relative to petroleum diesel. **Philip D. hill et al. [17]** assessed and integrated the biological, chemical and genetic attributes of the plant and describes about the different tree borne oilseeds in India. **Syed Khaleel Ahmed et al. [18]** investigated three basic routes to biodiesel production from oils and fats.(1)Base catalyzed transesterification of the oil (2) Direct acid catalyzed transesterification of the oil (3) Conversion of oil to its fatty acids and then to biodiesel.

J. San Jose et al. [19] Analyze combustion and emission of pressure operated mechanical burner of boiler using non edible oil and bled of oil with diesel produce from sunflower. A wide range of volumetric blends of 10% sunflower biodiesel and 90% diesel, 20% sunflower biodiesel and 80% diesel, 30% sunflower biodiesel and 70% diesel are used for performance measurement of Boiler with conventional heating burner. They reported that combustion efficiency was highest among all test fuels. All blends showed higher combustion efficiency than mineral diesel. They attributed this increase in combustion efficiency is due to biodiesel composition contain oxygen molecules which improves the combustion efficiency. The combustion efficiency of blends 10% sunflower biodiesel and 90% diesel, 20% sunflower biodiesel and 80% diesel are almost very close to combustion efficiency of diesel. Combustion efficiency is 2 % higher for blend 20% sunflower biodiesel and 80% diesel than pure diesel. They attributed this due to presence of increased amount of oxygen in respective fuels, which might have resulted in its improved combustion as compared to pure diesel. **Afshin Ghorbani et al.[20]** investigated the combustion performance and emission of experimental boiler, horizontal axis, jacketed running on diesel, volumetric blends of 5% sunflower biodiesel and 95% diesel, 10% sunflower biodiesel and 90% diesel, 20% sunflower biodiesel and 80% diesel, 50% sunflower biodiesel and 50% diesel, 80% sunflower biodiesel and 20% diesel. They observed that combustion efficiency of 20% sunflower biodiesel and 80% diesel is very close to combustion efficiency of pure diesel. Combustion efficiency of 20% sunflower biodiesel and 80% diesel is 5 % higher than combustion efficiency of pure diesel. **Bahamin Bazooyar et al. [21]** evaluated the performance and emission characteristics of semi industrial boiler using diesel, 20% sunflower biodiesel and 80% diesel are used for performance measurement of boiler with horizontal axis, pressure jet type, and stainless steel jacket. They observed that combustion efficiency of B20 is very close to combustion efficiency of pure diesel. Combustion efficiency ofB20 is 4.5 % higher than combustion efficiency of pure diesel due to the more oxygen content. **Nguyen et al. [22]** studied peanut oil extraction using diesel-based reverse-micellar micro-emulsions. Their product is a peanut oil-diesel blend which was tested for peanut oil fraction, viscosity, cloud point and pour point, all of which met the requirements for bio- diesel fuel. **Moser [23]**, on the other hand, prepared methyl esters from high-oleic peanut oil using catalytic sodium methoxide and obtained 92% yield of peanut methyl esters which exhibited excellent oxidative stability but poor cold flow properties. A study by **Kaya et al. [24]** showed ester conversion of 89% via sodium hydroxide-catalyzed transesterification of solvent-extracted oil from peanuts grown in Turkey. The obtained biodiesel has a viscosity close to petrodiesel but has calorific value 6% less than that for petrodiesel. Important fuel proper-ties such as density, flash point, cetane number, pour point and cold point fall within the set standards. **M.G. Bannikov [25]** has studied on Mustard methyl esters (further biodiesel) and regular diesel fuels were tested in direct injection diesel engine. Analysis of experimental data was supported by an analysis of fuel injection and combustion characteristics. Engine fuelled with biodiesel had increased brake specific fuel consumption, reduced nitrogen oxides emission and smoke opacity, moderate increase in carbon monoxide emission with essentially unchanged unburned hydrocarbons emission. **C.Solaimuthu, D.Senthil kumar [26]** studied the diesel engine performance, combustion and emission characteristics mahua bio diesel (mahua oil methyl ester) and its blends in different volumetric proportions with diesel. They found that the brake thermal efficiency is almost same and less fuel consumption and also show that reduced NOX and HC emissions.

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Lebedevas S et al[27] research in to the change of parameters concerning the fuel economy thrust and harmful components of exhaust gases was carried out to evaluate the efficiency of fuel replacement; and that is, mineral diesel fuel, which is normally used by diesel engine fleets of agricultural machinery in Lithuania, was replaced with biofuel (biodiesel), which is rapeseed oil methyl ester (RME) and the research was done on a model diesel engine F2L511 and a single section of diesel engine A41. Fuel blends of mineral diesel fuel and RME biodiesel fuel and pure RME were tested as B10, B15, B30, B100. A non-linear change of operational characteristics were determined depending on the loads of the diesel engine. **Ozkan M [28]** did comparative study of the effect of biodiesel and diesel fuel on a four cylinder, four strokes, turbocharged IDI CI engine. The engine was operated with the same settings for both fuel types during the experiments and no alternation has been made in the fuel system elements. In their study an oxygenated additive diethyl ether (DEE) was blended with biodiesel in the ratio of 5%, 10%, 15% and 20% and tested their performance in a computerized Kirloskar diesel engine of AVI model, four stroke, direct injection, naturally aspirated, water cooled engine. The diesel engine is coupled with an eddy current dynamometer and data acquisition system, for saving data. **Venkateswara Rao P. [29]** investigates the scope of utilizing biodiesel produced with ethanol and methanol as alcohols in the process of making biodiesel. Experiments were conducted on diesel engine with B20 of methyl and ethyl esters of Pongamia oil (POME20, POEE20), methyl and ethyl esters of Mahua oil (MOME20, MOEE20) and standard diesel fuel separately. The performance and emission characteristic results were compared with diesel fuel.

Ghosh S. et al [30] states the Potential use of Pongamia oil methyl ester as a substitute for diesel fuel in diesel engine. Various proportions of Pongamia and Diesel (B25, B50, B75, and B100) are prepared by transesterification process on volume basis and used as fuels in a four stroke single cylinder direct injection diesel engine to study the performance of these fuels and compared with neat diesel fuel. Experiments have carried out by **Krishna A Gopala et al. [31]** to examine the properties of palm oil biodiesel, performance and emissions of the engine with different blends (20%PBD, 40%PBD, 80%PBD, and 100% PBD) at different fuel injection pressures (190, 210, and 230bar) and the results obtained are compared with diesel (base line test values). **Dwivedi Gaurav et al. [32]** discussed the comprehensive review of engine performance and emissions using biodiesel from different feedstock and to compare that with the diesel. However, many further researches about modification on engine, low temperature performance of engine, new instrumentation and methodology for measurements, etc., are recommended while using biodiesel as a substitute of diesel. **R. D. Gorle et al. [33]** investigated the performance and emission characteristics of various blends of Jatropha biodiesel with diesel on a Single cylinder four stroke diesel engine. The acquired data were analyzed for various parameters such as brake thermal efficiency (BTE), brake mean effective pressure (BMEP), brake specific fuel consumption (BSFC), exhaust gas temperature (EGT). **Rajesh Kumar et al. [34]** Study the performance and emissions characteristics of methyl esters of Silk Cotton Oil (SCOME) and diesel blends in a diesel engine were experimentally investigated. For this study, methyl esters of Silk Cotton Oil were added to diesel by volume of 20% (B20), 40% (B40), 60% (B60) and 80% (B80), as well as pure blend 100% (B100). Fuels were tested in single cylinder, water-cooled, direct injection Kirloskar diesel engine loaded by eddy current dynamometer. The effect of blends on engine performance, exhaust emissions were examined at different loads (0%, 25%, 50%, 75%, and 100%) at constant engine speed of 1500 rpm. Engine performance parameters namely brake power, brake specific fuel consumption, brake thermal efficiency, exhaust gas temperature were determined. **Mamilla Venkata Ramesh et al.** [35] investigates the percentage substitution of jatropha methyl ester blends to diesel as fuel for automobiles and other industrial purposes. They analyzed the performance characteristics of the jatropha methyl esters and its comparison with petroleum diesel. The tests were carried out on a 3.7

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KW single cylinder, direct injection and a water-cooled diesel engine. The fuels used were neat jatropha methyl ester, diesel and different blends of the methyl ester with diesel. The experimental result shows that 20% of the blend shows better performance with reduced pollution. The analysis shows that jatropha methyl ester blended biodiesel is a good substitute for pure diesel. **Mihir J Patel et al. [36]** said that to meet increasing energy requirements, there have been growing interests in alternative fuels like biodiesel to provide a suitable diesel oil substitute for internal combustion engines. Biodiesels are offer a very promising alternative to diesel oil since they are renewable and have been similar properties. One of the economical sources for biodiesel production which doubles in the reduction of liquid waste and the subsequent burden of sewage treatment is waste cooking oil (WCO). **Leung D.Y.C and Guo Y. [37]** compared the transesterification reaction conditions for fresh canola oil and used frying oil. Higher molar ratio (7:1, methanol/used frying oil), higher temperature (60° C) and higher amount of catalyst (1.1 wt% NaOH) was maintained in used frying oil when compared to fresh canola oil where optimal conditions maintained were 315-318 K, 1.0 wt% NaOH and 6:1 methanol/oil molar ratio. However, less reaction time (20 min) was observed for used frying oil when compared to fresh canola oil reaction time (60 min). In the further work **Lingfeng Cui et al. [38]** developed biodiesel from cottonseed oil by using KF/γ-Al2O3 as heterogeneous catalysts for the transesterification of cottonseed oil with methanol. The operation variables used were methanol/oil molar ratio (6:1–18:1), catalyst concentration (1–5 wt %), temperature (50–68 °C), and catalyst type. The biodiesel with the best properties was obtained using a methanol/oil molar ratio of 12:1, catalyst (4%), and 65°C temperature with the catalyst KF/γ- Al2O3. **Sinha Shailendra et al. [39]** determined the optimum condition for transesterification of rice bran oil with methanol and NaOH as catalyst by mechanical stirring method. The condition was found at 55° C reaction temperature, 1 h reaction time, 9:1 molar ratio of rice bran oil to methanol and 0.75% catalyst (w/w). Further, the physical properties of rice bran methyl ester were tested and compared with other biodiesels and diesel.

Afterwards **Alamu J Oguntola et al. [40]** produced the biodiesel from through transesterification 100g coconut oil, 20.0% ethanol (wt% coconut oil) and 0.8% potassium hydroxide catalyst at 65°C reaction temperature with 120 min. reaction time. Low yield of the biodiesel (10.4%) was obtained. While **Tang Ying et al. [41]** developed a new method, in which catalyst benzyl bromide-modified CaO for production of biodiesel from rapeseed. The improved catalytic activity was obtained by better fat diffusion to the surface of the benzyl bromide-modified CaO. Further, a 99.2% yield of fatty acid methyl esters in 3h was obtained in comparison to by better fat diffusion to the surface of the benzyl bromide-modified CaO. The normal and modified CaO is shown in Fig.2. Further**, Silva F. Giovanilton et al. [42]**, produced biodiesel from soybean oil by transesterification with ethanol. Optimum conditions for the production of ethyl esters were the following: mild temperature at 56.7 °C, reaction time in 80 min, molar ratio at 9:1 and catalyst concentration of 1.3 M. For esterification reaction, HR2RSOR4R was added as a catalyst and for transesterification KOH was added as the catalyst with methanol. **Ali N. Eman and Tay Isis Cadence [43]**, investigated characteristics of biodiesel produced from palm oil via base catalyst transesterification process. To find the optimum yield value of biodiesel, three important parameters were selected such as reaction temperature 40, 50, and 60°C, reaction time 40, 60 and 80 min. and methoxide ratio 4:1, 6:1 and 8:1. By conducting the experiments the optimum yield value 88% was achieved by the parameters such as reaction temperature 60°C, reaction time 40 minutes and methoxide ratio 6:1. From the optimum yield value, the physical properties were calculated like, density is 876.0 kg/m3, kinematic viscosity of 4.76 mm2/s, cetane number of 62.8, flash point of 170°C, cloud point of 13°C. The produced biodiesel had similar properties of ASTM D 6751, and EN 14214. In the investigation of **Wakil Abdul Md. et al. [44]**, chosen Cottonseed oil, Mosna oil and Sesame oil for producing biodiesel. Biodiesel is produced

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by transesterifying the oil with an alcohol such as methanol under mild conditions in the presence of a base catalyst. Satisfactory amount of biodiesel is produced from Cottonseed oil at 3:1 molar ratio of methanol and oil. Three types of oil (cottonsed oil, mosna oil, sesame oil) are extracted from the seeds and chemically converted via an alkaline transesterification reaction to fatty acid methyl ester. The optimum conditions established for the methanolysis of crude cotton seed oil in the investigation were recorded to be: 3:1 molar ratio of methanol to oil and 1.00% (w/w) catalyst. For Mosna oil the optimum conditions were recorded to be 3. 5:1 M ratio of methanol to oil and 1.00% (w/w) catalyst. But small amount of biodiesel was found from this oil and production cost is higher than cottonseed oil. And for Sesame oil the optimum conditions were recorded to be 3.5:1 M ratio of methanol to oil and 1.00% (w/w) catalyst.
C**hakrabarti H. Mohammed and Ahmad Rafiq [45]**, presented work on extraction of oil from castor bean and converting it into biodiesel from transesterification. It was found that reaction mixture containing 65ml of methanol along with 2.4 g of catalyst (KOH) took a good start in half an hour at30°C. In this reaction, amount of glycerine removed as well as ester content produced was considerably increased with rise in temperature of mixture upto 70°C by extending time period (180-360 minutes). The removal of glycerine increased by two and half times and ester content by four times, respectively. When castor oil was subjected to acid esterification, prior to transesterification (a separate investigation), it was found that ester contents up to 95% could be obtained. **Tiwari Kumar Alok et al. [46]**, used response surface methodology to optimize three important reaction variables, including methanol quantity, acid concentration, and reaction time. The optimum the FFA of Jatropha oil from 14% to less than 1% was found to be 1.43% v/v sulphuric acid catalyst, 0.28 v/v methanol-to-oil ration and 88 min reaction time at 60 ºC. The properties of Jatropha oil biodiesel conform to European and American standards.

VCR Engine

Variable compression ratio (VCR) technology has long been recognized as a method for improving the automobile engine performance, efficiency, fuel economy with reduced emission. The main feature of the VCR engine is to operate at different compression ratio, by changing the combustion chamber volume, depending on the vehicle performance needs. VCR Engine Test Setup, 1-Cylinder: 4 Stroke Diesel (Computerized). The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and loat measurement. The setup has stand-alone panel box consisting of air box, two fuel tanks fa duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement.
The setup enables study of VCR engine performance for brake power, indicated power frictional power, BMEP, MEP, brake thermal efficiency, indicated thermal efficiency Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. Lab view based Engine Performance Analysis software package "Enginesoft" provided for on line performance evaluation. A computerized Diesel injection Pressure measurement is optionally provided.
Features

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1. CR changing without stopping the engine
2. No alteration in Combustion chamber geometry
3. Arrangement for duel fuel mst
4. PV plots, performance plots and tabulated results
5. Online measurements and performance analysis
6. Data logging. editing, printing and expon, Configurable graphs
7. IP, IMEP. FP indication
8. Combustion analysis

Technical Specifications

1. Product: VCR Engine test setup 1 cylinder, 4 stroke, Diesel (Com.)
2. Product code: 234, 234H.
3. Engine: Make Kirloskar, Type 1 cyl., 4 stmke Diesel, water cooled, power 3.5kW 50p. stroke 110mm, bore 87.5mm. 661., CR17.5. Modified to VCR engine CR 12 to 18
4. Dynamometer Product 234 Type:eddy current,water cooled, Product 234H: Type Hydraulic
5. Propeller shaft: With universal joints
6. Air box: M S fabricated with orifice meter and manometer
7. Fuel tank: Capacity 15 lit with glass fuel metering column
8. Calorimeter: Type Pipe in pipe
9. Piezo sensor: Range 5000 PSI, with low noise cable
10. Crank angle sensor, Resolution 1 Deg. Speed 5500 RPM with TDC pulse.
11. Data acquisition device: NI USB-6210. 16-bit, 250kS/s.
12. Piezo powering unit: Make-Cuadra, Model AX-40,
13. Temperature transmitter: Tppe two wire, Input RTD FT100, Range 0-100 Deg C, Output 4-20 mA and Ty, two wile. Input Thermocouple,
14. Load indicator: Digital, Range 0-50 Kg, Supply 230VAC
15. Load sensor Load cell, type strain gauge, range 0-50 Kg
16. Fuel flow transmitter: DP transmitter, Range 0-500 mm WC
17. Air flow transmitter: Presurc transmitter, Range (-) 250 mm WC
18. Software: "EngincsoftLV" Enginc performance analysis software
19. Rotameter: Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
20. Pump: Type Monoblock
21. Overall dimensions: W 2000 x D 2500 x H 1500 mm
    Optional: Computerized Diesel injection pressure measurement

Performance Test

The Engine performance is an indication of the degree of success of the engine performs its assigned task, i.e, the conversion of the chemical energy contained in the fuel into the useful mechanical work. The performance of an engine is evaluated on the basis of the following parameters.

Brake Power (B.P): The power developed at the output shaft of the engine is termed as Brake Power; it is the power available at the crankshaft of the engine.

Specific Fuel Consumption (SFC): It is defined as the ration of fuel consumed per unit time to power output.

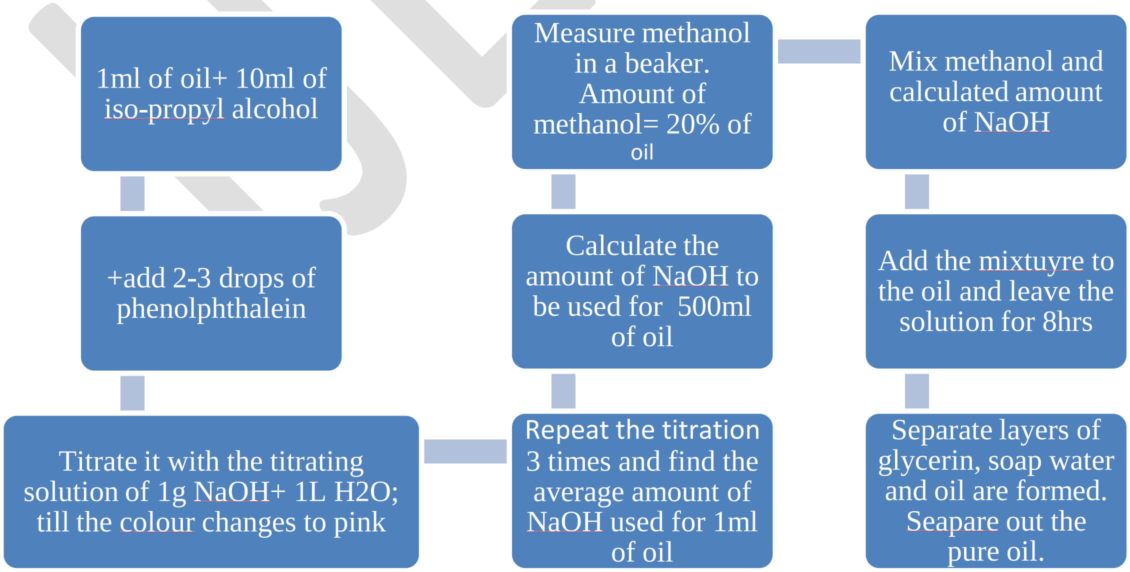
Brake Thermal Efficiency (BTE): It is the ratio of output shaft power (Brake power) to the Heat input supplied to the engine.

Brake Mean Effective Pressure (BMEP): Mean effective Pressure is defined as a hypothetical pressure which is thought to be acting on the piston throughout the power stroke. If the mean effective pressure is based on Brake power then it is called as Brake Mean Effective Pressure (BMEP).

Formulae Used For Calculations

1) Quantity of fuel used,$m_f = \frac{X_{CC} * SG}{t * 1000}$Kg / Sec
Where Xcc = Volume of fuel Consumed
SG = Specific Gravity of the fuel
t = Time taken for Fuel consumed
2) Heat supplied to the Engine, $Q_f = m_f * CV$in kW;
Where CV = Calorific Value Of fuel in (KJ/Kg)
3) Brake Power Output, B.P = $\frac{2\pi NT}{60*000}$in kW
Where, T = Torque in (KN-m) = P*r*9.81
P = Net Load in Kg
r = Radius of rope (0.152m)
N = Rated rpm of the Engine (1500rpm)
4) Specific Fuel Consumption, S.F.C =$\frac{m_f * 3600}{BP}$ Kg/KW-Hr
5) Mean effective pressure,$P_m = \frac{60*BP}{L*A*N*10000*K*n}$Bars
Where, L= stroke length
A=area
N=rpm
K=0.5 for 4 stroke engine
n = number of cylinders
6) Brake thermal efficiency,$\eta_{BTE} = \frac{BP}{Q_f}$

Biodiesel Production Process



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Results

Table: Values for Engine Parameters

Fuel type	Bsfc	Brake thermal efficiency	Mean effective pressure
5% sunflower oil	0.23	36	6.725
10% sunflower oil	0.24	33	5.645
15% sunflower oil	0.26	31	5.5
5% peanut oil	0.23	34	6.8
10% peanut oil	0.25	32	5.65
15% peanut oil	0.28	30	5.5

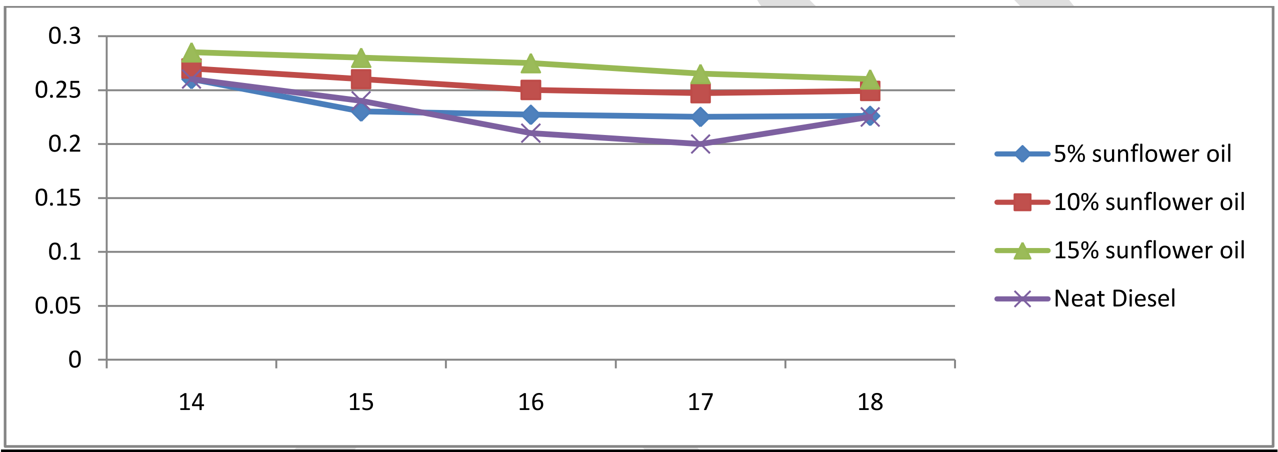

Figure: The comparisons of BSFC v/s Compression ratio curves of sunflower oil blends with neat diesel

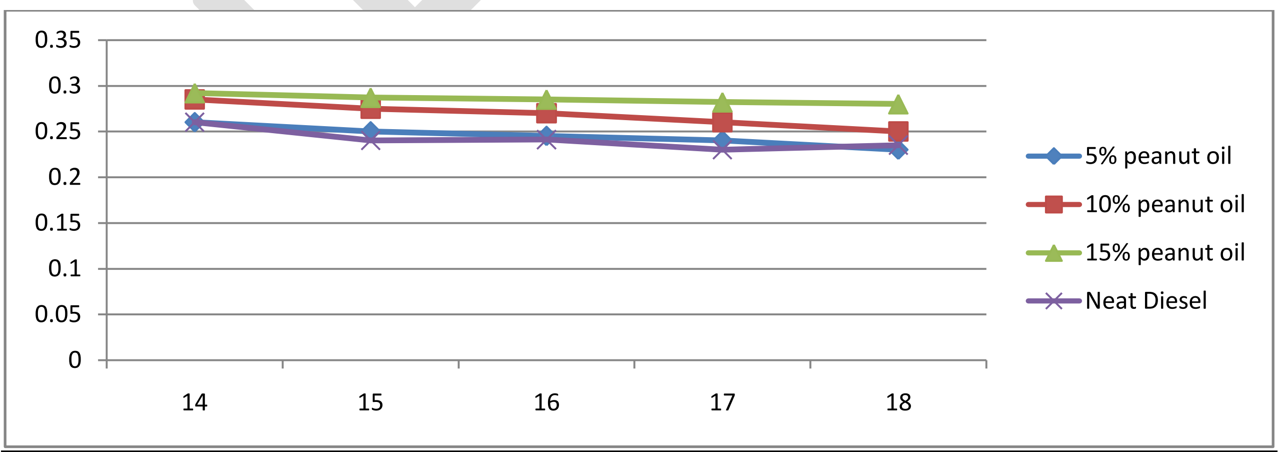

Figure: The comparisons of BSFC v/s Compression ratio curves of peanut oil blends with neat diesel

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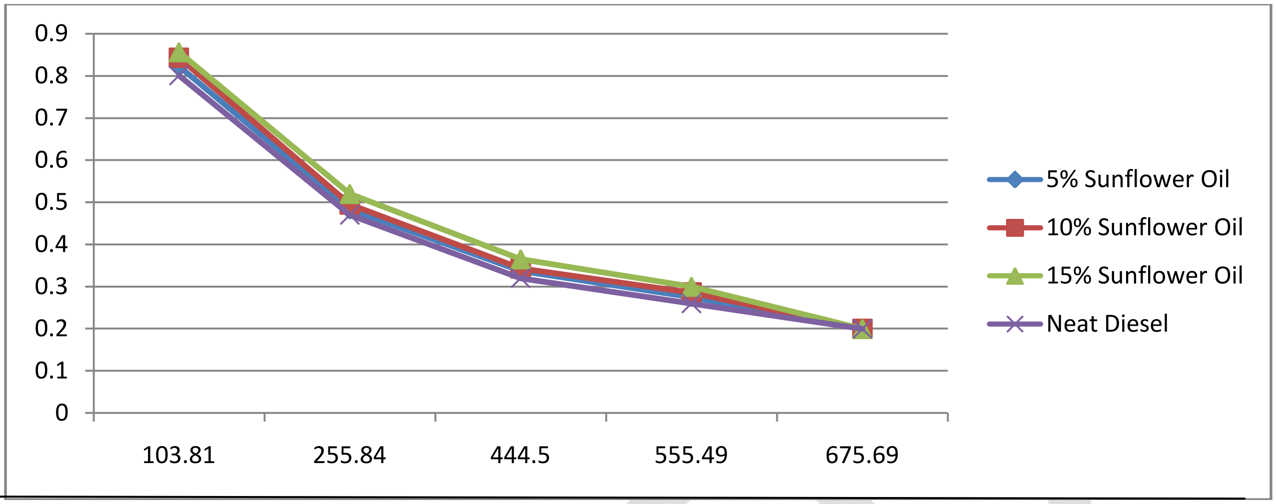

Figure: The comparison of BMEP v/s BSFC curves for sunflower oil blends with diesel

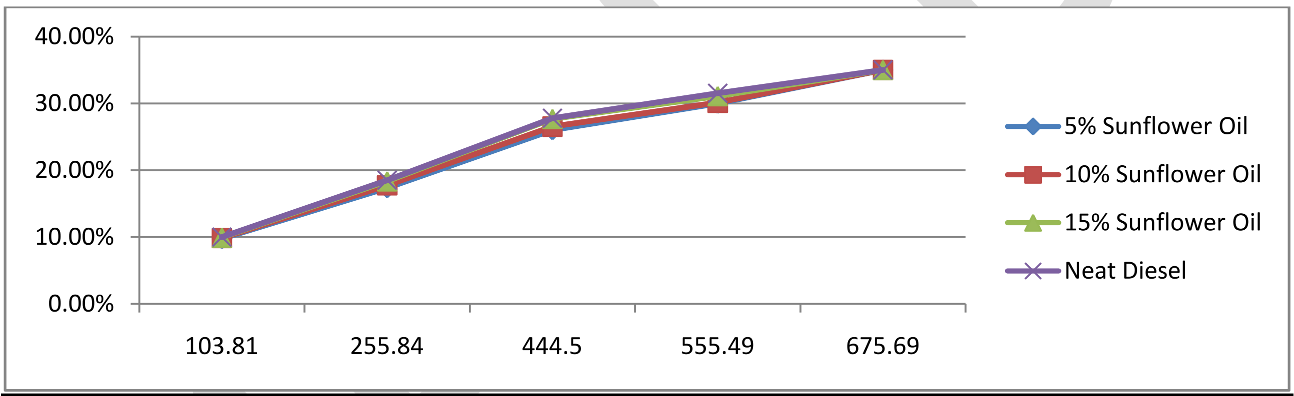

Figure: The comparison of BMEP v/s BTE curves for sunflower oil blends with diesel

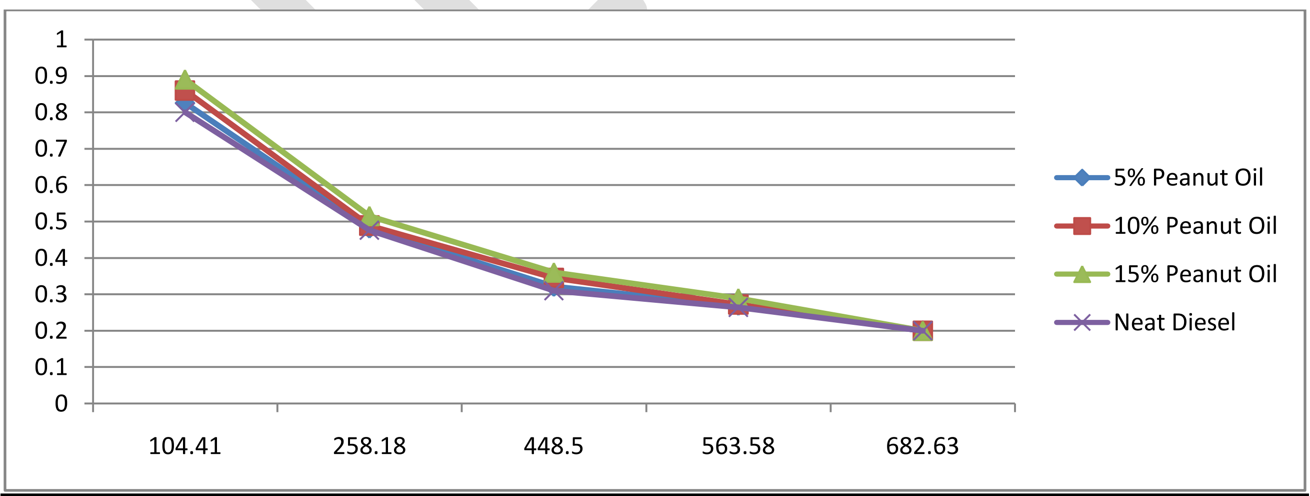

Figure: The comparison of BMEP v/s BSFC curves for peanut oil blends with diesel

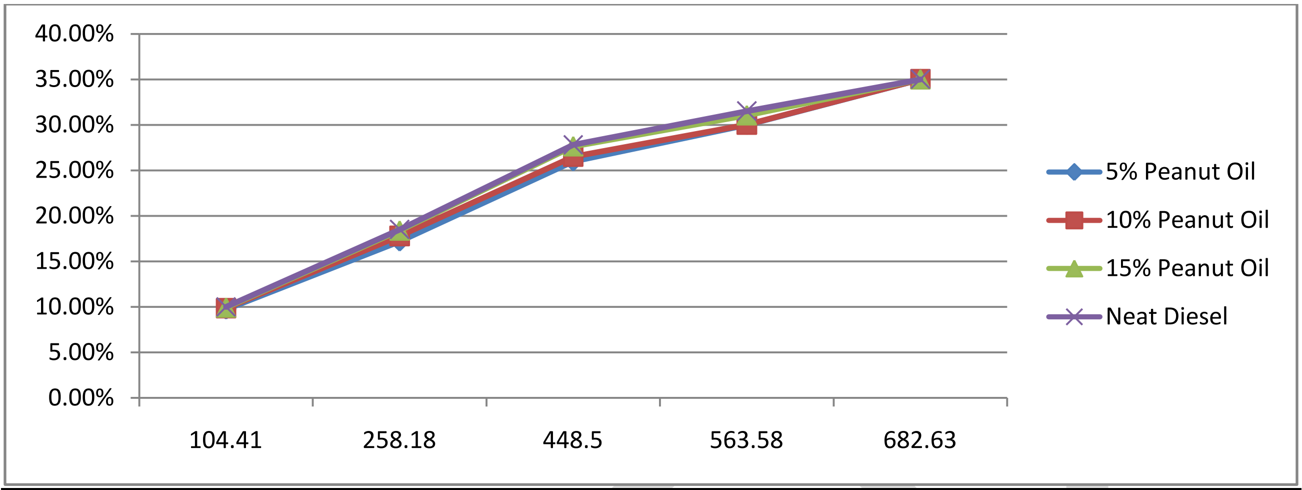

Figure: The comparison of BMEP v/s BTE curves for peanut oil blends with diesel

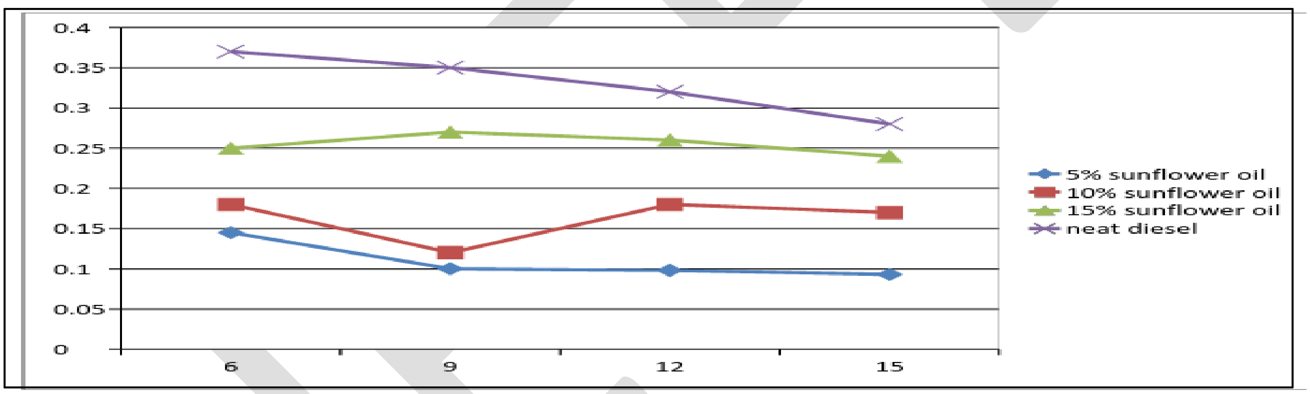

Figure: The BSFC VS LOAD for Sunflower Oil Blends

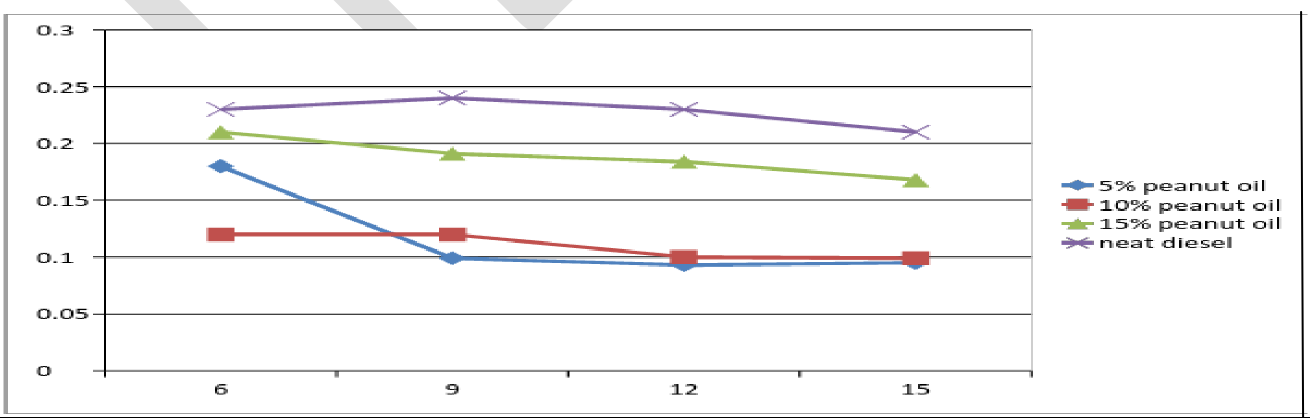

Figure: The BSFC VS LOAD for Peanut Oil Blends

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