EFFECT OF CORN OIL BIODIESEL ON THE PERFORMANCE OF A DIESEL ENGINE

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In

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ABSTRACT

Accessibility of energy sources and climate change are the two biggest challenges that mankind facing in this century. The fast-growing population and the increasing prosperity have led to rapid rise in the energy demand. Human civilization predominantly depends on the utilization of energy, it plays a big role in socio-economic development by improving the standard of living. Energy is vital for the economic development of every country. Every sector of the economy such as agriculture, industry, transport, commercial and domestic sectors require energy. The high energy demand in the industrialized world as well as in the domestic sector had caused environmental pollution problems due to their widespread use of fossil fuels. The concerns about environmental impacts have increased and trigged the examination of alternative energy sources. Biodiesel is a substitute to diesel fuel derived from the triglycerides of vegetable oils or animal fats. In this study, a analysis on the effect of corn oil- BIO DIESEL on performance and of a diesel engine is performed. The purpose of this study is to determine various effects of using corn oil which has been converted into biodiesel, on the performance of a diesel engine and to identify a suitable composition of fuel to achieve optimal engine performance. Engine performance tests will be performed on a diesel engine at various loads to determine performance of a diesel engine using corn oil as biodiesel as fuel and the performance curves for the following will be plotted.

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INTRODUCTION

INTRODUCTION

5.1 FOSSIL FUELS:

Decomposing plants and other organisms, buried beneath layers of sediment and rock, have taken millennia to become the carbon-rich deposits we now call fossil fuels. These non-renewable fuels, which include coal, oil, and natural gas, supply about 80 percent of the world's energy. They provide electricity, heat, and transportation, while also feeding the processes that make a huge range of products, from steel to plastics.

When fossil fuels are burned, they release carbon dioxide and other greenhouse gases, which in turn trap heat in our atmosphere, making them the primary contributors to global warming and climate change.

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 fuel sis 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. green house gas emissions in2010. 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.

5.2 ALTERNATIVE FUELS:

Alternative fuels include gaseous fuels such as hydrogen, natural gas, and propane; alcohols such as ethanol, methanol, and butanol; vegetable and waste-derived oils; and electricity. These fuels may be used in a dedicated system that burns a single fuel, or in a mixed system with other fuels including traditional gasoline or diesel, such as in hybrid-electric or flexible fuel vehicles

.

Alcohol-based *Ethanol* derived from fermenting and distilling crops is already being blended with gasoline in India to increase octane levels and improve emission quality. Though it is renewable in nature, subsidies attached to it have a negative impact on food prices.

Natural Gas is already being used in homes and fertiliser plants successfully because of its lower emissions compared with gasoline or diesel. However, the methane created is far worse for global warming than carbon di-oxide.

Electricity is a feasible alternative to run vehicles and electric vehicles are getting a lot of attention from the Government. Electric vehicles no doubt will help reduce pollution levels dramatically, but as things stand today, a large amount of electricity is produced from fossil fuels such as coal, which adds to the bad carbon footprint.

Hydrogen as an additive to natural gas or its use in fuel-cell vehicles is yet another emerging alternative since it offers near zero emission problems. But it could be a costly alternative today. Technology enhancements in the future will help overcome its cost, and distribution infrastructure constraints.

Liquefied Petroleum Gas (LPG) or *Propane,* a by-product of natural gas processing has already entered our kitchens on commercial basis and is popular in the transportation sector primarily because of its lower emission properties. But its production, storage and distribution hamper its rapid acceptance as an alternative fuel.

Biodiesel, based on vegetable oils and animal fats is an alternate fuel which is considered safe and biodegradable. It is, however, yet to be fully exploited commercially.

Alternative fuels have both advantages and disadvantages relating to their impact on the environment and society in general. But the time has come to increase the utilisation of alternative fuels to help create a better and cleaner world for everyone.

5.3 NEED FOR ALTERNATE FUELS:

Despite growing attention on clean energy, fossil fuels still account for 80 percent of global energy consumption and 75 percent of greenhouse gas emissions. Our fossil fuel-based energy system comes at a massive cost. Fossil fuels drive economic vulnerability, where countries and businesses are subject to volatile fuel prices; many are reliant on costly energy imports. Coal, oil and gas also increase human vulnerability: Dangerous outdoor air pollution due to fossil fuel burning kills 4.2 million people a year globally, according to the World Health Organization.

Renewables have the potential to eliminate these risks while providing a range of economic opportunities for businesses and communities to thrive.

5.4 BIODIESEL:

Biodiesel is a form of diesel fuel derived from plants or animals and consisting of long-chain fatty acid esters. It is typically made by chemically reacting lipids such as animal fat (tallow), soybean oil, or some other vegetable oil with an alcohol, producing a methyl, ethyl or propyl ester.

Unlike the vegetable and waste oils used to fuel converted diesel engines, biodiesel is a drop-in biofuel, meaning it is compatible with existing diesel engines and distribution infrastructure. Biodiesel can be used alone or blended with Petro diesel in any proportions. Biodiesel blends can also be used as heating oil.

5.5 BLENDS:

Blends of biodiesel and conventional hydrocarbon-based diesel are most commonly distributed for use in the retail diesel fuel marketplace. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix:

- 100% biodiesel is referred to as B100
- 20% biodiesel, 80% Petro diesel is labelled B20
- 5% biodiesel, 95% Petro diesel is labelled B5
- 2% biodiesel, 98% Petro diesel is labelled B2

Blends of 20% biodiesel and lower can be used in diesel equipment with no, or only minor modifications, although certain manufacturers do not extend warranty coverage if equipment is damaged by these blends. The B6 to B20 blends are covered by the ASTM D7467 specification. Biodiesel can also be used in its pure form (B100), but may require certain engine modifications to avoid maintenance and performance problems. Blending B100 with petroleum diesel may be accomplished by:

- Mixing in tanks at manufacturing point prior to delivery to tanker truck
- Splash mixing in the tanker truck (adding specific percentages of biodiesel and petroleum diesel)
- In-line mixing, two components arrive at tanker truck simultaneously.
- Metered pump mixing, petroleum diesel and biodiesel meters are set to X total volume

5.6 PROPERTIES:

Biodiesel has promising lubricating properties and cetane ratings compared to low sulfur diesel fuels. Fuels with higher lubricity may increase the usable life of high-pressure fuel injection equipment that relies on the fuel for its lubrication. Depending on the engine, this might include high pressure injection pumps, pump injectors (also called *unit injectors*) and fuel injectors.

The calorific value of biodiesel is about 37.27 MJ/kg. This is 9% lower than regular Number 2 Petro diesel. Variations in biodiesel energy density is more dependent on the feedstock used than the production process. Still, these variations are less than for Petro diesel. It has been claimed biodiesel gives better lubricity and more complete combustion thus increasing the engine energy output and partially compensating for the higher energy density of Petro diesel.

The colour of biodiesel ranges from golden to dark brown, depending on the production method. It is slightly miscible with water, has a high boiling point and low vapor pressure. The flash point of biodiesel exceeds 130 °C (266 °F), significantly higher than that of petroleum diesel which may be as low as 52 °C (126 °F). Biodiesel has a density of ~0.88 g/cm^3, higher than Petro diesel (~0.85 g/cm^3).

Biodiesel contains virtually no sulfur, and it is often used as an additive to ultra-low-sulfur diesel (ULSD) fuel to aid with lubrication, as the sulfur compounds in Petro diesel provide much of the lubricity.

5.7 Fuel efficiency:

The power output of biodiesel depends on its blend, quality, and load conditions under which the fuel is burnt. The thermal efficiency for example of B100 as compared to B20 will vary due to the differing energy content of the various blends. Thermal efficiency of a fuel is based in part on fuel characteristics such as: viscosity, specific density, and flash point; these characteristics will change as the blends as well as the quality of biodiesel varies. The American Society for Testing and Materials has set standards in order to judge the quality of a given fuel sample.

One study found that the brake thermal efficiency of B40 was superior to traditional petroleum counterpart at higher compression ratios (this higher brake thermal efficiency was recorded at compression ratios of 21:1). It was noted that, as the compression ratios increased, the efficiency of all fuel types – as well as blends being tested – increased; though it was found that a blend of B40 was the most economical at a compression ratio of 21:1 over all other blends. The study implied that this increase in efficiency was due to fuel density, viscosity, and heating values of the fuels.

5.8 Emissions:

Emissions are inherent to the combustion of diesel fuels that are regulated by the U.S. Environmental Protection Agency (E.P.A.). As these emissions are a by-product of the combustion process, in order to ensure E.P.A. compliance a fuel system must be capable of controlling the combustion of fuels as well as the mitigation of emissions. There are a number of new technologies being phased in to control the production of diesel emissions. The exhaust gas recirculation system, E.G.R., and the diesel particulate filter, D.P.F., are both designed to mitigate the production of harmful emissions.

A study performed by the Chonbuk National University concluded that a B30 biodiesel blend reduced carbon monoxide emissions by approximately 83% and particulate matter emissions by roughly 33%. NOx emissions, however, were found to increase without the application of an E.G.R. system. The study also concluded that, with E.G.R, a B20 biodiesel blend considerably reduced the emissions of the engine. Additionally, analysis by the California Air Resources Board found that biodiesel had the lowest carbon emissions of the fuels tested, those being ultra-low-sulfur diesel, gasoline, corn-based ethanol, compressed natural gas, and five types of biodiesel from varying feedstocks. Their conclusions also showed great variance in carbon emissions of biodiesel based on the feedstock used. Of soy, tallow, canola, corn, and used cooking oil, soy showed the highest carbon emissions, while used cooking oil produced the lowest.

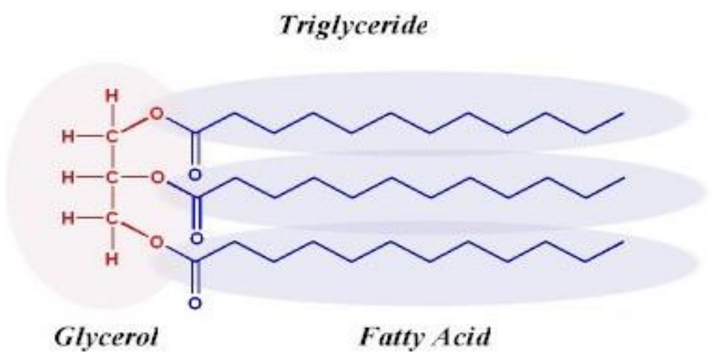
5.9 Feedstock:

The specifications for biodiesel allow a variety of feedstocks and processes to be used in its production. Biodiesel can be produced commercially from a variety of oils and fats:

- Animal fats: edible, inedible, and all other variations of tallow, lard, choice white grease, yellow grease, poultry fats, and fish oils;
- Plant oils: soy, corn, canola, sunflower, rapeseed, cottonseed;
- Recycled greases: used cooking oils and restaurant frying oils.

Biodiesel can also be made from other oils, fats, and recycled oils such as mustard, palm, coconut, peanut, olive, sesame, and safflower oils, trap greases, and even oils produced from algae, fungi, bacteria, molds, and yeast. Some properties of finished biodiesel such as cetane number, cloud point, and stability depend heavily on the feedstock (US Department of Energy, 2009).

The words “oil” and “fats” designate substances with no solubility in water (hydrophobic) composed mainly by products of the condensation between glycerol and fatty acids, called triglycerides (Figure 1). In general fats have a high ratio of saturated fatty acids whereas oils contain more unsaturated fatty acids. The main distinction between them is in appearance: fats are solid whereas oils are liquid (Hartman, 1982).



Besides triglycerides, oils and fats contain a small amount of other compounds, such as free fatty acids, mono and diglycerides, phosphatides, alcohols, hydrocarbons and vitamins (Sonntag, 1979).

Compared with the chemistry of diesel fuel, which contains hundreds of compounds, the chemistries of different fats and oils typically used for biodiesel are very similar. Each fat or oil molecule is made up of a glycerin backbone of three carbons, and on each carbon is attached a long-chain fatty acid that reacts with methanol to make the methyl ester, or biodiesel. The glycerin backbone is turned into glycerin and sold as a by-product of biodiesel manufacturing. The fats and oils contain 10 common types of fatty acids that have 12 to 22 carbons, more than 90% of which are 16 to 18 carbons. Some of these chains are saturated, some are monounsaturated, and others are polyunsaturated. Within the limits of the specifications, the differing levels of saturation can affect some biodiesel fuel properties (US Department of Energy, 2009).

5.10 Corn Oil:

Corn oil, edible oil obtainable from the seeds (kernels) of corn (maize), valued for its bland flavour and light colour.

The oil constitutes about half of the germ (embryo) of the corn kernel, which is separated from the rest of the kernel during the operation of milling to produce meal, animal feed, hominy, breakfast foods, or other edible solids. The corn germ is dried in a kiln, and the oil is extracted by either a hydraulic or a screw press; the pressed cake is further treated by washing it with a solvent, ordinarily hexane, and the dissolved oil is recovered by evaporating the solvent. The oil cake remaining after solvent extraction is ground and used as an animal fodder known as hominy feed.

Corn oil is used primarily for food. It is favoured as a salad oil and frying oil because it contains little cholesterol; large quantities of it are converted into margarine by hydrogenation, a process in which the oil is combined with hydrogen at high temperature and pressure in the presence of a catalyst.

5.11 Corn Oil Production Process:

The Corn oil processing always starts with the **Corn Germ**. The Germ is a part the corn plant called an embryo, which is recognizably different from the usual nutrients found in the endosperm. The endosperm is a tissue which is produced inside the seed of the plant. It protects the embryo and gives it nutrition.

Corn Seeds Composition	Seed Coat	Germ	Endosperm
Proportion of the whole seeds (%)	6%~9%	7%~12%	80%~85%
Oil Content (%)	1.3%	83%	15%

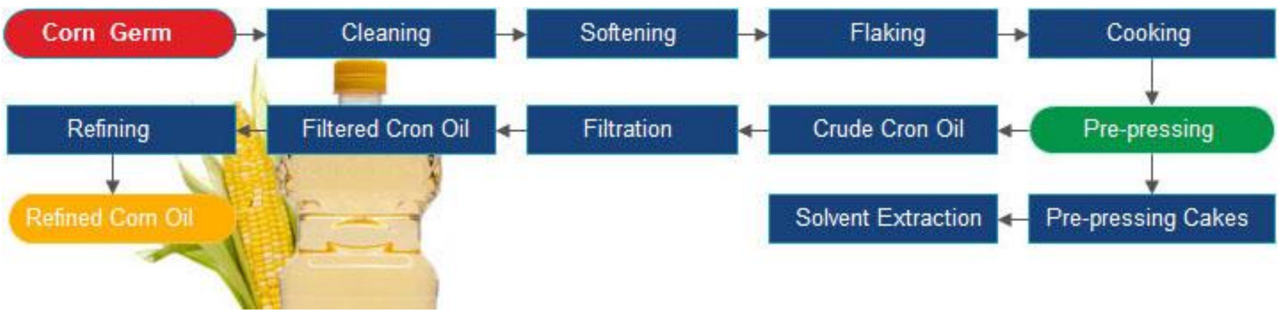
5.12 Corn Germ Separation Process:

The first step of corn oil production is Corn Germ Separation. It is also known as corn embryo extracting or germ extraction. There are 3 main corn germ separation processes:

- Dry type corn germ separation
- Wet type corn germ separation
- Half-wet corn germ separation

5.13 Corn Germ Oil Extraction Process:

The amount of oil in corn germ is around 85% of all the oil in the whole seed. How to make cooking oil from corn? There are a few steps in the corn oil production line.



Generally, corn oil is produced by expeller pressed method, then solvent-extracted the oil cake by using hexane or iso hexane. The solvent is then recovered for re-use by evaporation. The extracted crude corn oil is then sent to refining plant (including degumming, dewaxing, alkali treatment) to get high quality edible corn germ oils.

5.14 Corn Oil Refinery Process:

During the corn oil refining process, degum 11ming or alkali treatment is used to remove phosphatides. Alkali treatment also neutralizes fre12e fatty acids and removes colour of the crude oil. Winterization is the then comes up to re 13move waxes. The final step of refining is deodorization by steam distillation of the oil at 232– 14260 °C under high vacuum.

5.15 Properties of corn oil:

Corn oil is 100% fat, containing no protein or carbs. One tablespoon (15 ml) of corn oil provides (1Trusted Source):

- **Calories:** 122
- **Fat:** 14 grams
- **Vitamin E:** 13% of the Reference Daily Intake (RDI)

During the process of extracting corn oil from corn, many vitamins and minerals are lost. Still, the oil has a fair amount of vitamin E.

Corn oil has an omega-6 to omega-3 ratio of 46:1, which can contribute to this imbalance (1Trusted Source).

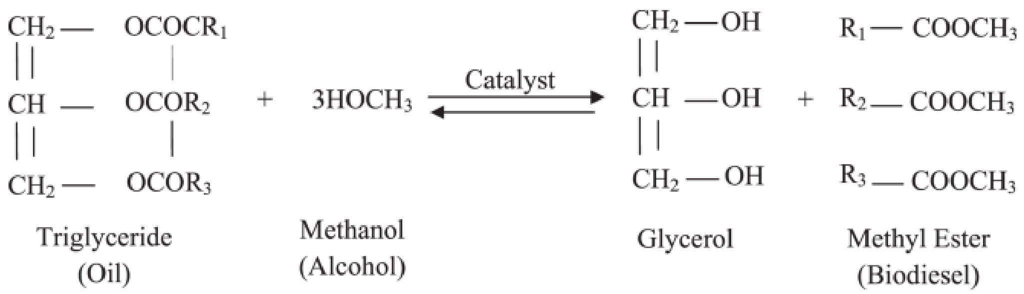
Corn oil is 100% fat and provides 122 calories per tablespoon (15 ml). It's mostly made of polyunsaturated omega-6 fats and contains some vitamin E.

5.16 Biodiesel Production from Corn Oil:

Biodiesel is produced from triglycerides in the presence of alcohol with catalyst through transesterification reaction. The biodiesel production from corn oil with methanol in the presence of nano-sized calcium oxide nano-catalyst was done at a laboratory scale. Transesterification reaction is carried out in a flask with overall volume of 300 ml flask was placed on a hot plate equipped with a controlled magnetic stirrer and temperature sensor. Corn oil was preheated to the required reaction temperature before methanol and the catalyst were added into the reaction flask.

The calculated amount of methanol to oil ratio was poured into the reactor. Then the CaO catalyst was added in a range between 0.5 to 5% by weight with respect to mass of the Corn Oil, and then the formed reaction mixture was mixed for 10 minutes. 100 ml of corn oil was added and temperature of the mixture was set from 30 to 70 °C, 5 °C interval. Transesterification proceeded under continuous stirring of the reaction mixture for a desired duration.

All transesterification reactions were carried-out at atmospheric pressure with stirring speed of 1500 rpm. Thermometer was inserted into the flask to monitor the reaction temperature. After the completion of the reaction, the mixture was transferred into a separating funnel and allowed to stand overnight. Three phases were formed due to the solid catalyst and glycerol is denser than biodiesel.



The separated biodiesel was heated above the boiling point of methanol (64.7 °C) to remove excess unreacted methanol. Moreover, very few suspended solid catalysts are removed by settling it for two to three days then the Biodiesel viscosity, specific gravity, water and sediment, total acidity, ash content, sulfur content, Flash Point and Cloud Point were checked according to the American Society for Testing and Materials (ASTM D 6751).

5.17 Purification:

After the reaction of transesterification, there is the separation of glycerol and ethyl or methyl esters, which are only called biodiesel after reaching the appropriate specifications, that is, after the removal of contaminants such as free glycerol, soaps, metals, excess alcohol, catalyst, and others (Cooke, 2007).

Among the most widely used treatments for the purification of biodiesel are washing it with water and acidified water. The great advantage of washing is the efficient removal of glycerol and ethanol, and residues of sodium salts and soaps, the latter dependent on the amount of free fatty acids present in the original raw material.

LITERATURE REVIEW

6.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:

V. Gopinath and P. Suresh [1], In this paper an attempt has been made to investigate four types of fuels are considered 100% Diesel, 90% Diesel+10% Corn oil Methyl Ester, 80% Diesel+20% Corn oil Methyl Ester, 70% Diesel+30% Corn oil Methyl Ester and 60% Diesel+40% Corn oil Methyl Ester. The various performance parameters like, brake thermal efficiency, Mechanical efficiency and brake specific fuel consumption were measured and analyzed. In this experiment it is found, that the biodiesel blends gives comparable performance to diesel.

YedilfanaSetargeMekonnen [2], investigated the production of biodiesel from three mixtures of vegetable oil and used cooking oil by alkali catalysed transesterification. Three kinds of vegetable oils, including jatropha, roselle and coconut oils were tested. The effect of used cooking oil content in oil feedstock (used cooking oil/vegetable oil ratios of 0.03-0.2 v/v) on methyl ester formation was investigated and optimized. The methyl ester content from each reaction condition was determined by gas chromatography (GC). The optimum used cooking oil/vegetable oil ratio was 0.03 v/v for all three kinds of oil feedstock.

Chatpalliwarl et al. [3], described the brief overview of the Biodiesel 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.

Vlada B.Veljković[a]Milan O.Biberdžić[b]Ivana B.Banković-Ilić[a]Ivica G.Djalović[c]Marija B.Tasić[a]Zvonko B.Nježić[d]Olivera S.Stamenković[a] [4],This paper deals with biodiesel production from corn oil as a feedstock via the transesterification and esterification reactions. Here, after brief discussion of the issues related to corn botany, cultivation, and use, as well as the corn germ and oil composition, properties and use, the methods of corn processing for germ and DDGS recovery are presented. In addition, the mechanical and solvent extraction techniques for oil recovery from whole ground corn kernels, germs, and DDGS are considered. Furthermore, biodiesel production from corn oil, waste frying corn oil, and CDO is critically analyzed. It is expected that further investigation will be directed toward developing simpler, more effective and energy-saving technologies for biodiesel production from corn oil-based feedstocks, especially from CDO. The integration of biodiesel production directly into corn-based ethanol production will advance the overall economy of industrial plants. Furthermore, the fuel properties, performances and exhaust gas emissions of corn-based biodiesel and its blends with diesel fuel are discussed, taking into account the biodiesel quality standards. Finally, issues related to the environmental and socio-economic impacts of corn-based biodiesel production and use are also tackled.

MertGülüm, AtillaBilgin [5], In this study, densities of produced corn oil biodiesel and its blends with commercially available petro-diesel fuel have been investigated. The effects of temperature (T) and biodiesel percentage in blend (X) on the densities of blends were examined. The blends (B5, B10, B15, B20, B50 and B75) were prepared on a volume basis and their densities were measured by following ISO test method at temperatures of 10, 15, 20, 30 and 40 ° C. The qualities of the corn oil biodiesel and its blends were evaluated by determining the other important properties such as flash point temperature and higher heating value. In order to predict these properties, some equations were also evaluated as a function of biodiesel percentage in blend.

RecpAltin, SelimCentinkaya [6], the author presents a potential of using vegetable oil fuels as fuel for diesel engines. The effects of vegetable oil fuels and their methyl esters (raw sunflower oil, raw cottonseed oil, raw soybean oil and their methyl esters, refined corn oil, distilled opium poppy oil and refined rapeseed oil) on a direct injected, four stroke, single cylinder diesel engine performance and exhaust emissions was investigated. The results showed that from the performance viewpoint, both vegetable oils and their esters are promising alternatives as fuel for diesel engines. Because of their high viscosity, drying with time and thickening in cold conditions, vegetable oil fuels still have problems, such as flow, atomization and heavy particulate emissions.

Avinash Kumar Agarwal [7], reported the technical feasibility of using straight vegetable oils (Jatropha oil), into a constant speed direct injection compression ignition engine. Vegetable oils have very high viscosity, which make their direct usability in engines questionable. In this investigation, SVO's were preheated by using waste heat from engine exhaust, in order to reduce their viscosity. The effect of using these oils on typical engine problems such as injector coking, piston ring sticking, lube oil dilution etc. was investigated in detail. Long-term endurance test (For a duration of 512 hours) of SVO fuelled engine vis-à-vis mineral diesel fuelled engine was executed and the results are compared.

M Dantas, Marta Conceicao, V. Fernandes Jr, Nataly Santos, R. Rosenhaim, Aldalea Marques, Ieda Santos and A. Souza [8], This work evaluates the thermal and kinetic behaviour of corn biodiesel obtained by the methanol and ethanol routes. As to the TG curves, in air three thermal decomposition steps are for the methanol biodiesel and two steps are for the ethanol biodiesel. These steps are related to the evaporization and/or combustion of the methyl and ethyl esters, respectively. The corn oil presented four thermal decomposition steps in air, and only one step in nitrogen. These steps were attributed to the evaporization and/or decomposition of triglycerides.

N. El Boulifi,[1] A. Bouaid,[1] M. Martinez,[1] and J. Aracil[9], Response surface methodology (RSM) based on central composite design (CCD) was used to optimize biodiesel production process from corn oil. The process variables, temperature and catalyst concentration were found to have significant influence on biodiesel yield. The optimum combination derived via RSM for high corn oil methyl ester yield (99.48%) was found to be 1.18% wt catalyst concentration at a reaction temperature of 50degress C. Biodiesel from corn oil was stored for a period of 30 months, and the physico-chemical parameters of samples were measured at regular interval of time. Results show that the acid value (AV), peroxide value (PV), and viscosity () increased while the iodine value (IV) decreased. These parameters changed very significantly when the sample was stored under normal oxygen atmosphere.

Teresa M. Mata, Igor R.B.G. Sousa , Sara S. Vieira and Nídia S. Caetano [10],This work permoente experimental results on alkali and enzymatic catalysis of corn oil into biodiesel with an optimization of operating conditions and forther perimenta on enzyme reuse. A comparison of the alkali-catalyzed methanolysis and ethanolysis of corn oil is done, followed by the study of the enzymatio talyd ethanolysis using the alcohol at different concentrations (ethanol absolute, 96 %, and 70 %, v/v). Results show that the best operating conditions for diesel production using absolute ethanol (containing no water) as reagent are an oil/alcohol molar ratio of 1:6, a catalyst/oil weight percentage of 28 wit a rection time of 12 h, and a reaction temperature of 35 °C. For these conditions it was possible to obtain a reaction yield of 98.95 wt% with a fatty acid hylsters (FAEE) content of 69.2 wt %, with linoleate (C18:2) and oleate (C18:1) being the most significant esters (with relative percentages of 42.97% and 22.54 wt%, respectively). Regarding the evaluation of the enzyme activity loss during reaction, it was concluded that under these conditions it is possible. in reun the enzyme four times after which there was a significant loss of the biodiesel quality according to the EN 14214:2009 standard.

F. Aydin,A. B. Kafadar,S. Erdogan,A. Saydut,C. Kaya &C. Hamamci [11], in this study Biodiesel was prepared from corn by transesterification of the crude oil with methanol in the presence of NaOH as catalyst. Transesterified corn oil has better properties globally because it has the greater monounsaturated content. Determination of blend levels is one important issue to the quality control of biodiesel due to the increase of biodiesel-diesel blends commercialization. The objective of this study was to characterize how the key fuel properties changed when the commercial petroleum diesel fuel was blended with methyl ester produced from corn oil. In the present study, commercially available diesel fuel was blended with the biodiesel prepared from corn oil. The blends of biodiesel petroleum diesel were prepared on a volume basis. The important properties of corn oil methyl ester (biodiesel)-diesel fuel blends, such as density and kinematic viscosity, are found out and compared to those of No. 2 petroleum diesel, ASTM, and EN biodiesel standards.

RavishankarSathyamurthy,D.Balaji[b],ShivaGorjian[c],S.JenorisMuthiya[d],R.Bharathwaaj[a], S.Vasanthaseelan[a], Fadl A.Essa[12], In the present experimental investigation, corn oil methyl ester (COME) and its blends of biodiesel fueled in diesel engine to assess the combustion, performance, emission characteristics. The maximum blend ratio of corn oil methyl ester is limited to 30% with neat diesel. Results showed that using B10 biodiesel blend significantly improved the performance of engine and the maximum engine efficiency using B10 biodiesel blend is found as 33.98% and it is lower than neat diesel. Similarly, the BSFC of diesel engine using B10 biodiesel blend is increased only by 2%, whereas, using B20 and B30, the brake specific fuel consumption (BSFC) increased to about 4 and 6%, respectively. Results showed that the formation of NOx is higher as the oxygen content available in the fuel is higher and similarly, the CO_2 during combustion increased. The other emission such as CO and HC are reduced.

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 Analysis of Diesel Engine using Corn oil as Biodiesel is carried out by following the experimental procedure.

PROBLEM STATEMENTS

7.PROBLEM STATEMENTS

There are two problem statement in that has to be solved in this research. First is the prediction of the engine performance and exhaust emissions of diesel engine using biodiesel fuel and second is how the inputs affect the outputs of engine.

7.1 PROJECT OBJECTIVES

There are two main objectives in that has to be achieved in this research. First is to investigate the performance characteristicS of a diesel engine operating with biodiesel and second is to investigate the different performance of biodiesel and diesel fuel blends.

7.2 PROJECT SCOPES

There are two main scopes in this research. First is diesel engine testing at various engine speeds and Second is collect all the performance characteristics.

EXPERIMENTAL SETUP

8.EXPERIMENTAL SETUP

8.1 Diesel engine:

A diesel engine also known as a compression-ignition engine. It is an internal combustion engine that uses the heat of compression to initiate ignition to burn the fuel that has been injected into the combustion chamber. This is in contrast to spark-ignition engines such as a petrol engine, gasoline engine or gas engine using a gaseous fuel as opposed to gasoline, which uses a spark plug to ignite an air-fuel mixture. The engine was developed by German inventor Rudolf Diesel in 1893.

The diesel engine has the highest thermal efficiency of any regular internal or external combustion engine due to its very high compression ratio. Low-speed diesel engines are used in ships and for other applications where overall engine weight is relatively unimportant, can have a thermal efficiency that exceeds 50%.

Diesel engines are manufactured in two-stroke and four-stroke versions. They were originally used as a more efficient replacement for stationary steam engines. Since the 1910s they have been used in submarines and ships. Its use in locomotives, trucks, heavy equipment and electric generating plants followed later. In the 1930s, they slowly began to be used in a few automobiles. Since the 1970s, the use of diesel engines in larger on-road and off-road vehicles in the USA increased. As of 2007, about 50% of all new car sales in Europe are diesel.

The world's largest diesel engine is currently a Wartsila-Sulzer RTA96-C Common Rail marine diesel of about 84,420 kW (113,210 HP) @ 102 rpm output. According to the British Society of Motor Manufacturing and Traders, the EU average for diesel cars account for 50% of the total sold, including in France 70%, and in the UK - 38%.

8.2 Size Groups:

There are three size groups of Diesel engines.

- Small -Under 188 kW (252 HP) output
- Medium
- Large

8.3 Engine speeds:

Within the diesel engine industry, engines are often categorized by their rotational speeds into three groups:

- High-speed engines (>1,000 rpm),
- Medium-speed engines (300 - 1,000 rpm), and
- Slow-speed engines (<300 rpm).

High-speed and Medium-speed engines are predominantly four-stroke engines; except for the Detroit Diesel two-stroke range. Medium-speed engines are physically larger than high-speed engines and can burn lower-grade (slower-burning) fuel than high-speed engines.

Slow-speed engines are predominantly large two-stroke crosshead engines, hence very different from high- and medium-speed engines. Due to the lower rotational speed of slow-speed and medium-speed engines, there is more time for combustion during the power stroke of the cycle.

8.4Major Advantages:

Diesel engines have several advantages over other internal combustion engines:

- They burn less fuel than a petrol engine performing the same work, due to the engine's higher temperature of combustion and greater expansion ratio. Gasoline engines are typically 30% efficient while diesel engines can convert over 45% of the fuel energy into mechanical energy.
- They have no high voltage electrical ignition system, resulting in high reliability and easy adaptation to damp environments. The absence of coils, spark plug wires, etc., also eliminates a source of radio frequency emissions which can interfere with navigation and communication equipment, which is especially important in marine and aircraft applications.
- The life of a diesel engine is generally about twice as long as that of petrol engine due to the increased strength of parts used. Diesel fuel has better lubrication properties than petrol as well.
- Diesel fuel is distilled directly from petroleum. Distillation yields some gasoline, but the yield would be inadequate without catalytic reforming, which is a more costly process .Diesel fuel is considered safer than petrol in many applications. Although diesel fuel will burn in open air using a wick, it will not explode and does not release a large amount of flammable vapour. The low vapour pressure of diesel is especially advantageous in marine applications, where the accumulation of explosive fuel-air mixtures is a particular hazard. For the same reason, diesel engines are immune to vapour lock.

- For any given Partial load, the fuel efficiency (mass burned per energy produced) of a diesel engine remains nearly constant, as opposed to petrol and turbine engines which use proportionally more fuel with partial power outputs. They generate less waste heat in cooling and exhaust.
- Diesel engines can accept super- or turbo-charging pressure without any natural limit, constrained only by the strength of engine components. This is unlike petrol engines, which inevitably suffer detonation at higher pressure.
- The carbon monoxide content of the exhaust is minimum; therefore diesel engines are used in underground mines.
- Biodiesel is easily synthesized, non-petroleum-based fuel (through transesterification) which can run directly in many diesel engines, while gasoline engines either need adaptation to run synthetic fuels or else use them as an additive to gasoline (e.g., ethanol added to gasohol).

8.5 Engine Description:

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
Orifice Diameter	20 mm
Cooling	Water Cooled
Starting	Hand Cranking
Dynamometer	Rope Brake

The prepared fuel blends are used in Kirloskar made Four stroke, single cylinder diesel engine-test rig in the laboratory and load test is held with additional attachment of muffler to the exhaust smoke pipe. By the load test, the performance characteristics and from smoke analysis, combustion analysis of fuel is obtained.

The given I.C engine is a vertical, single cylinder, 4-stroke, and water-cooled constant speed diesel engine. It is fitted with a flywheel sufficient enough to give momentum to absorb energy when in power stroke and release during the other three strokes to get a uniform speed. Provision is made to measure the exhaust heat with the help of a calorimeter and thermocouples fixed at salient points. This engine is provided with a crank handle for starting. The engine is mounted with an absorption thermometer of brake drum type. The engine set up is also provided with burette, graduations duly marked and a three way to measure the fuel flow rate.

Properties of diesel and corn oil methyl ester:

Properties	**Diesel**	**Corn oil methyl ester**
Viscosity at 40°C [CST]	5	8.6
Calorific Value [MJ/kg]	42	39.5
Specific Gravity	0.853	0.875
Flash Point [°C]	57	153
Fire Point [°C]	65	161
Pour Point [°C]	-25	-5
Cloud Point [°C]	-5	7
Density [kg/m^3]	853	875

EXPERIMENTAL PROCEDURE

9. EXPERIMENTAL PROCEDURE

9.1 Blending:

It is the main process involved for making biodiesels. It is nothing but mixing of transesterified oil in certain proportions to obtain the required properties. This process involves:
Taking proportions of the transesterified oil.
Mixing of biodiesel and diesel in the mixture up to the foam arises.

9.2 Blending of oil:

In this process, the conventional diesel fuel is mixed with transesterified Corn oil and Methanol in required proportions to obtain the required blends.

Following are the blends obtained in this process:

D100 –DIESEL 100%
D90 - CORN OIL BIODIESEL 10 %, DIESEL 90%
D80 - CORN OIL BIODIESEL 20%, DIESEL 80%
D70 - CORN OIL BIODIESEL 30%, DIESEL 70%
D85 - CORN OIL BIODIESEL 10%, DIESEL 85%, METHANOL 5%
D75 - CORN OIL BIODIESEL 20%, DIESEL 75%, METHANOL 5%

When biodiesel is blended with petroleum diesel, the cloud point of the diesel fuel and bio fuel are the two most important properties. The blended fuel must still need the seasonal temperature for cloud point for the region the fuel is being used. If blending is done into seasonal diesel, it must be done such that the seasonal cloud point temperatures are maintained. Therefore, the cloud point of biodiesel and petroleum diesel must be known. In some cases, this may govern the blend level of the biodiesel blend. Operators that blend even low percentages of biodiesel with seasonal diesel in the winter or shoulder seasons, risk having operational issues due to the raised cloud point. Therefore, it is important to know the cloud point of diesel used for blending, the biodiesel intended for blending and regional seasonal cloud point for the biodiesel blend. Blending of biodiesel blends without knowing the cloud points of the fuels being blended is not recommended.

9.3 Performance Characteristics of the Diesel Engine:

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

Indicated thermal efficiency is the ratio of energy in the indicated power (IP) to the input fuel energy
Brake thermal efficiency is the ratio of energy in the brake power (BP), to the input fuel energy.
Brake thermal efficiency is the true indication of the efficiency with which the thermodynamic input is converted into mechanical work. It also accounts for
combustion efficiency.

Mechanical efficiency is defined as the ratio brake power to the indicated power.

Mean effective pressure is the average pressure inside the cylinders of an internal combustion engine based on the calculated or measured power output. Mean effective pressure, gives an indication of engine displacement utilization higher the mean effective pressure higher will be power developed by the engine for a given displacement.

Specific fuel consumption is an important parameter that reflects how good the engine performance is. It is the reciprocal of thermal efficiency. Specific fuel consumption is widely used to compare the performance of different engine.

9.4 Procedure:

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

9.5 Basic Data:

1. Rated brake power of engine "BP" -5HP
2. Speed of the engine 1500RPM
3. Effective radius of break drum "R" —0.12 meter.
4. Stroke length —$110*10^{-3}$ meter
5. Diameter of cylinder bore -0.08 meter

9.6 Variables to be considered:

1. Specific Gravity of fuel.

2. Dead load applied on break drum "W "(Kg).

3. Spring balance reading "S". (Kg).

284. Calorific value of fuel.

5. Time taken for 10 cc fuel consumption.

9.7Calculations:

Fuel consumption (F.C) = (10*SP. Gravity*3600)/(t*1000)

Brake power (B.P) = (2πN(W-S) *9.81*r)/60000

Friction power (F.P) = (from graph)

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

Specific fuel consumption (S.F, C) = F.C/B. P

Brake thermal efficiency (η_{Bth}) = (B.P*3600)/ (F.C*C. V)

Indicated thermal efficiency (η_{Ith}) = (I.P*3600)/(F.C*C. V)

Mechanical efficiency (η_{mech}) = B.P/ I.P

Brake mean effective pressure (B.M.E.P) = (B.P*60000)/(L*(π/4)d^2*(N/2))

Indicated mean effective pressure (I.M.E.P) = (I.P*60000)/(L*(π/4) d^2*(N/2))

CALCULATION AND ANALYSIS

10. CALCULATION AND ANALYSIS

10.1 Basic Data:

4-Stroke single cylinder vertical diesel engine

Rated brake power of engine B.P = 5 H.P = 3.7KW

Speed of engine N = 1500rpm

Effective radius of the brake drum R = 0.213 m

Specific gravity of fuel = 0.853 gm/cc

Load on brake drum(W-S) =(W-S)

Stroke length L =110×10^{-3} m

Diameter of cylinder bore D =80×10^{-3} m

Calorific Value of fuel CV = 42000 kJ/kg

Time taken for 10cc consumption of fuel is 't' sec

10.2 Calculation: -

10.2.1. D100:

W-S (kgf)	T (sec)	BP (kW)	FC (kg/hr)	IP (kW)	SFC (kg/kW hr)	Break thermal efficiency	Indicated thermal efficiency	Mechanical efficiency	IMEP	BMEP
0	69	0	0.445	3.1	0	0	59.71%	0	4.485	0
1.6	57	0.525	0.538	3.625	1.024	8.3%	57.75%	14.4%	5.244	0.75
3.4	52	1.115	0.59	4.215	0.529	16.19%	61.23%	26.45%	6.098	1.61
5.2	47	1.706	0.653	4.806	0.382	22.39%	63.08%	35.49%	6.953	2.46
7	43	2.29	0.714	5.39	0.311	27.4%	64.70%	42.48%	7.798	3.31
8.6	36	2.822	0.853	5.922	0.302	28.35%	59.5%	47.65%	8.568	4.08

Maximum load = $\frac{Rated\ B.P\times60000}{2\pi NR\times9.81}$

$=\frac{3.7\times60000}{2\pi\times1500\times0.213\times9.81}$

=11.27 kg

Brake power (B.P) $= \frac{2\pi N(W-S)\times 9.81\times R}{60000} = \frac{2\pi\times 1500\times 1.6\times 9.81\times 0.213}{60000}$

= 0.525kW

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

= (10/57) $\times\frac{0.853\times 3600}{1000}$ kJ/hr

= 0.538kJ/hr

Frictional power from graph (F.P) = 3.1Kw

Indicated power (I.P) = B.P + F.P = 0.525+3.1

= 3.625 kW

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

$= \frac{0.538}{0.525}$

= 1.024kJ/kW hr

Brake thermal efficiency $\eta_{Bth} = \frac{B.P\times 3600}{FC\times CV}$

$= \frac{0.525\times 3600}{0.538\times 42000}$

= 8.3%

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

$= \frac{3.625\times 3600}{0.538\times 42000}$

= 59.71%

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

$= \frac{0.525}{3.625}$

= 14.4%

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

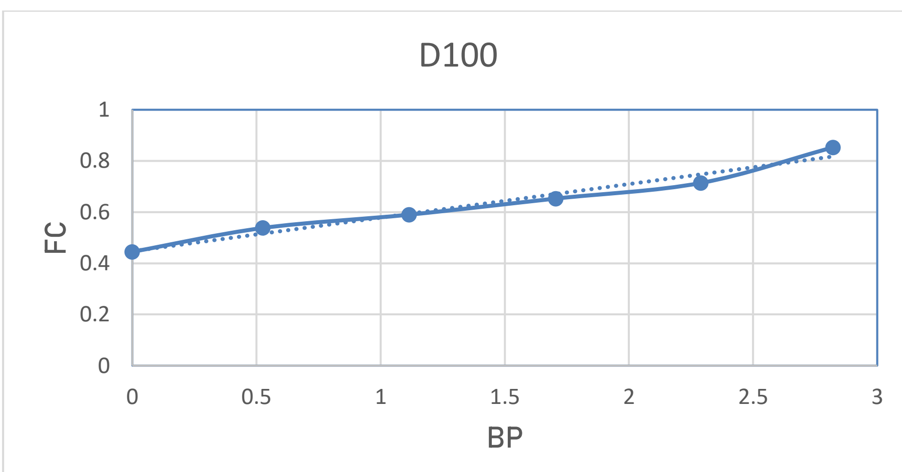
$$= \frac{3.625 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

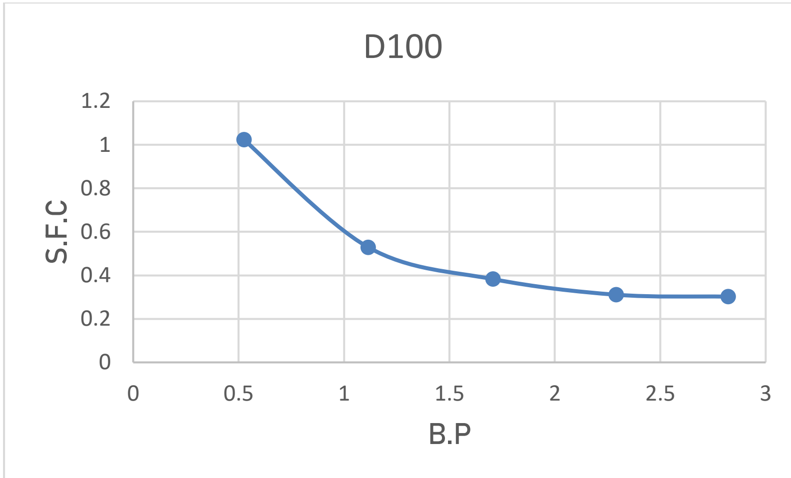
= 4.485 bar

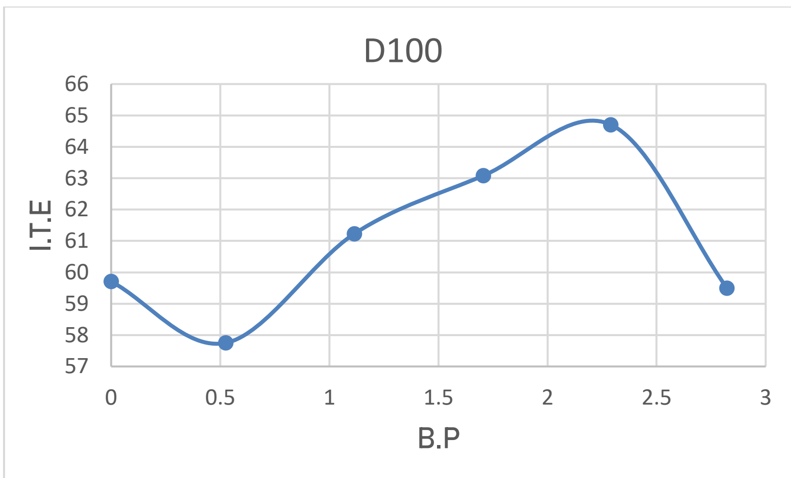
Brake mean effective pressure (BMEP) $= \frac{B.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

$$= \frac{0.525 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

= 0.75 bar




D100
S.F.C
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
B.P


D100
I.T.E
66
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64
63
62
61
60
59
58
57
0
0.5
1
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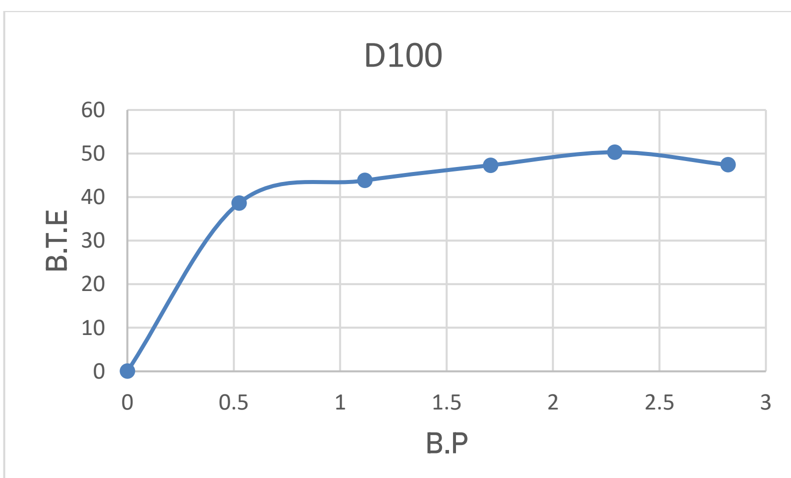
2
2.5
3
B.P


D100
B.T.E
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50
40
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2
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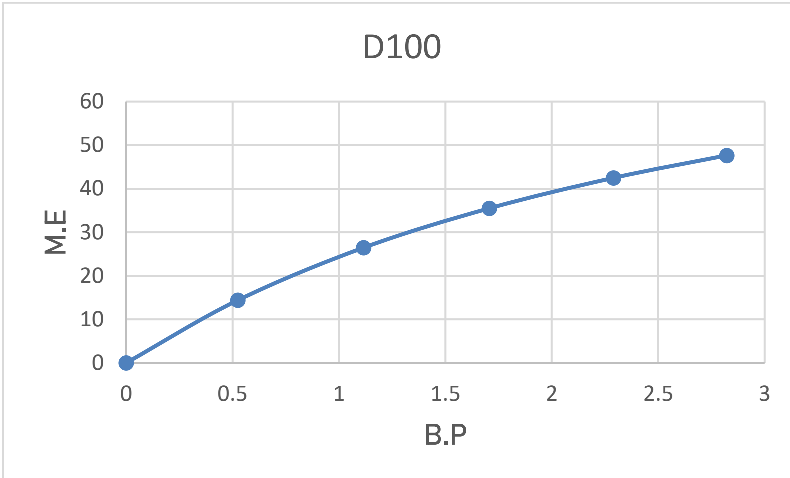
3
B.P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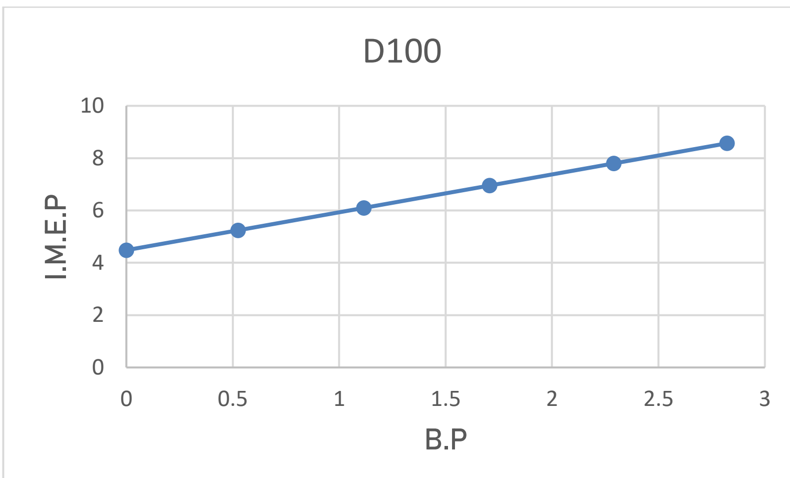
D100
I.M.E.P
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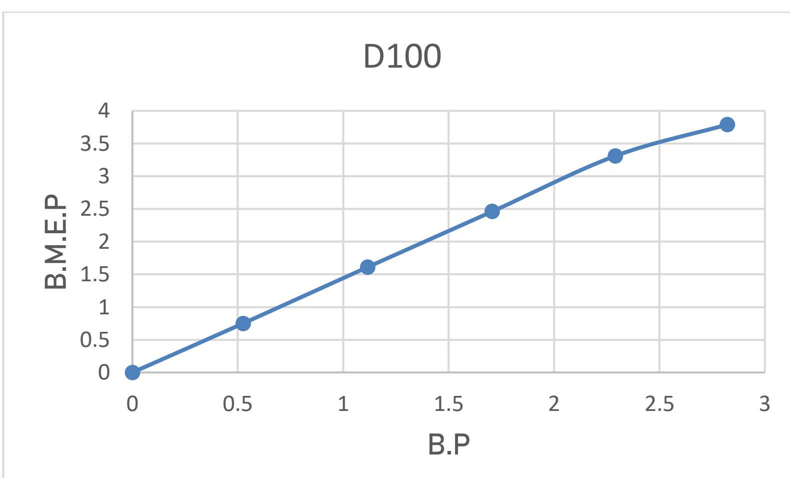

D100
B.M.E.P
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
B.P

10.2.2. D90:

W-S (kgf)	**T (sec)**	**BP (kW)**	**FC (kg/hr)**	**IP (kW)**	**SFC (kg/kW hr)**	**Break thermal efficiency**	**Indicated thermal efficiency**	**Mechanical efficiency**	**IMEP**	**BMEP**
0	78	0	0.394	2.15	0	0	47.05%	0	3.110	0
1.7	64	0.557	0.481	2.707	0.863	9.9%	48.5%	20.5%	3.916	0.805
3.4	58	1.050	0.53	3.2	0.504	17.01%	52.06%	32.8%	4.629	1.519
4.8	50	1.575	0.61	3.725	0.387	22.26%	52.65%	42.2%	5.389	2.278
6.4	46	2.1	0.66	4.25	0.314	27.43%	55.52%	49.41%	6.149	3.038
8	38	2.62	0.81	4.77	0.309	27.89%	50.7%	54.9%	6.90	3.79

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 kg

Brake power (B.P) $= \frac{2\pi N(W-S)\times 9.81\times R}{60000} = \frac{2\pi\times 1500\times 1.7\times 9.81\times 0.213}{60000}$

= 0.557kW

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

= (10/57) $\times\frac{0.8552\times 3600}{1000}$ kJ/hr

= 0.481kJ/hr

Frictional power from graph (F.P) = 2.15Kw

Indicated power (I.P) = B.P + F.P = 0.557+2.15

= 2.707kW

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

$= \frac{0.481}{0.557}$

= 0.8635kJ/kW hr

Brake thermal efficiency $\eta_{Bth} = \frac{B.P \times 3600}{FC \times CV}$

$= \frac{0.557 \times 3600}{0.481 \times 41750}$

= 9.9%

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

$= \frac{2.707 \times 3600}{0.481 \times 41750}$

= 48.5%

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

$= \frac{0.557}{2.707}$

= 20.5%

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

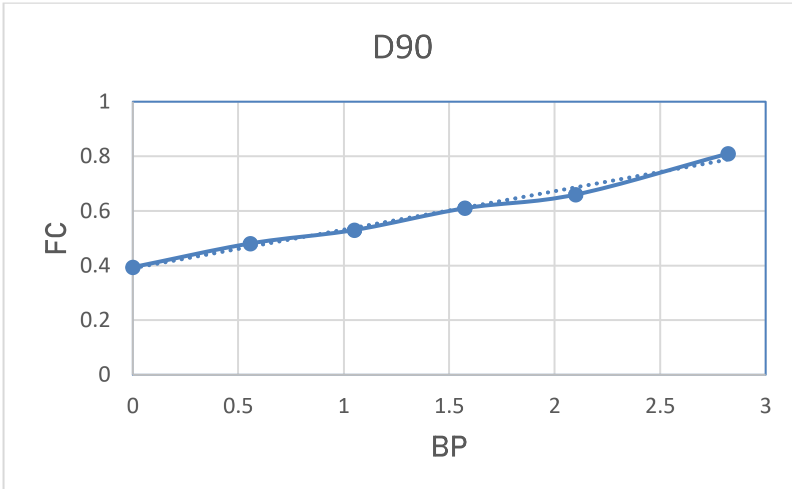
$= \frac{2.707 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$

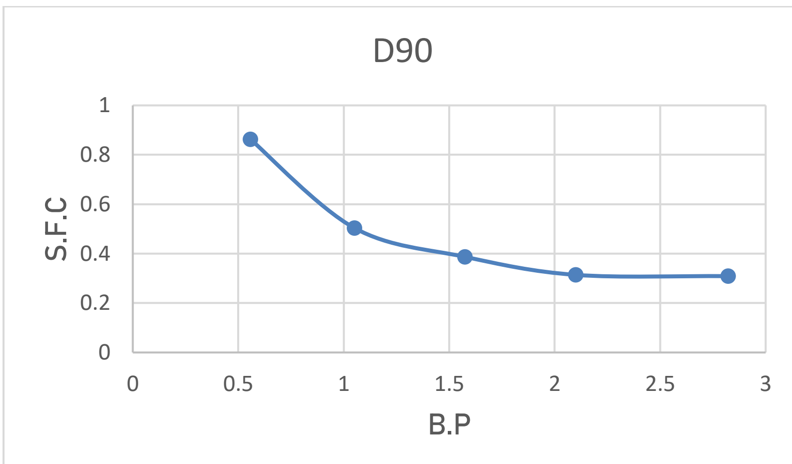
= 3.916 bar

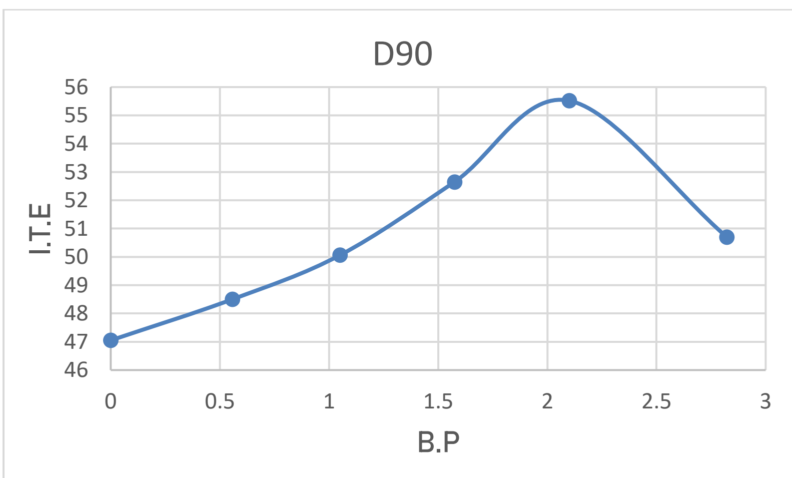
Brake mean effective pressure (BMEP) $= \frac{B.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

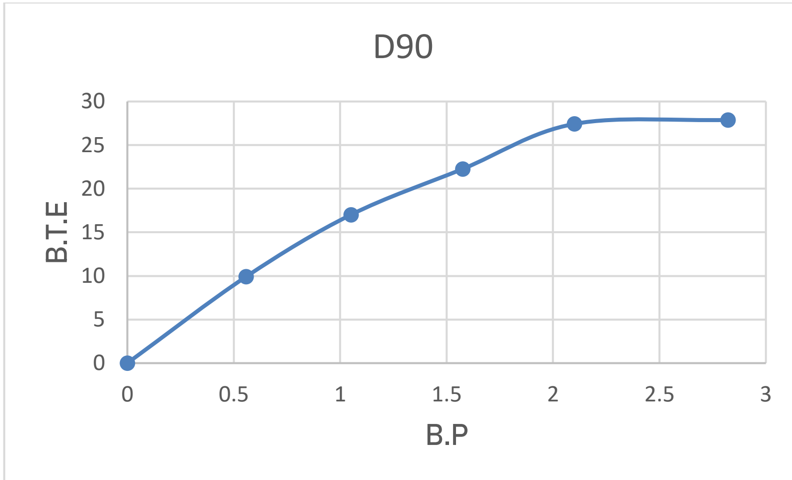
$$= \frac{0.557 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4}(80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

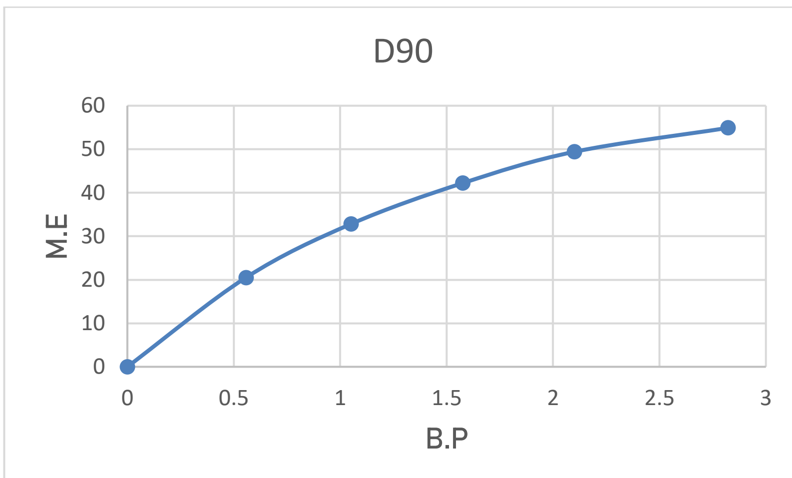
$= 0.805$ bar

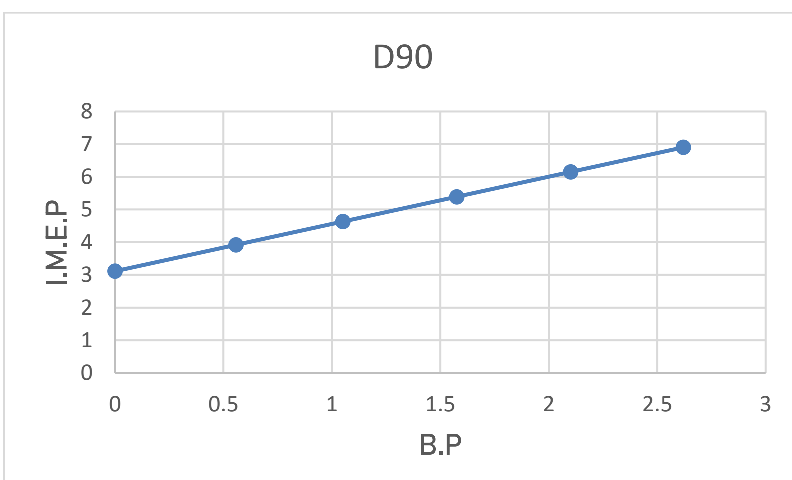


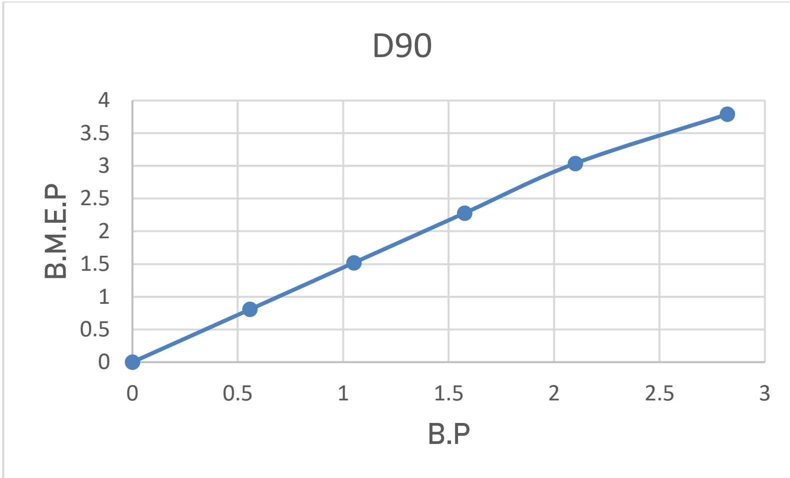





D90
B.T.E
B.P
0
5
10
15
20
25
30
0
0.5
1
1.5
2
2.5
3


D90
M.E
B.P
0
10
20
30
40
50
60
0
0.5
1
1.5
2
2.5
3


D90
I.M.E.P
B.P
0
1
2
3
4
5
6
7
8
0
0.5
1
1.5
2
2.5
3



10.2.3.D70:

W-S (kgf)	T (sec)	BP (kW)	FC (kg/hr)	IP (kW)	SFC (kg/kW hr)	Break thermal efficiency	Indicated thermal efficiency	Mechanical efficiency	IMEP	BMEP
0	82	0	0.377	2.39	0	0	55.32%	0	3.458	0
1.6	65	0.525	0.476	2.915	0.906	9.6%	53.44%	18.01%	4.217	0.759
3.2	57	1.050	0.542	3.44	0.516	16.02%	55.39%	30.52%	4.977	1.519
4.8	51	1.575	0.606	3.965	0.384	22.68%	57.10%	39.72%	5.736	2.278
6	44	1.969	0.703	4.359	0.357	24.44%	54.11%	45.17%	6.306	2.848
7.8	38	2.56	0.814	4.95	0.317	27.44%	53.07%	51.71%	7.161	3.703

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 kg

Brake power (B.P) $=\frac{2\pi N(W-S)\times 9.81\times R}{60000}=\frac{2\pi\times 1500\times 1.6\times 9.81\times 0.213}{60000}$

$= 0.525 kW$

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

$= (10/65) \times \frac{0.8596 \times 3600}{1000}$ kJ/hr

$= 0.476 kJ/hr$

Frictional power from graph (F.P) = 2.39Kw

Indicated power (I.P) = B.P + F.P = 0.525+2.39

$= 2.915\ kW$

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

$= \frac{0.476}{0.525}$

$= 0.9066 kJ/kW\ hr$

Brake thermal efficiency $\eta_{Bth} = \frac{B.P \times 3600}{FC \times CV}$

$= \frac{0.525 \times 3600}{0.476 \times 41250}$

$= 9.6\%$

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

$= \frac{2.915 \times 3600}{0.476 \times 41250}$

$= 53.44\%$

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

$= \frac{0.525}{2.915}$

$= 18.01\%$

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

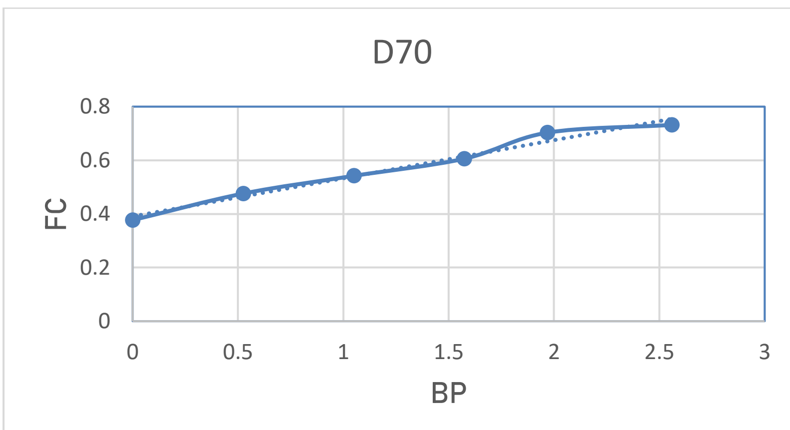
$$= \frac{2.915 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

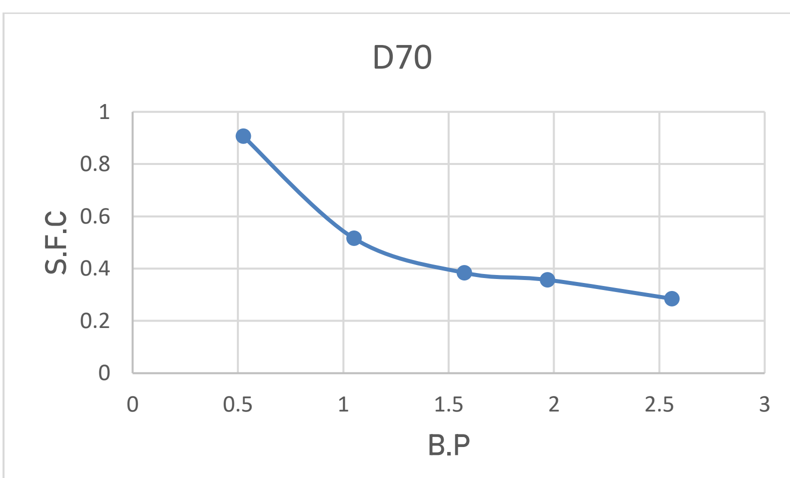
$= 4.317$ bar

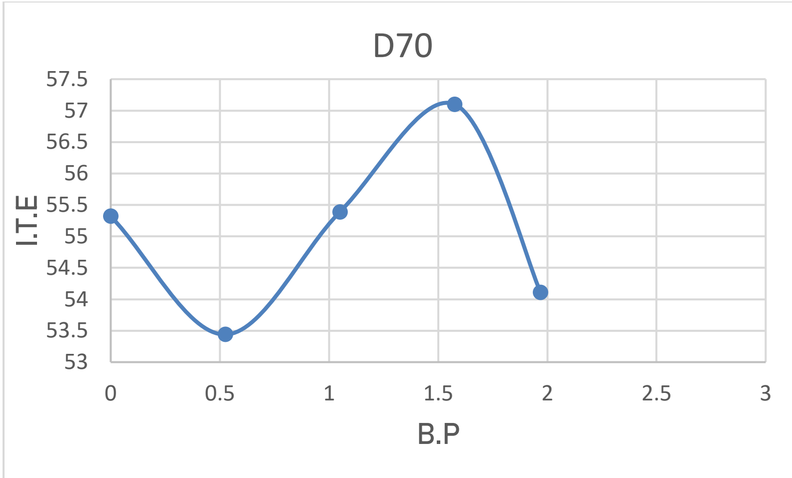
Brake mean effective pressure (BMEP) $= \frac{B.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

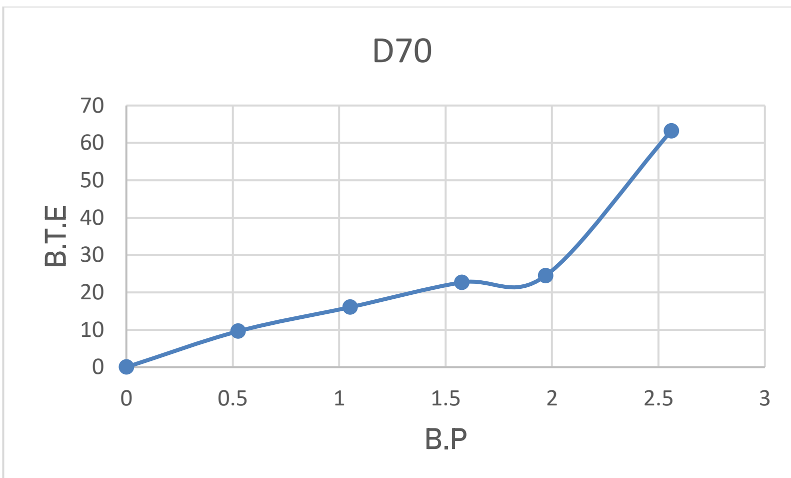
$$= \frac{0.525 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

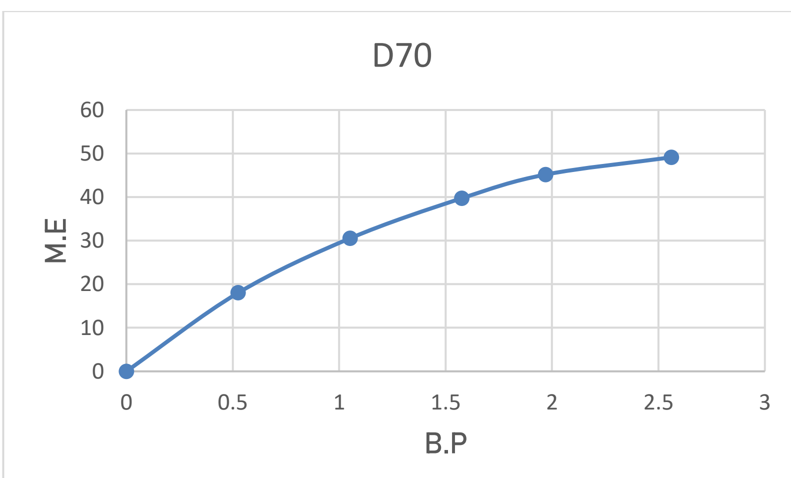
$= 0.75$ bar

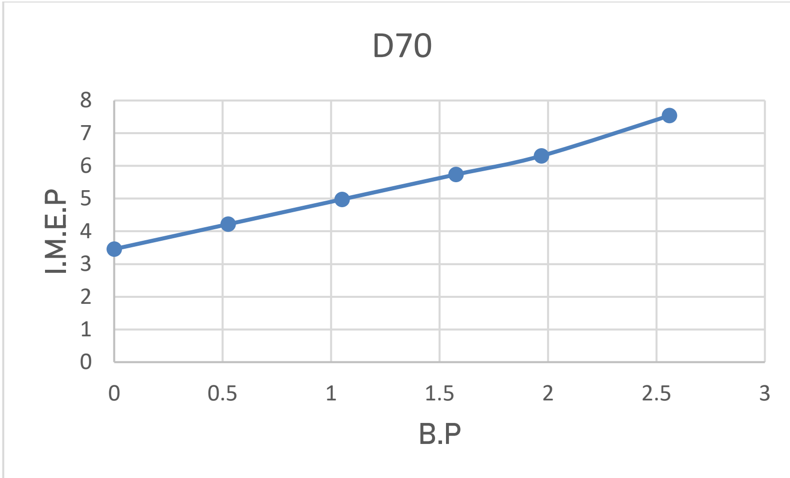


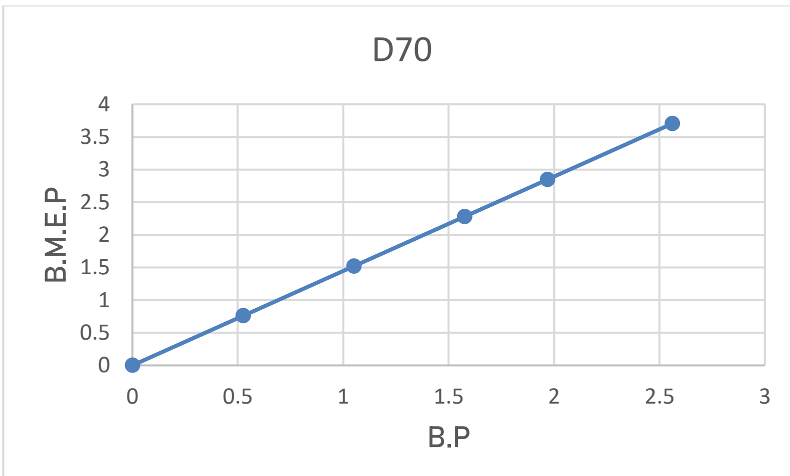



D70
I.T.E
57.5
57
56.5
56
55.5
55
54.5
54
53.5
53
0
0.5
1
1.5
2
2.5
3
B.P


D70
B.T.E
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
B.P


D70
M.E
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
B.P





10.2.4.D85:

W-S (kgf)	T (sec)	BP (kW)	FC (kg/hr)	IP (kW)	SFC (kg/kW hr)	Break thermal efficiency	Indicated thermal efficiency	Mechanical efficiency	IMEP	BMEP
0	77	0	0.398	3.1	0	0	68.75%	0	4.485	0
1.6	66	0.525	0.464	3.625	0.883	9.98%	68.95%	14.4%	5.24	0.759
3.2	57	1.050	0.538	4.15	0.512	17.22%	68.08%	25.3%	6.044	1.519
4.8	51	1.575	0.601	4.675	0.381	23.13%	68.66%	33.68%	6.764	2.278
6	44	1.969	0.697	5.069	0.353	24.93%	64.19%	38.84%	7.334	2.848
7.8	39	2.56	0.786	5.66	0.307	28.74%	63.56%	45.22%	8.189	3.703

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 kg

Brake power (B.P) $= \frac{2\pi N(W-S) \times 9.81 \times R}{60000} = \frac{2\pi \times 1500 \times 1.6 \times 9.81 \times 0.213}{60000}$

= 0.525kW

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

= (10/66) × $\frac{0.8596 \times 3600}{1000}$ kJ/hr

= 0.464kJ/hr

Frictional power from graph (F.P) = 3.1w

Indicated power (I.P) = B.P + F.P = 0.525+3.1

= 3.625 kW

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

$= \frac{0.464}{0.525}$

= 0.883kJ/kW hr

Brake thermal efficiency $\eta_{Bth} = \frac{B.P \times 3600}{FC \times CV}$

$= \frac{0.525 \times 3600}{0.464 \times 41250}$

= 9.98%

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

$$= \frac{3.625 \times 3600}{0.464 \times 41250}$$

= 68.95%

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

$$= \frac{0.525}{3.625}$$

= 14.4%

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

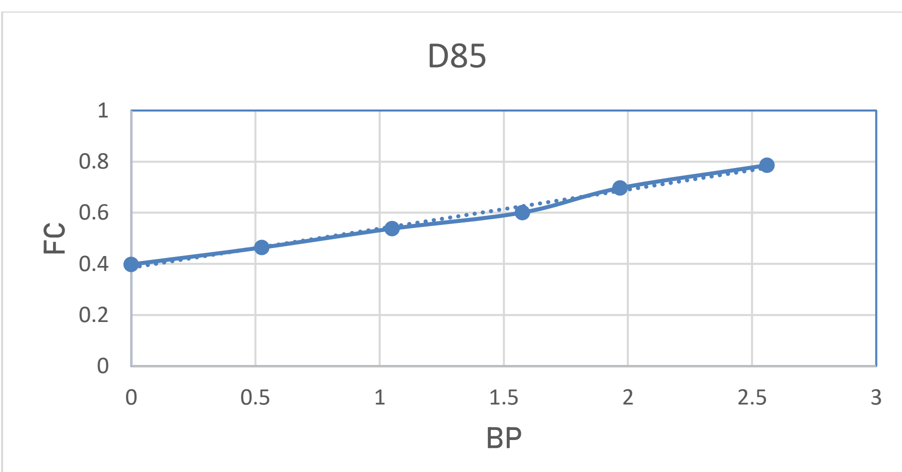
$$= \frac{3.625 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

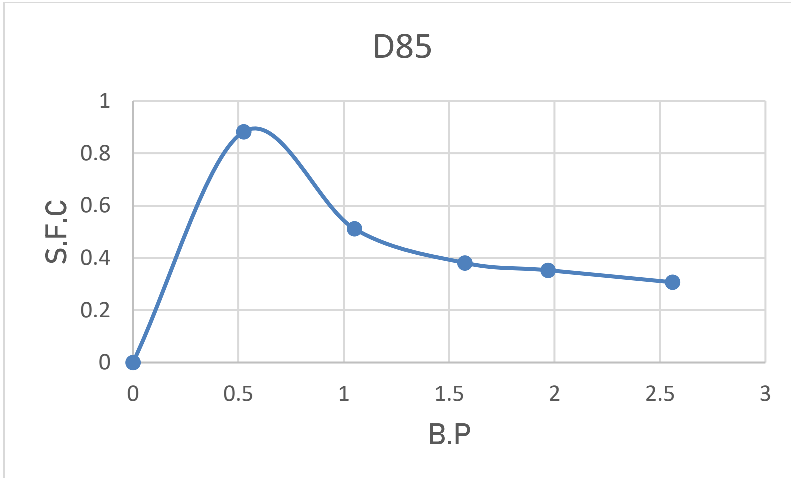
= 5.24 bar

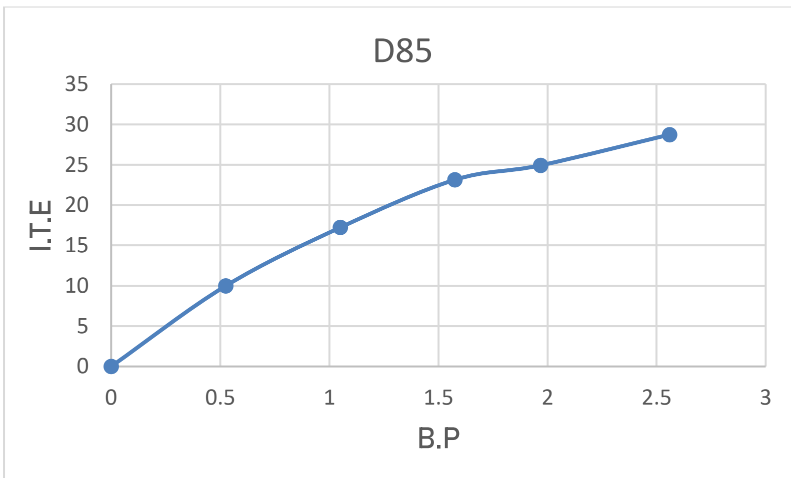
Brake mean effective pressure (BMEP) $= \frac{B.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

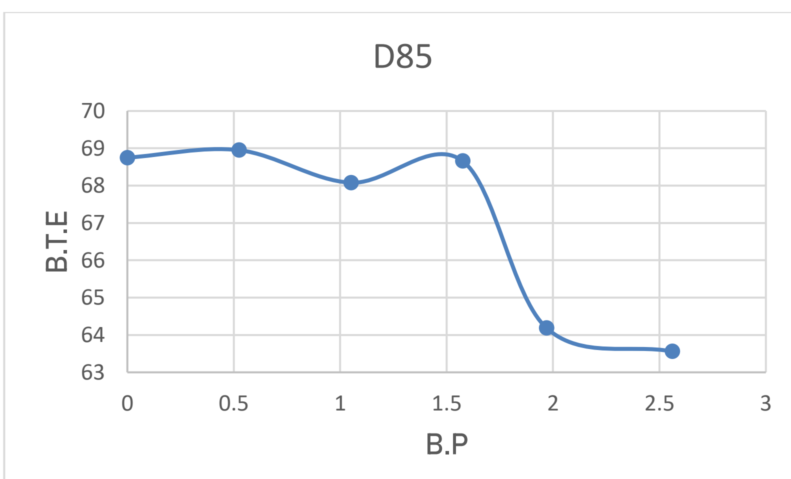
$$= \frac{0.525 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

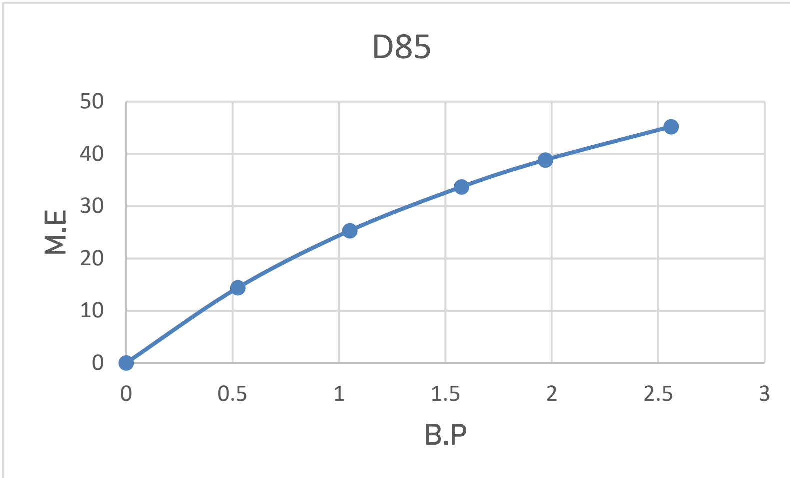
= 0.75 bar

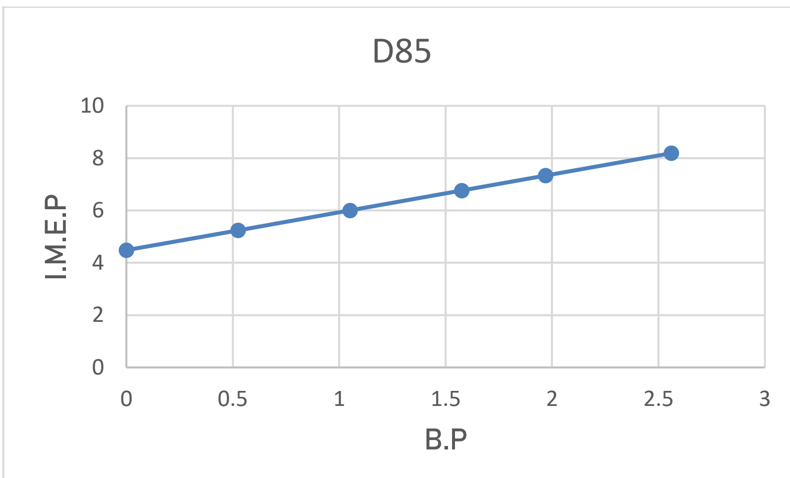


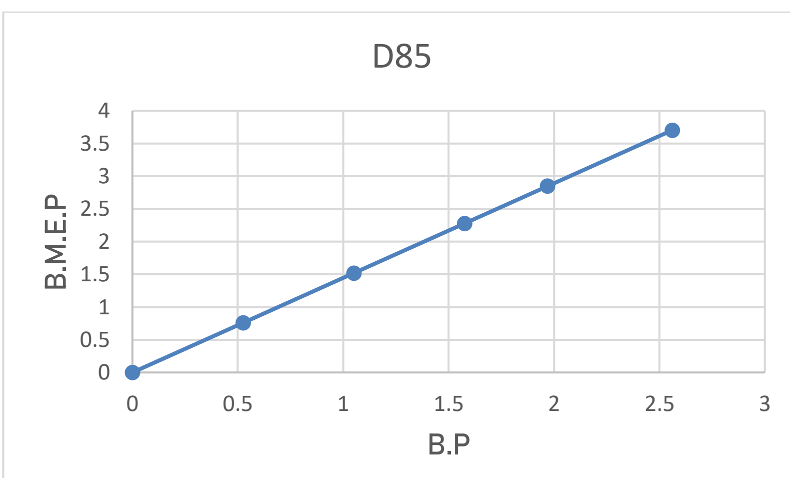

D85
S.F.C
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
B.P


D85
I.T.E
35
30
25
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
B.P


D85
B.T.E
70
69
68
67
66
65
64
63
0
0.5
1
1.5
2
2.5
3
B.P


D85
M.E
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
B.P


D85
I.M.E.P
10
8
6
4
2
0
0
0.5
1
1.5
2
2.5
3
B.P


D85
B.M.E.P
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
B.P

10.2.5.D80:

W-S (kgf)	T (sec)	BP (kW)	FC (kg/hr)	IP (kW)	SFC (kg/kW hr)	Break thermal efficiency	Indicated thermal efficiency	Mechanical efficiency	IMEP	BMEP
0	77	0	0.400	3.1	0	0	67.09%	0	4.485	0
1.6	65	0.525	0.474	3.625	0.904	9.6%	66.34%	14.48%	5.24	0.759
3.2	57	1.050	0.541	4.15	0.515	16.83%	66.54%	25.3%	6.044	1.519
4.8	50	1.575	0.617	4.675	0.391	22.14%	65.72%	33.68%	6.764	2.278
6.2	45	2.034	0.685	5.134	0.336	25.75%	65.01%	39.61%	7.428	2.942
7.9	39	2.592	0.812	5.692	0.331	27.69%	60.8%	45.37%	8.235	3.75

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 kg

Brake power (B.P) $= \frac{2\pi N(W-S)\times 9.81\times R}{60000} = \frac{2\pi\times 1500\times 1.6\times 9.81\times 0.213}{60000}$

= 0.525kW

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

= (10/65) $\times\frac{0.8574\times 3600}{1000}$ kJ/hr

= 0.474kJ/hr

Frictional power from graph (F.P) = 3.1w

Indicated power (I.P) = B.P + F.P = 0.525+3.1

= 3.625 kW

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

$= \frac{0.474}{0.525}$

= 0.904kJ/kW hr

Brake thermal efficiency $\eta_{Bth} = \frac{B.P \times 3600}{FC \times CV}$

$= \frac{0.525 \times 3600}{0.474 \times 41500}$

= 9.6%

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

$= \frac{3.625 \times 3600}{0.474 \times 41500}$

= 66.34%

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

$= \frac{0.525}{3.625}$

= 14.4%

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

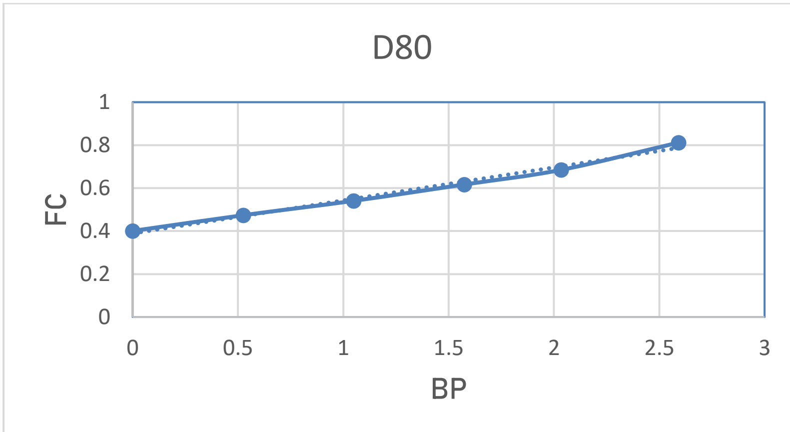
$= \frac{3.625 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times \frac{1500}{2}}$

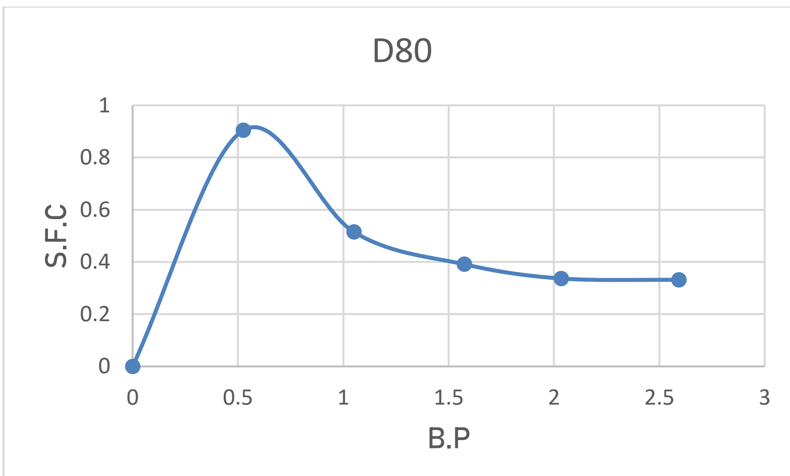
= 5.24 bar

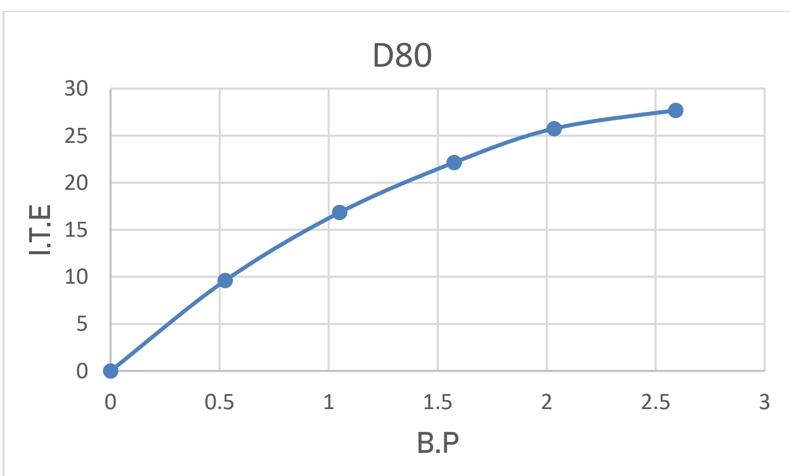
Brake mean effective pressure (BMEP) $= \frac{B.P \times 60000}{L \times \frac{\pi}{4} D^2 \times \frac{N}{2}}$ N/m^2

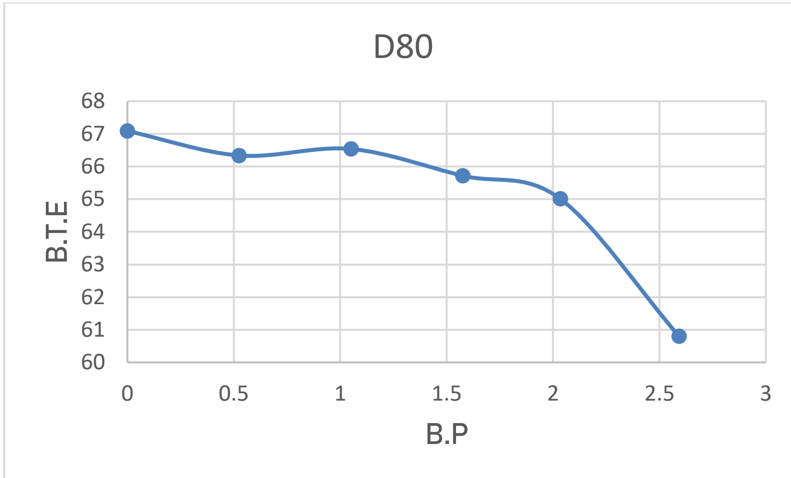
$$= \frac{0.525 \times 60000}{110 \times 10^{-3} \times \frac{\pi}{4}(80 \times 10^{-3})^2 \times \frac{1500}{2}}$$

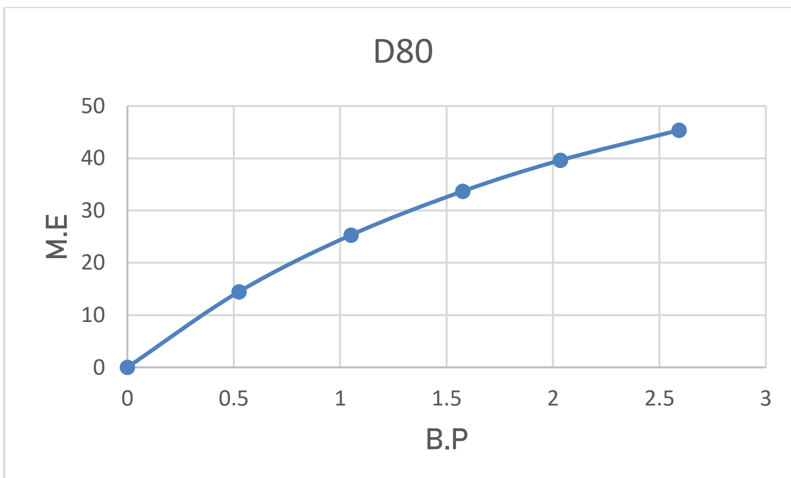
$= 0.75$ bar

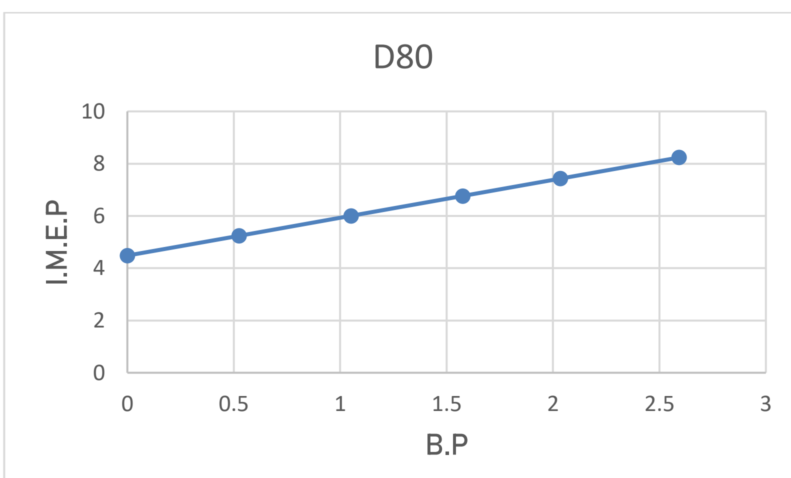


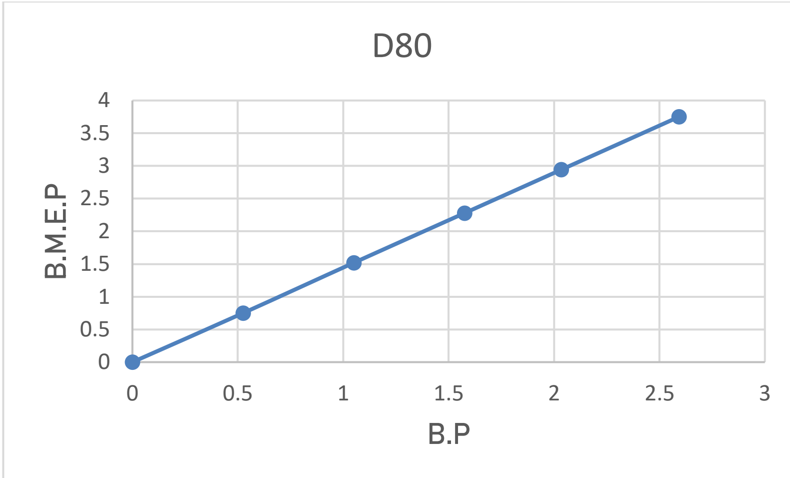





D80
B.T.E
68
67
66
65
64
63
62
61
60
0
0.5
1
1.5
2
2.5
3
B.P


D80
M.E
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
B.P


D80
I.M.E.P
10
8
6
4
2
0
0
0.5
1
1.5
2
2.5
3
B.P



10.2.6.D75:

W-S (kgf)	T (sec)	BP (kW)	FC (kg/hr)	IP (kW)	SFC (kg/kW hr)	Break thermal efficiency	Indicated thermal efficiency	Mechanical efficiency	IMEP	BMEP
0	85	0	0.361	2.65	0	0	62.98%	0	3.703	0
1.6	68	0.525	0.452	3.175	0.863	10.31%	62.38%	16.5%	4.593	0.759
3.2	58	1.050	0.53	3.7	0.504	17.59%	62.00%	28.37%	5.353	1.519
4.8	52	1.575	0.591	4.225	0.375	23.66%	63.49%	37.27%	6.112	2.278
6	45	1.969	0.683	4.619	0.346	25.6%	60.06%	42.62%	6.683	2.848
7.8	42	2.56	0.732	5.21	0.285	31.05%	63.21%	59.13%	7.538	3.703

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 kg

Brake power (B.P) $=\frac{2\pi N(W-S)\times 9.81\times R}{60000}=\frac{2\pi\times 1500\times 1.6\times 9.81\times 0.213}{60000}$

= 0.525kW

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

$= (10/68) \times \frac{0.853 \times 3600}{1000}$ kJ/hr

$= 0.452$kJ/hr

Frictional power from graph (F.P) = 2.65Kw

Indicated power (I.P) = B.P + F.P = 0.525+2.65

= 3.175 kW

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

$= \frac{0.452}{0.525}$

= 0.86kJ/kW hr

Brake thermal efficiency $\eta_{Bth} = \frac{B.P \times 3600}{FC \times CV}$

$= \frac{0.525 \times 3600}{0.452 \times 40535}$

= 10.31%

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

$= \frac{3.175 \times 3600}{0.452 \times 40535}$

= 62.38%

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

$= \frac{0.525}{3.175}$

= 16.5%

Indicated mean effective pressure (IMEP) $= \frac{I.P\times60000}{L\times\frac{\pi}{4}D^2\times\frac{N}{2}}$ N/m^2

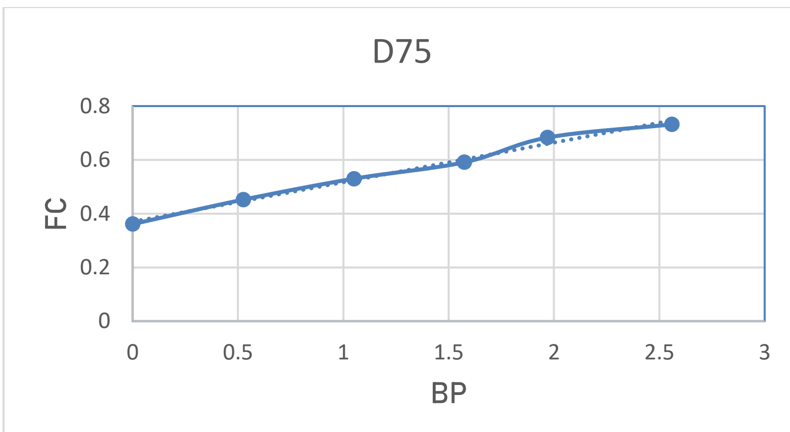
$$= \frac{3.175\times60000}{110\times10^{-3}\times\frac{\pi}{4}(80\times10^{-3})^2\times\frac{1500}{2}}$$

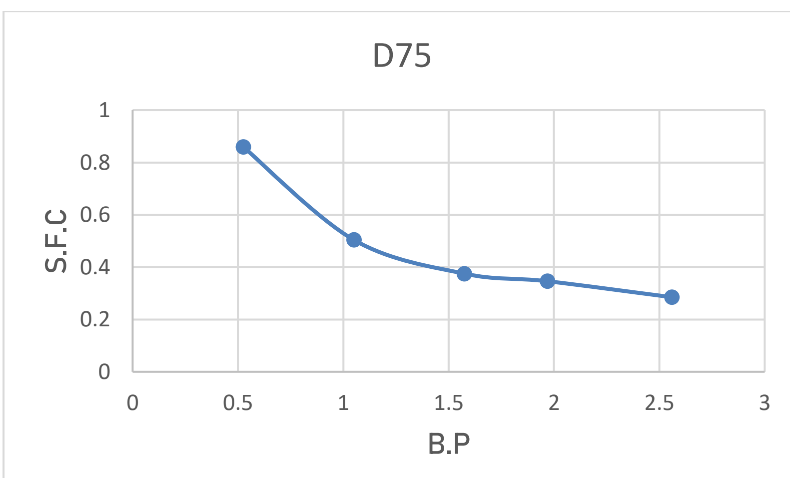
= 4.593 bar

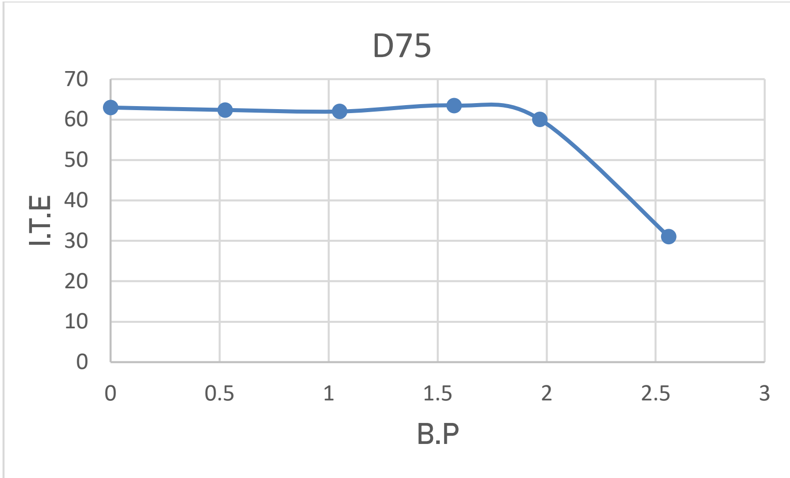
Brake mean effective pressure (BMEP) $= \frac{B.P\times60000}{L\times\frac{\pi}{4}D^2\times\frac{N}{2}}$ N/m^2

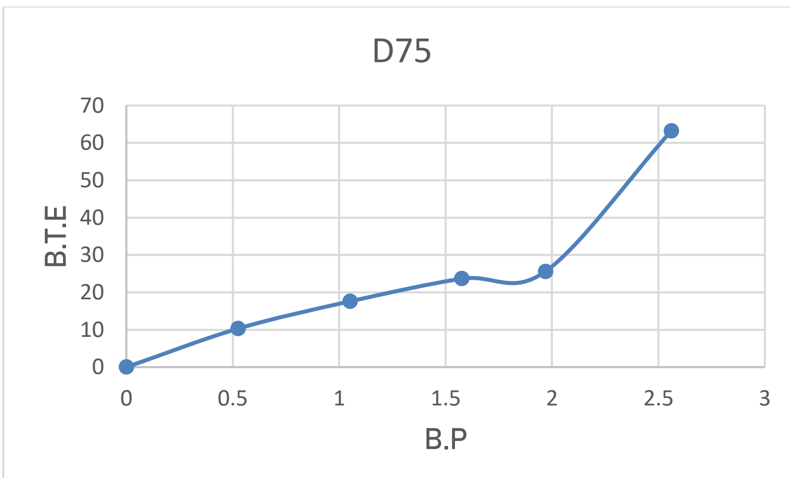
$$= \frac{0.525\times60000}{110\times10^{-3}\times\frac{\pi}{4}(80\times10^{-3})^2\times\frac{1500}{2}}$$

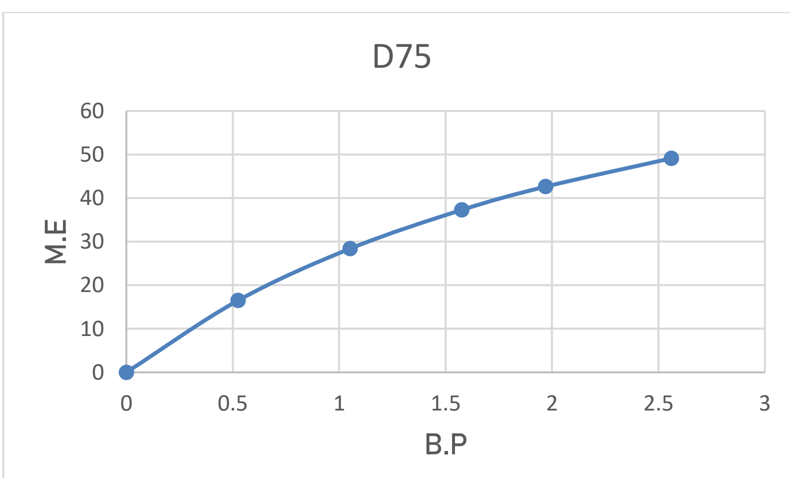
= 0.75 bar

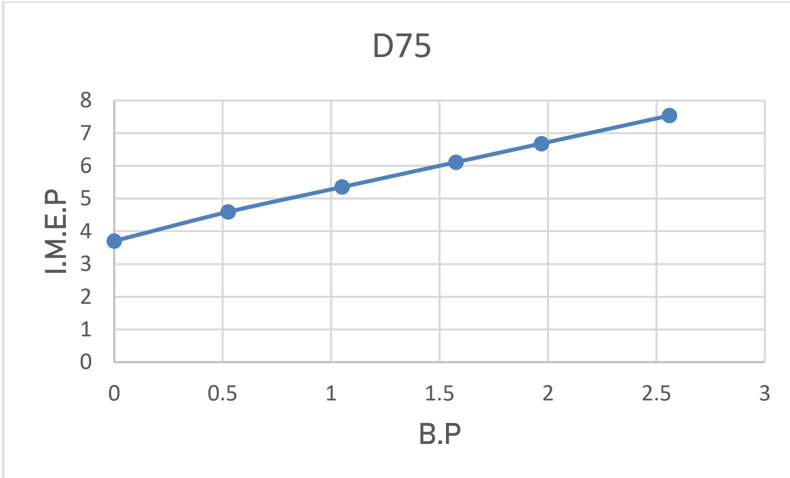




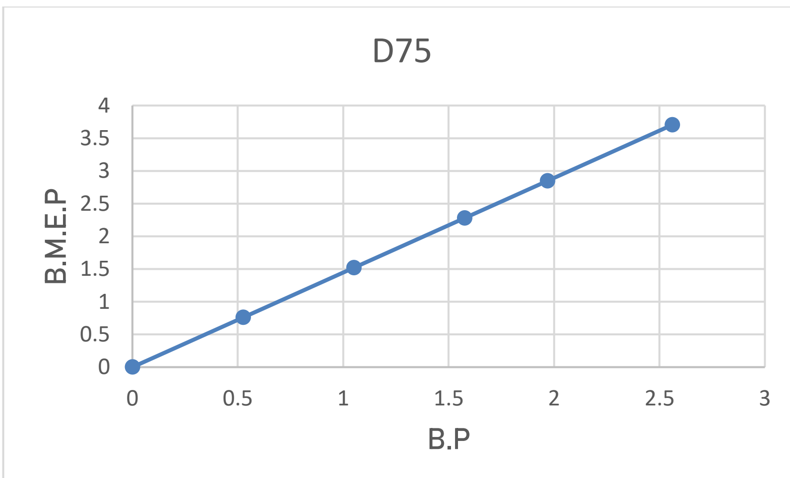

D75
I.T.E
B.P
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3


D75
B.T.E
B.P
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3


D75
M.E
B.P
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3



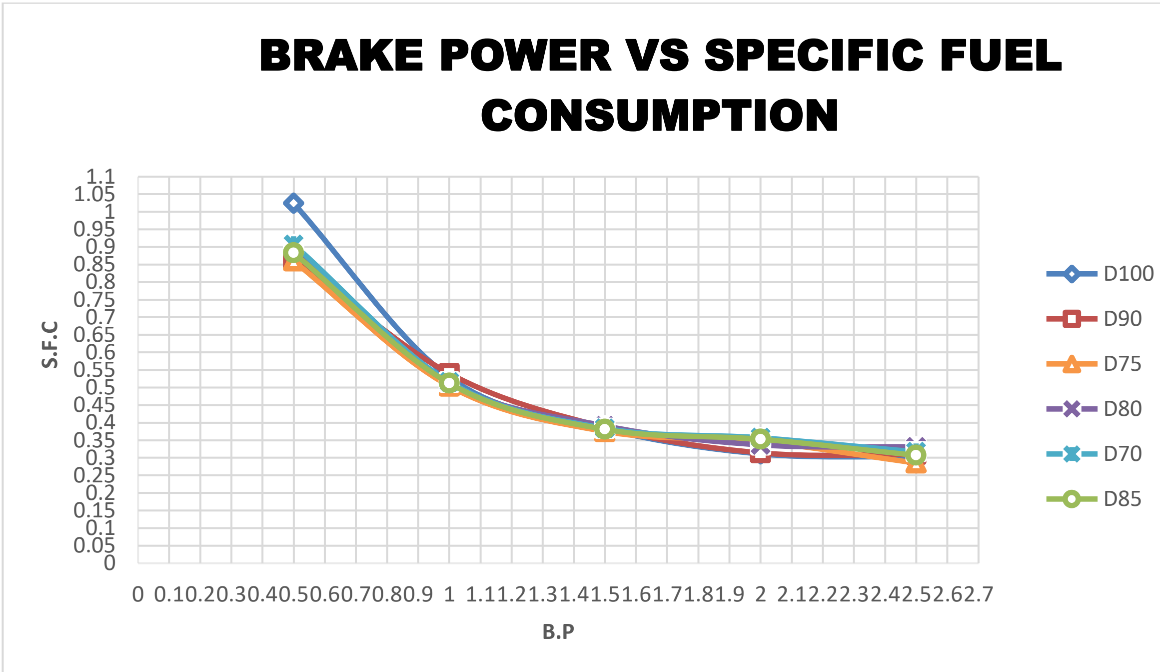
D75
I.M.E.P
8
7
6
5
4
3
2
1
0
0
0.5
1
1.5
2
2.5
3
B.P

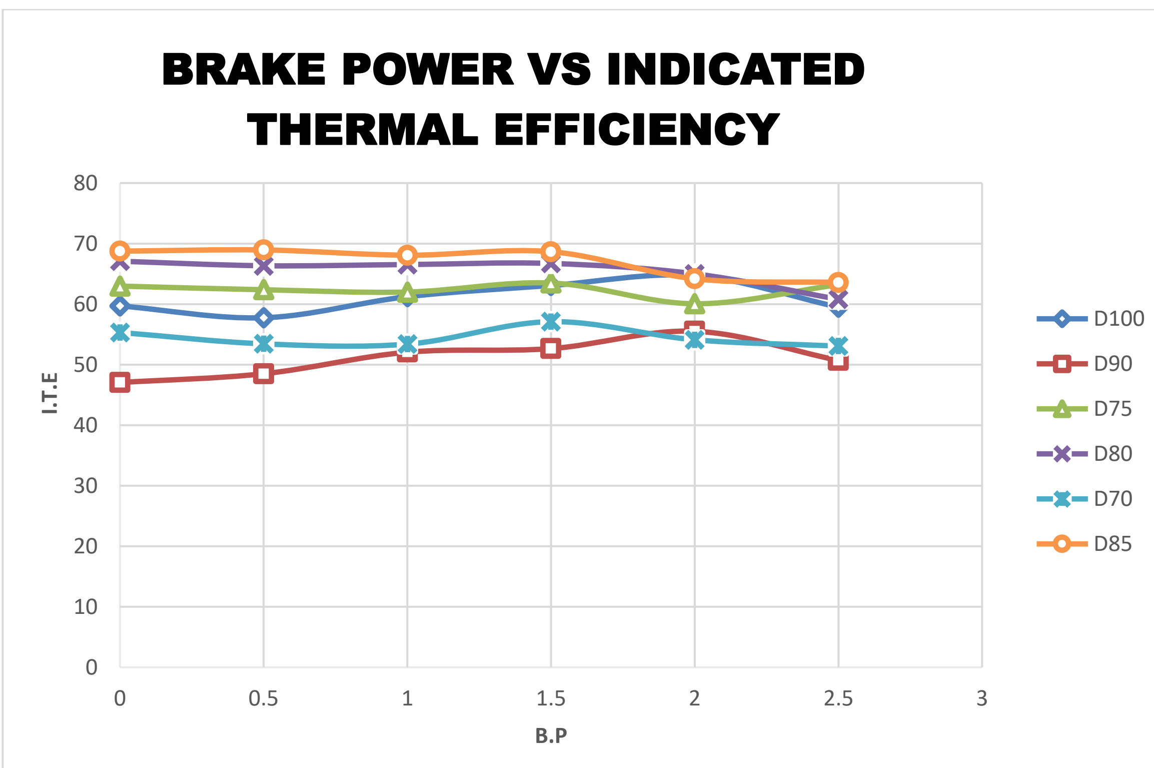


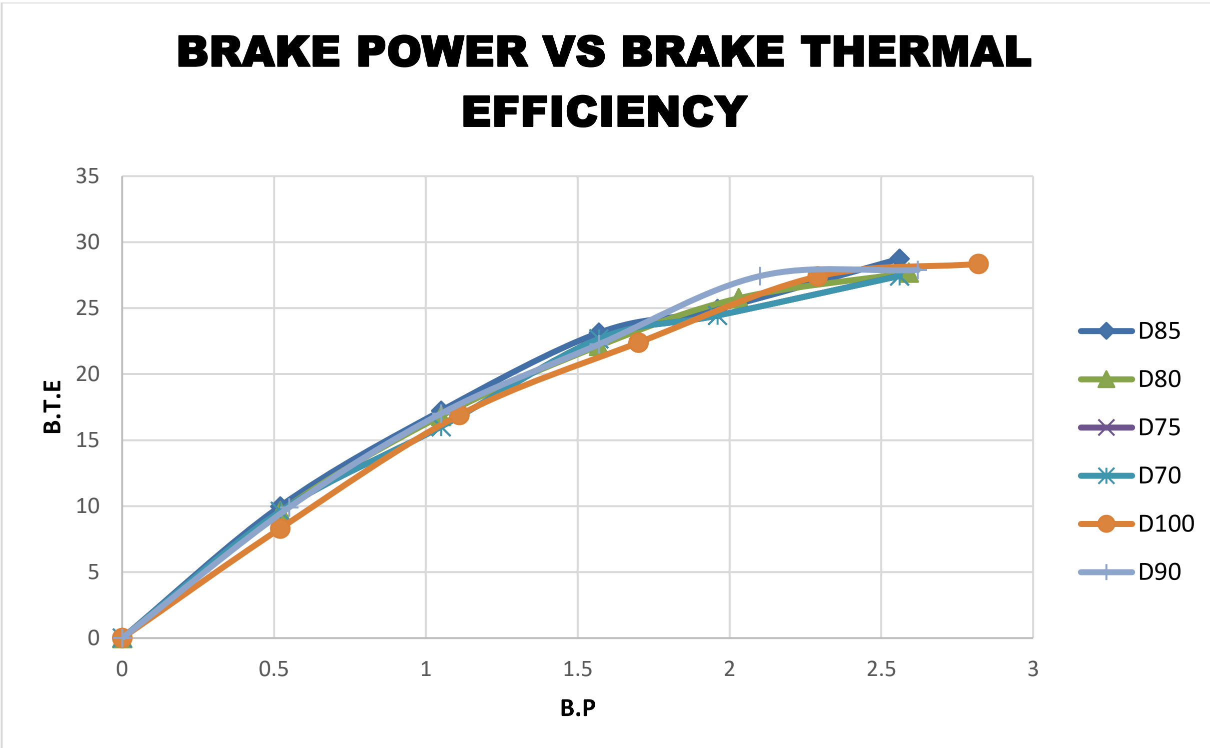
D75
B.M.E.P
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
B.P

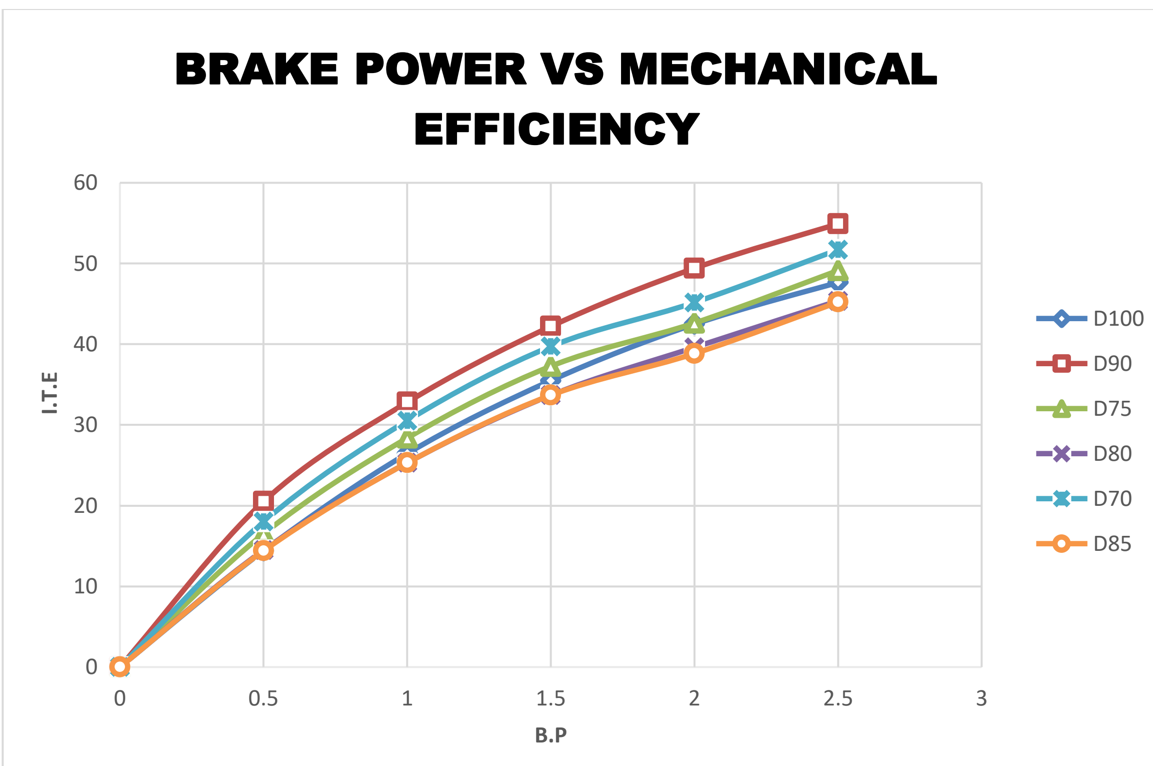
PERFORMANCE CHARACTERISTICS

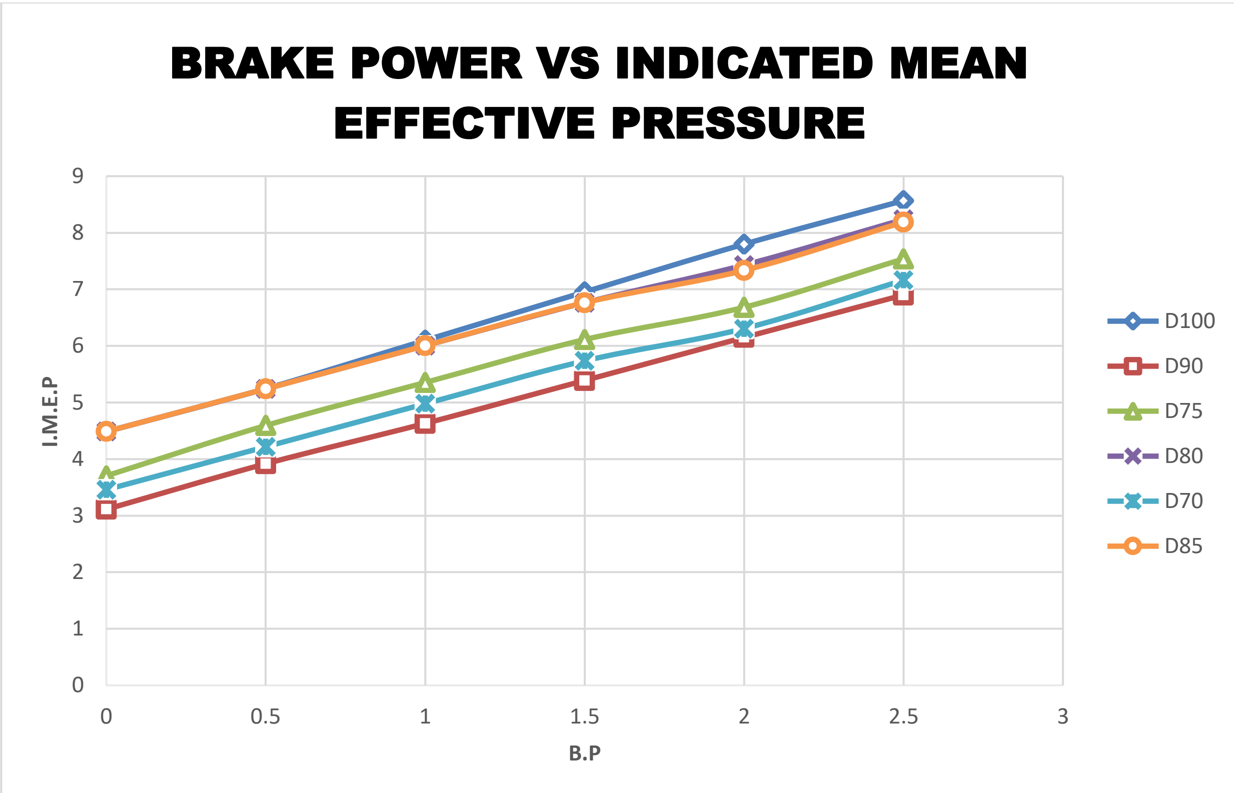
11. PERFORMANCE CHARACTERISTICS

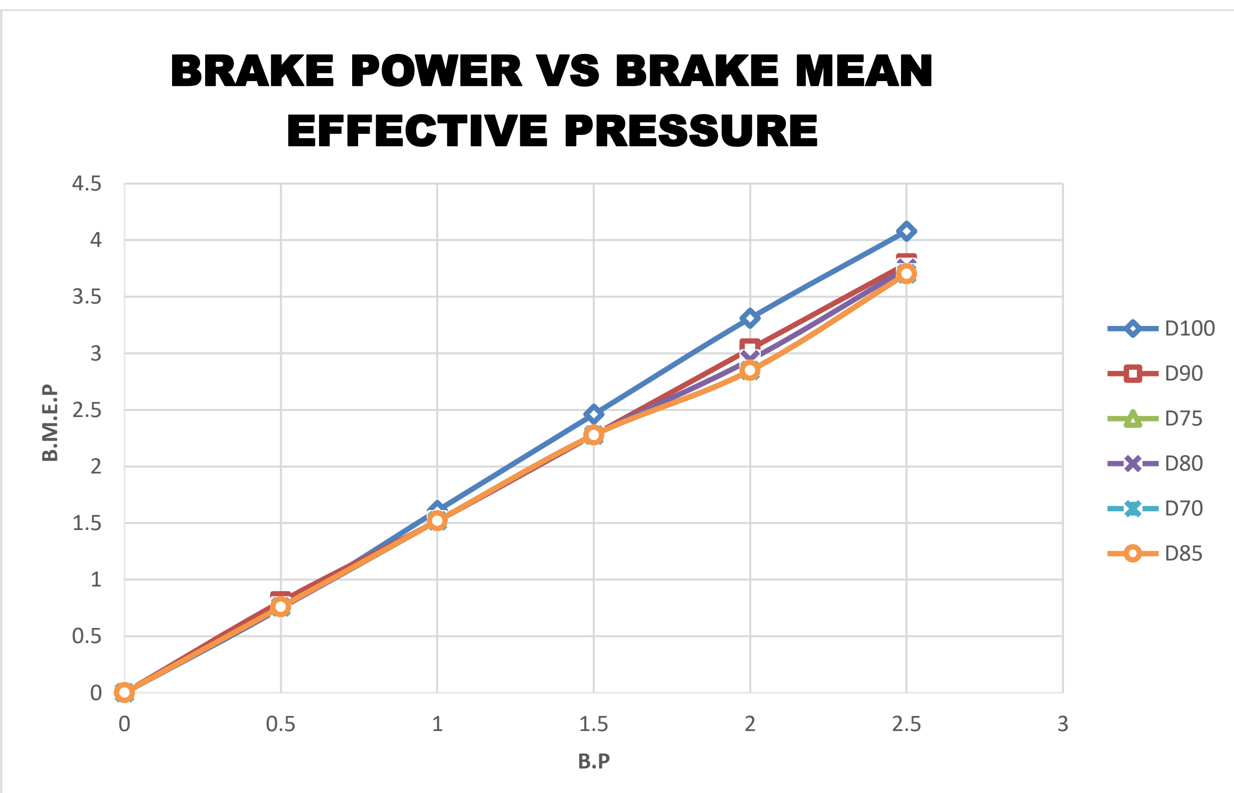





BRAKE POWER VS BRAKE THERMAL EFFICIENCY
B.T.E
35
30
25
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
B.P
D85
D80
D75
D70
D100
D90


BRAKE POWER VS MECHANICAL EFFICIENCY
I.T.E
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
B.P
D100
D90
D75
D80
D70
D85


BRAKE POWER VS INDICATED MEAN EFFECTIVE PRESSURE
I.M.E.P
B.P
9
8
7
6
5
4
3
2
1
0
0
0.5
1
1.5
2
2.5
3
D100
D90
D75
D80
D70
D85


BRAKE POWER VS BRAKE MEAN EFFECTIVE PRESSURE
B.M.E.P
B.P
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
D100
D90
D75
D80
D70
D85

RESULTS AND DISCUSSIONS

12. RESULTS AND DISCUSSIONS

A comparative analysis of diesel with different blends of diesel and transesterified corn oil with reference to the performance of the engine and cost of the fuel was taken up for experimental study and analysis. It has been observed that a right blend of two oils only gives best performance but is not economically viable. The following observations were made from graphs plotted:

1. It is found that frictional power which is generally function of speed of engine is also found to be variable which changes with composition. From experimentation, it is inferred that D90 blend has minimum losses in terms of mechanical power and power consumed by auxiliaries, which put together generally known as Frictional Power. Therefore D90 blend offers the best mechanical efficiency.
2. The specific fuel consumption varies directly with respect to fuel consumption. It is observed that at no loads, specific fuel consumption is less for D75 blend and also at higher loads D75 is found to be the best.
3. Indicated thermal efficiency of diesel engine varies inversely with fuel consumption rate. The lesser the fuel consumption, higher is the indicated thermal efficiency and vice versa. It is observed that at higher loads D85 offers higher indicated thermal efficiency.
4. All the blended samples are higher in cost when compared to the cost of conventional diesel fuel.

COST ANALYSIS: (1000 ML)

SAMPLE	PRICE(RUPEEES)
DIESEL	94.36
D90	100.024
D85	96.706
D80	105.688
D75	102.37
D70	111.352

CONCLUSION

13. CONCLUSION

The experimental study is conducted to evaluate and compare the blends of Corn oil biodiesel to conventional diesel fuel in single cylinder naturally aspirated vertical diesel engine.

The series of tests are conducted using each of fuels with the engine working at a constant speed of 1500 rpm and at different loads starting from no load. In each test fuel consumption, specific fuel consumption, thermal efficiency, mechanical efficiency and mean effective pressure are computed from measured flow rate and calorific value.

From the performance characteristics it is observed that when mechanical efficiency values are considered it is better to use D90 blend. But conventional diesel fuel still remains a economically viable option as price being lesser than the other blends. When specific fuel consumption is considered it is found that D75 has low specific fuel consumption than other blends. When indicated thermal efficiency is considered D85 is more preferable than other blends.

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