

EMISSION EXAMINATION ON CERIUM OXIDE NANO ADDITIVE AND GINGER GRASS OIL BLENDED WITH DIESEL IN CONSTANT SPEED DIESEL ENGINE

**Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering degree in Mechanical Engineering**

By

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**DEPARTMENT OF MECHANICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING**

**SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A” by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ARULSELVAN C. (37150019), ASHWIN KOWSHIK S. (37150022)** who carried out the project entitled “EMISSION EXAMINATION ON CERIUM OXIDE NANO ADDITIVE AND GINGER GRASS OIL BLENDED WITH DIESEL IN CONSTANT SPEED DIESEL ENGINE” under our supervision from ____.

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ABSTRACT

Demand for energy is a hot topic in both developing and developed countries. Every day, the demand for energy rises dramatically. As a result, an environmentally friendly alternative solution is required; Biodiesel is a promising alternative solution for this issue. The main purpose of this paper is to test and compare the performance of diesel engine using Ginger grass oil Biofuel blended with diesel, Cerium oxide is used as a catalyst. Ginger grass oil is esterified using the transesterification method. Then samples S1, S2, S3, S4, S5 were prepared using magnetic stir ration process. The measuring parameters are break power, break thermal efficiency, specific fuel consumption, and all emission parameter results shows that S5 gives better performance than D100 and other biodiesel samples.

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LIST OF ABBREVIATIONS

GG	Ginger grass oil
CSP	Coconut shell powder
SFC	Specific Fuel Consumption
BTHE	Break Thermal Efficiency
CO	Carbon monoxide
BP	Brake power
HC	Hydro carbon
NO _x	Nitrogen oxide
BMEP	Brake mean effective pressure
IMEP	Indicated Mean Effective Pressure
CeO ₂	Cerium Oxide
CV	Calorific value
RPM	Revolution per minute
B20	Ginger Grass Oil 20% with diesel 80%
O ₂	Oxygen
PPM	Parts per million

CHAPTER 1

INTRODUCTION

In recent years, there has been a lot of study on fuel consumption and pollution reduction. Because of the fluctuating price of fossil fuels and their depletion, there is an increasing interest in alternative fuels. Diesel engines are used as a main source in a variety of applications, including transportation, power generation, and marine applications. Owing to rapid population growth and lifestyle changes over the last century, the use of fossil fuels has increased. This results in fossil fuel depletion crises for diesel engines, necessitating the urgent development of suitable alternative fuels. In this project we will examine the use of Ginger grass oil in diesel four stroke engine. With diesel and different blends of Ginger grass oil, an attempt will be made to analyze the performance and emission characteristics of a diesel engine. The use of biodiesel leads to reduction in HC and CO emissions and increase in fuel consumption. When the Nano particles are used there will be an increase in thermal efficiency and decrease in NO_x emission. When biodiesel is used then there will be less emission compared to diesel. The effect of combining a vegetable oil-based additive with a metal-based additive on biodiesel-fueled 4-stroke diesel engine exhaust emissions.

1.1 BIOFUELS

The biofuels are produced from biomass. The biofuels may be in solid (vegetables wastes, and a fraction of the urban and industrial wastes) liquid (bio alcohols and biodiesel) or gaseous (biogas and hydrogen) form. Cereal crops (wheat, maize), oil crops (grape, palm oil), and sugar crops are used to make first-generation biofuels. The first-generation biofuel is biodiesel. Bioethanol, biogas, and pure vegetable oils are examples of first-generation biofuels. Lignocellulosic materials are used to render second-generation biofuels. Second-generation biofuels such as Biomass to liquid (BTL), Bio Dimethylether / Methanol, Biosynthetic Natural Gas, and biohydrogen use syngas generated by biomass gasification as a precursor. Second-generation biofuels include bio oil, which is produced by pyrolysis of biomass, and cellulosic ethanol.

1.2 BIODIESEL

The biodiesel refers to methyl or ethyl esters obtained by trans-esterification of animal fats or vegetable oils. Biodiesel can be blended with Petro diesel. In the case of mixtures, the respective proportion of biodiesel in Petro diesel should be indicated. B20 means a mixture 20% biodiesel and 80% petroleum diesel. B100 is pure biodiesel. Vegetable oil and waste cooking oil are the two main types of raw materials used in biodiesel processing. The cooking used oil is an important waste and it can be used for biodiesel production. However, the current trend is to use pure vegetable oils that have been grown for energetic purposes. Biodiesel is made primarily from conventional vegetable oils such as sunflower, grapeseed, soybean, ginger grass oil, coconut, and palm.

1.2.1 Solid Bio-Fuels

Converting solid bio-fuels to energy has been a long-standing human tradition, ranging from ancient fires to modern cooking stoves and electricity generation from biogenic residues burned to generate steam for high-pressure turbine power plants. Biomass gasification technology based on solid bio-fuels has become commercially viable in recent times for both - power generation and process heat applications in industry. Realizing the potential of gasification technology to meet the distributed power energy and industrial applications for process heat in Small and Medium Enterprises (SMEs), a number of large projects are under implementation in several countries. Interestingly, the market

Enterprises (SMEs), a number of large projects are under implementation in several countries. Interestingly, the market introduction of such technologies in developing countries is far more rapid such as India than in industrialized ones

Medium-to-large-scale biofuel cogeneration is already on the market, and gasification developments could support it, especially for industrial process heat and on-site cogeneration. With “hybrid” schemes and “bio-refineries” for multiple outputs becoming available in the next decade, power and fuel markets might well overlap or even merge, allowing the bio-energy industry to optimize their outputs according to market development, and revenue opportunities. With the emerging bio- and thermo chemical conversion systems for bio-energy, the bioenergy power and heat sector will be coupled more closely to the transport sector. Indirectly, the energy market

would be related to commodity prices for conventional agricultural and forestry products. This development would mean that the agro and forestry product industries will have to consider the developments in the bio-fuel markets far more closely, and then decide whether to become active in those markets. For this, there is a clear need of support for the decision-making process, especially for SMEs.

1.2.2 Liquid Bio-Fuels

Bio-ethanol and bio-diesel have emerged as dominating liquid bio-fuels on the global scale in replacing fossil fuels (i.e. gasoline and diesel) not only in the transport sector, but also with huge potential for heat and electricity generation. Bio-ethanol from biomass as a substitute for gasoline is currently the main biofuel globally as it has proven efficiencies, and established economics. Suitable biogenic feedstock contains high shares of sugar, or starch, which is catalyzed into simple sugars, and then fermented into ethanol. Sugar cane in particular stands as the feedstock that already provides a large amount of ethanol in Brazil. Cassava, maize, potatoes, sorghum, sugar beet, and wheat are some of the other crops that can be processed into ethanol. Since the conversion of their starch content into sugar needs a lot of energy, the product's cost is very large.

Oilseed-producing plants such as castor, cotton, jatropha, palm, grape, soy, and others provide a feedstock from which Straight Vegetable Oils (SVO) can be extracted through physical and chemical treatment (milling/refining). The SVO can then be processed further into Fatty Acid Methyl Esters (FAME), also known as bio-diesel. With respect to future market potentials, smaller-scale bio-fuel cogeneration systems with diesel engines using liquid bio-fuels (SVO or FAME) as inputs become attractive additional options, especially for stand-alone and mini-grid applications in developing countries as well as for “green” electricity generation in industrialized nations. For developing countries, it is potentially valuable that bio-diesel can also be derived from plants such as Jatropha, which show comparatively low yields, but need only minor inputs so that their overall costs might be moderate if land and labour costs are low. Jatropha can also be grown on marginal and even degraded land, and needs only little irrigation during the first years.

1.2.3 Gaseous Bio-Fuels

Development of Biogas has reached far beyond the mere fermentation of biomass residues like dung, liquid manure, or organic household wastes: It can now be obtained from “modern” bio-energy crops such as maize (or corn), wheat, and, more intriguingly, industrial wastes, as well as from mixed or double cropping farming systems that can incorporate various “old” plant varieties into their rotation and produce net energy yields comparable to the best palm oil or sugarcane plantations. High rate bio-methanation process has been applied in many countries to obtain biogas from industrial wastes as well as from liquid municipal wastes for use on a commercial basis to generate power or process heat. India through its nationwide program of biogas installations proved success of their technology

1.3 BIODIESEL PRODUCTION

The commercial method used for the biodiesel production is the trans-esterification (also called alcoholysis). Trans-esterification is the reaction of oils or fats (triglycerides with 15 to 23 atoms, with 18 being the most common) with a low molecular weight alcohol (usually ethanol or methanol) and an alkaline catalyst (usually NaOH or KOH) to create esters and glycerin. Normally, the reaction occurs at ambient pressure and a temperature of 65°C. During the process, continuous agitation is used for one to twelve hours at a time. The trans-esterification consists of three consecutive and reversible reactions (Figure 1). The stoichiometric ratio for the trans-esterification reaction is three moles of alcohol and one mole of triglyceride (Figure 2). In order to move the reaction to the methyl esters formation an extra amount of alcohol is added. Glycerin is also formed in the reaction.

1 oil/fat + 3 methanol = 3 methyl esters + 1 glycerin Figure 2. Trans-esterification reaction

1.4 BIODIESEL FEATURES

The properties of biodiesel are determined by the feedstock used (new vegetable oil, waste cooking oils, animal fats, etc). The following are some of the biodiesel's most significant characteristics:

- It can be used in engines either pure or combined with petro-diesel.
- It can be used without any modifications in diesel engine
- it can be storage in the same containers than Petro diesel
- It can prolong engine life due to

the higher lubrication capacity • It improves combustion process. At least 11% oxygen is present in biodiesel. Biodiesel burns cleaner than petroleum diesel (with less unburned fuel emissions). There is less smoke generated. The use of biodiesel would result in a 90% reduction in unburned hydrocarbon (HI) emissions. • It generates employment • It lubricates moving engines • It is Biodegradable • It does not contain sulfur. • It produces no sulphur dioxide during combustion • It is less flammable than Petro diesel. • As compared to Petrol diesel, biodiesel releases less toxic gases into the atmosphere during combustion. Using biodiesel eliminates the health risks associated with petroleum diesel. PAH emission is reduced when biodiesel is used (identified as cancer causing). Biodiesel is absolutely healthy to drink.

Greenhouse gas advantage. The CO₂ cycle is closed, during the combustion of biodiesel. The CO₂ produced during the combustion is the amount of CO₂ which the plants are able to metabolize through photosynthesis during growth. Furthermore, since plants have a medium carbon content of 77.8% and animal fats have a medium carbon content of 76.1 percent, this phase results in low CO₂ emissions. The carbon content of fossil diesel, on the other hand, is 86.7 percent. The use of biodiesel can reduce the CO₂ emissions up to 50% in comparison to the use of petroleum diesel. • Since biodiesel has a flashpoint temperature of about 170°C, compared to 60 to 80 °C for petroleum diesel, biodiesel transport and storage are safer than petroleum diesel. • It has a good fragrance and is non-irritating to the skin.

Furthermore, other economic considerations may be considered in addition to those benefits:

a) Biodiesel contribute to diversification of energy sources. It is important for countries that do not have access to fossil fuels. b) Biodiesel helps to improve agriculture and rural areas. The following are the most important biodiesel drawbacks as opposed to fossil fuels: 1) The cost. The biodiesel production is today expensive compared with Petro diesel. 2) Due to its high cloud point, biodiesel requires more additives, particularly in colder climates. 3) There is a decline in long-term storage stability. Due to oxidation and bacterial air, the biodiesel becomes rancid. Aldehydes, ketones, and acids are produced during the rancidification process, all of which have strong and unpleasant odours. 4) Because of their lower

calorific capacity, biodiesel needs 1.1 litres to substitute one litre of petroleum diesel

5) Biodiesel blends with a high percentage of biodiesel can weaken and degrade some elastomers and natural rubbers. The materials in the fueling system must be handled with caution in this case. 6) Biodiesel has the ability to dilute engine lubricant oil. 7) The biodiesel produces more NO_x emissions than Petro diesel- a comparison of the emissions from biodiesel and Petro diesel is shown in table 4.

1.5 ADVANTAGES OF BIO-DIESEL

Biofuels are seen as a more sustainable alternative to conventional petrol and diesel derived from fossil fuels because they come from renewable sources, which also absorb carbon dioxide (CO₂), although CO₂ will be emitted because of energy used in the harvesting and production process. Studies indicate that the overall CO₂ savings from biofuels compared to conventional petrol and diesel vary between 20% to 70% depending on the type of crop and the energy consumed in growing, harvesting, transporting and processing the crop into a fuel.

- Biodiesel is the comparatively very clean and environmentally friendly only alternative fuel
- Biodiesel can run in any conventional unmodified diesel engine. It can also be kept in any place where petroleum /diesel fuel is kept.
- Biodiesel can be used alone or combined with petroleum diesel fuel in any ratio.
- Studies have found that the lifecycle production and use of biodiesel produces approximately between 80-100% less carbon dioxide and almost 100% less Sulphur dioxide emissions.
- β Combustion of biodiesel alone provides over a 90% reduction in total unburned hydrocarbons and a 75-90% reduction in aromatic hydrocarbons.
- Biodiesel also reduces particulates and carbon monoxide emissions far more than petroleum diesel fuel.
- Biodiesel provides a 90% reduction in cancer risks, based on Ames Mutagenicity tests
- Biodiesel has an oxygen content of 11% by weight and no sulphur. Since biodiesel is more lubricating than petroleum diesel fuel, it can prolong the life

of diesel engines while having no effect on fuel consumption, ignition, power output, or engine torque.

- Biodiesel is safe to treat and transport because it is as biodegradable as sugar, 10 times less toxic than table salt, and has a flashpoint of around 125 degrees Celsius, compared to 55 degrees Celsius for petroleum diesel fuel.
- Biodiesel can be made from renewable oilseed crops such as soybeans, grapeseed, cottonseed and mustard seed and non-edible oilseeds.

1.6 PROCESS DESCRIPTION

Biodiesel is made by trans esterifying oil with methanol (alcohol) and sodium hydroxide (NaOH) (catalyst). The following are the steps in the procedure:

- 1) We obtain the vegetable and waste cooking oils. They are transported to the plant with trucks.
- 2) The oils are stored in outside tanks of the plant.
- 3) Drying and pretreatment of the oil.
- 4) The oil trans-esterification.

The reactor is set to operate for 8000 hours a year, generating 200 tonnes of biodiesel per day. The refined oil is the first step in the process. The oils are combined with methanol and, if there is any left over, NaOH in the reactor (catalyst)

- 5) A mineral acid is used to neutralise the reaction products. Methanol in excess is evaporated, and then condensed and stored to be reused in the next cycle.

- 6) To avoid its oxidation, the biodiesel is stored in tanks with nitrogen coverage. The truck load is performed under nitrogen injection to avoid its degradation in transport.

1.7 ESSENTIAL OILS

The concentrated aromatic oils of plant leaves, buds, seeds, bark, roots, and the rinds of certain fruits are known as essential oils. They come in a variety of strengths, but they're all extremely strong, and they usually smell better when diluted (as in other oils, colognes, and shampoos). Essential oils derived from trees are

typically produced through a lengthy steam distillation process using either chopped wood or the tree's leaves and branch ends.

1.8 ESSENTIAL OIL SCENT CATEGORIES

The essential oil scents can be classified into the following categories:

1.8.1 Camphoraceous

A camphoraceous scent is a powerful floral, almost medicinal scent that is similar to camphor. Eucalyptus, frankincense, hyssop, marjoram, rosemary, sage, and, of course, camphor are all camphoraceous essential oils.

1.8.2 Floral

Floral scents are essential oils extracted from flowering botanical sources. Clary sage, chamomile, geranium, jasmine, juniper berry, lavender, rose, and ylangylang are among the essential oils used.

1.8.3 Mint

Mint family herbs are highly aromatic, and herbalists have long admired their fragrance. In reality, mint is known as "the herb of hospitality" in Greek mythology. Mint was used as an air deodorizer for the first time.

1.8.4 Musky

Musky essential oils have a solid, earthy aroma that is especially penetrating and titillating to our sense of smell. Myrrh, patchouli, and citronella are among them.

1.8.5 Spicy

Spicy essential oils are aromatic and invigorating, and they can liven up any place. Anise, basil, cinnamon, ginger, nutmeg, oregano, tea tree, thyme, and other essential oils have this fragrance.

1.8.6 Sweet

Our sweet-scented oils include citronella, grapefruit, Ginger grass, Ginger, lime, orange, and tangerine, and are one of the most common fragrance categories.

1.9 COMMONLY USED TYPES

Some of the most common essential oils among the hundreds available are:

1.9.1 Clary Sage

Helps to relieve hot flashes and promotes sleep

1.9.2 Eucalyptus

Clears congestion and colds

1.9.3 Lavender

Improves sleep and frequently used for relaxation

1.9.4 Ginger Oil

Ginger oil is widely used in the kinds of commercially available items you come across on a daily basis. Anything from household cleaner to hand soap to flavoured sparkling water with the essence of Ginger can be found in the aisles of any grocery store. The fragrance is similar to that of the citrus fruit from which it was derived, as is the case with many citrus oils: vivid, soft, zesty, and clean.

1.9.5 Peppermint

Best for treating headaches and other types of pain

1.9.6 Sweet orange oil

When inhaled, it decreased anxiety, and when applied topically, it slowed participants' heart rates and breathing rates, as well as making them feel more cheerful and enthusiastic.

1.9.7 Rosemary

A refreshing scent that boosts attention and focus.

1.9.8 Tea Tree

Treats fungal skin infections and it is also a spot treatment for acne.

1.9.9 Cinnamon oil

Cinnamon oil is sweet and spicy, musky and warm, while ginger oil is vivid, cold, and energizing. Cinnamon evokes a distinct combination of seductive exoticism and comforting familiarity in me, which makes sense given that it's both a Far Eastern import and a pantry staple.

1.10 TRANS-ESTERIFICATION

This process changes the molecular structure of lipid molecules and as a consequence, the physical properties are affected. Even though refined pure plant oil (PPO) can be used directly in refitted diesel engines, biodiesel, which is produced through a trans-esterification step, is very similar to fossil diesel and can thus be consumed in common diesel engines that are easily refitted. Trans-esterification, also known as alcoholysis, is the mechanism of separating the glycerine from processed oil molecules, resulting in glycerine soap and methyl or ethyl esters (biodiesel). Triglycerides are three hydrocarbon chains bound by glycerol that make up organic fats and oils. Hydrolysis breaks the bonds, resulting in free fatty acids. The methyl or ethyl fatty acid esters are formed when these fatty acids are mixed with methanol or ethanol (monocarbon acid esters).

The mixture separates and settles out leaving the glycerine on the bottom and the biodiesel (methyl-, ethyl ester) on the top. To prevent a reversed reaction, the separation of these two substances must now be completed fully and rapidly.

The addition of an acid or base also catalyses these trans-esterification reactions. The alcohols methanol and ethanol are primarily used in the trans-esterification process. Trans-esterification can potentially be achieved with higher or secondary alcohols. Considering wide variety of oils and fats that can be used to produce biodiesel, there is a greater range in the characteristics of biodiesel fuels than for ethanol fuel. Ethanol is a specific molecule, while biodiesel is a mixture of molecules that differ significantly depending on the oil or fat source used to make the fuel.

1.11 GINGERGRASS OIL

The Ginger Grass (*Zingiber officinale*) is a herbaceous perennial aromatic plant belongs to the family Zingiberaceae, mostly distributed in East Asia and tropical Australia, the rhizomes of which are used as a spice. Ginger was historically used in

Indonesia as a spice, a beverage ingredient, and a source of medicine. In the fields of medicine, ginger was used for treating various diseases such as colds, intestinal worms, gout, bronchitis, asthma, heart disease, and can be used to improve digestion. Ginger can also be processed to obtain the essential oil apart from its raw usage. The essential oil derived from ginger has many usage and advantages such as, it is proven to be an active antimicrobial not only for gram-positive bacteria but also for gram-negative bacteria and it has also proven having an antioxidant ability which makes it fit to be used as natural food preserver.



Fig:1.11 Ginger Grass raw Materials

Nutritional value per 100 g	
Energy	80kcal
Carbohydrates	17.7g
Fat	0.75g
Protein	1.82g
Vitamin A	6mg
Vitamin C	5mg
Minerals	Calcium 1.6%, copper 25%, iron 7.5%, magnesium 11%, zinc 3%

1.12 MAIN GINGER GRASS OIL EXTRACTION PROCESS

At present, there are 4 main extraction technologies for wheat germ oil processing: supercritical CO₂ fluid extraction, traditional solvent extraction, low temperature

pressing and subcritical low temperature extraction. But some of these methods contains some defects.

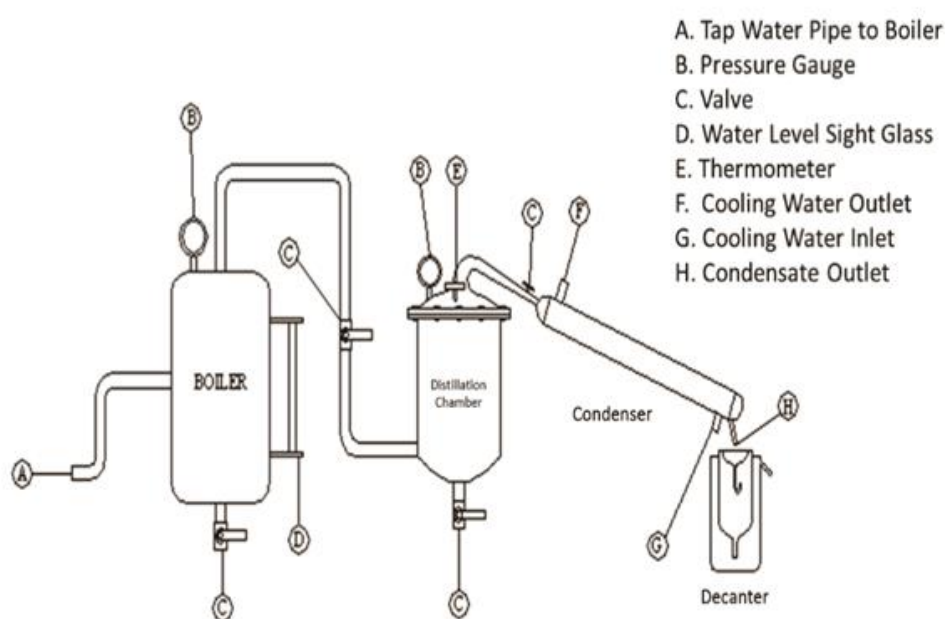
1.12.1 Supercritical CO2 fluid extraction

High Cost, Low Output: As its requirements for equipment is very high, supercritical CO2 fluid extraction machine is very expensive, apart from its low output and its difficulty to adapt to large-scale production.

High processing temperature, high energy intake, poor quality of oilcakes or meals with traditional solvent extraction (hexane). It's a method of extracting oil under normal pressure with the aid of hexane. The extraction and desolventizing processes are carried out at high temperatures, resulting in a high rate of protein degeneration in oilcakes or meals. Low-temperature oil pressing results in high residual oil content in oil cakes and meals, as well as high impurities and moisture content. For low oil yield materials like Ginger grass oil, direct squeezing or expelling is not recommended.

The oil is obtained from the leaves of the ginger grass plant by means of steam distillation. The oil is amber yellow in colour with fresh, citrus odour.

Fig 1.12.1 The Extraction Process of Ginger Grass oil



1.13 ADVANTAGES OF STEAM DISTILLATION EXTRACTION TECHNOLOGY

Steam distillation process was carried out in a custom sized distillation device coupled with an electrical steam boiler. Electrical steam boiler used 220 volts, 16-amperes worth electric current and capable of producing 20 bars (max) at 214°C of steam. The distillation device was equipped with custom sized condenser and glass decanter to separate oil from condensate. The scheme of the apparatus can be seen in Figure 1. The volume and diameter of distillation chamber were 16.5 liters, 256 mm respectively and using stainless steel with the thickness of 2 mm as the material. The distillation chamber was also equipped with a steam distributor which is mounted 700 mm from the bottom of the chamber and grating which is mounted 300 mm from the steam distributor, which is the place to put ginger rhizome. About 500 grams pre-treated rhizomes were placed on the grating inside the distillation chamber and 1.5 bar steam were used with the flow rate of 0.35; 0.55; 0.76; and 1.16 ml/s as the variable. These process conditions were based on the capacity of apparatus. The distillation process was maintained for 8 hours with measurement of the oil obtained in every hour. This process was repeated twice.

1.14 WHY GINGER GRASS OIL

India, China, and France are among the countries that grow the plant. The plant can also be found in Madagascar, Brazil, and a few Asian countries. After ten months of growth, the ginger grass plant is ready to harvest. It is a perennial plant that can reach a height of 9 feet.

The plant has been used since the 18 century in India. It's a herbaceous plant with long, elongated, slender stems that each have a flowering top at the end. The oil was used by ancient aroma therapists to alleviate tension and improve blood circulation. This oil has been used by Indian soap makers for decades.

1.15 ENGINE EXHAUST EMISSIONS PARAMETER

- a) Unburnt hydrocarbons
- b) Oxides of carbon
- c) Oxides of nitrogen
- d) Oxides of Sulphur

e) Particulates, soot and smoke

The first four are common to both SI and CI engines and the last two mainly from CI engines. Unburned hydrocarbons from the fuel tank and crankcase blow-by are the major non-exhaust pollutants.

For $\Phi < 0.8$, HC emissions also increase due to poor combustion and misfire. The generation of nitrogen oxide emissions is a function of the combustion temperature, highest near stoichiometric conditions when temperatures are at a peak value. Maximum NO_x emissions occur at slightly lean conditions, where the combustion temperature is high and there is an excess of oxygen to react with the nitrogen.

1.15.1 Hydrocarbon (HC)

CI engines have a lower total fuel lean equivalence ratio than SI engines, resulting in around one-fifth the HC emissions. On average, diesel fuel has a higher molecular weight than gasoline blend. Some HC particles condense-s onto the surface of the solid carbon soot that is generated during combustion, as the mixing and combustion process begins, the rest of this is burned. In addition to the solid carbon particles themselves, HC components condensed on the surface of the carbon particles contribute to the engine's HC emissions. CI engine has a combustion efficiency of only 2% of HC fuel being emitted. HC emissions are generated by CI engines for the same reasons as SI engines: wall deposit absorption, oil film absorption, and crevice depth.

1.15.2 Carbon monoxide (CO) emission

Carbon monoxide is a colorless and odorless gas but a poisonous gas. It is produced in an engine when it is operated with a fuel - rich equivalence ratio. When there is not enough oxygen to convert all carbon-to-carbon di oxide, some fuel is not burned, and some carbon ends up as Carbon monoxide. Not only CO is considered an undesirable emission, but it is also representing lost chemical energy.

Maximum CO is produced when an engine runs rich. CO emissions can also be caused by improper mixing, local rich causes, and incomplete combustion.

1.15.3 Oxides of Nitrogen (NO_x)

An engine's exhaust gases can contain up to 2000 parts per million of nitrogen oxides. NO_x is released into the atmosphere and reacts with ozone to form ozone, which is one of the main causes of photochemical smog. The majority of NO_x is generated by nitrogen in the air. Nitrogen is also found in fuel blends. NO can be formed by a number of possible reactions. Many of the limitations are most likely triggered by the combustion process. At low temperatures, oxygen and water vapour are stable, but at high temperatures, they become reactive and lead to the formation of NO_x. In addition to temperature, the formation of NO_x depends upon the pressure and the air- fuel ratio.

1.16 PERFORMANCE PARAMETER

1.16.1 Compression ratio

At the end of the compression stroke, there is an increase in the compression temperature of the air with increase in compression ratio. Also, at the minimum auto ignition temperature of a fuel decreases due to increased density of the compressed air. As a result of the closer interaction between the fuel and oxygen molecules, the reaction time is shortened.

1.16.2 Engine speed

The delay duration can be defined in terms of absolute time or crank angle degree. In a variable speed operation with a given fuel, the delay time in terms of crank angle degree decreases as the engine speed increases. As the engine operates at higher rpm, the degrees of crank travel in delay period increases. Due to the fact that the fuel pump is geared to the engine, the amount of fuel injected during the delay time is determined by the crank degree.

1.16.3 Output

As engine output increases, the air-fuel ratio falls, the operating temperature rises, and the delay time shortens. While the peak pressure reached is high, the rate at which the pressure increases is unchanged.

1.16.4 Injection timing

For three injection advance timings of 9, 18, and 27 degrees before TDC, the effect of injection advance on pressure variation was studied. The quality of fuel injected per cycle is constant, and it is determined by the injection pressure and temperature at the start.

1.16.5 Quality of fuel

The most significant property of fuel that affects the delay time is its self-ignition temperature. Furthermore, higher cetane fuels have a shorter delay time and smoother engine operation. Volatility, latent heat, viscosity, and surface tension are some other fuel properties that affect the delay time.

1.16.6 Engine Brake power

The engine brake power (P) is delivered by the engine and absorbed by the load. It is the product of torque and angular engine speed, where P represents engine brake power in kW and N represents engine angular speed in rpm, as follows:

$$P = \frac{2\pi NT}{60000}$$

1.16.7 Brake specific fuel consumption

The relation of an engine's performance with its fuel consumption in kg/kW/hr is known as brake specific fuel consumption (BSFC), where (mf) is the fuel consumption rate in kg/hr.

$$\text{BSFC} = \frac{\text{Fuel consumption rate}}{\text{Engine brake power}}$$

1.16.8 Break thermal efficiency

The percentage of the engine's brake thermal efficiency is proportional to the engine's brake power and total energy input.

$$\text{Brake power} \times 3600$$

$$\text{Fuel consumption rate} \times \text{Higher calorific value}$$

1.16.9 Intake pressure and temperature

The compressed air temperature rises as the intake temperature rises, resulting in a shorter delay time.

The auto ignition temperature is lowered by increased intake pressure or supercharging, resulting in a shorter delay period.

1.17 NOISE PARAMETER

1.17.1 Exhaust system noise

The noise from exhaust gas bursts exiting the muffler or trail pipe is included in the exhaust system noise, as is noise generated from the vibrating surface of the exhaust system part. Two types of excitation forces cause noise to be emitted from the surface of exhaust system components. Those created by pulsing exhaust gas flow and transmitted from the vibrating engine to the exhaust system.

1.17.2 Intake System Noise

The noise produced by the flow of air through the system air inlet, as well as noise emitted by the vibrating surface part, make up the intake system noise. In many instances in engine air cleaner will provide significant attenuation of intake air noise. An intake air silencer can be added to the system if further attenuation is required. Proper design, selection, and mounting of intake system components are needed to reduce surface radiated noise.

1.17.3 Engine Surface of Noise

The sound generated from the vibrating surfaces of engine components and accessories, as well as other items used in the engine exhaust, is referred to as engine surface noise. Reduced running clearance and engine machining tolerances

are among the intake and cooling system techniques used to minimize engine surface radiated noise. At high engine loads, part acoustical treatment or redesign, use of acoustic treated shields, vibrating isolation and damping of engine covers, and turbocharging of a diesel engine can both help to reduce engine surface radiated noise.

CHAPTER 2

LITERATURE SURVEY

2.1 GENERAL

1. R. SATHIYAMOORTHY: Applied Thermal Energy 2016

Effect of CeO₂ Nano additive on performance and emission characteristics of diesel engine fueled by neem oil-biodiesel

In this study BN20 (Biodiesel from Neem oil) and Cerium oxide blended BN20 (Diesel 80% and 20% Biodiesel from neem oil on volumetric percentage), and the results are compared with standard diesel fuel operation. The addition of Nano additive has resulted higher BSFC and BTE when compared to standard diesel fuel. In the case of emission, NO_x, Smoke, HC and CO emissions reduced considerably by the addition of Nano additive in the BN20 fuel blend

2. K. Nanthagopal : Energy conversion and management 2017

Influence of fuel injection pressures on Calophyllum inophyllum methyl ester fueled direct injection diesel engine

Experimental investigations with varying injection pressures of 200 bar, 220 bar and 240 bar have been carried out to analyze the parameters like brake thermal efficiency, specific fuel consumption, the experimental results revealed that brake specific fuel consumption of C. inophyllum methyl ester fueled engine has been reduced to a great extent with higher injection pressure.

3. Nidal H.: Fuel 2016

A comparative study of almond and palm oils as two bio-diesel fuels⁴ for diesel engine in terms of emissions and performance

Different fuel blends containing 0%, 10%, 30% and 50% on volume basis of almond biodiesel with diesel fuel were tested. Another fuel blend consist of 0%, 10%, 30% and 50% on volume basis of palm oil biodiesel in a palm biodiesel–diesel fuel were also tested. In terms of emissions, almond biodiesel resulted in lower carbon monoxide 43

(CO), oxides of nitrogen (NO_x), total particulate and unburned fuel emissions in the exhaust gas.

4. S. Nagaraja: Ecotoxicology and Environmental Safety 2017

Influence of fuel injection pressures on Calophyllum methyl ester fuelled direct injection diesel engine

The COME was blended together with diesel in different proportion percentages along with B20, B40, B60, B80, and B100. The emission and performance tests for various blends of COME was carried out using single cylinder, four stroke diesel engine. The results give clear information that COME has low exhaust emissions and increase in performance compared to D100 without any modifications

5. Tajidin et al., (2012)

reported that the effects of three maturity stages at harvest of Ginger grass on essential oil, chemical composition and citral contents. The Ginger grass plant was planted using a randomized complete block design with four replications, at the University Agriculture Park, University Putra Malaysia. The plants were harvested at 5.5, 6.5, and 7.5 months after planting. After harvest, the essential oil, chemical composition and citral contents were analysed using gas chromatography-mass spectrometry (GC-MS) analysis. Sanjay Patil and Akarte., (2012) presented that biodiesel as an alternative to diesel could reduce the dependency on petroleum products and the pollution problem. The physical properties of the fuel such as viscosity, volatility and flash point also affect the combustion process, thereby engine performance. Specifically, atomization of the fuel during the injection is attributed to higher viscosity of biodiesel. Injected fuel droplets get smaller as the injection pressure increases which contributes to better atomization of the fuel. Meiyappan Venkatesan., (2013) stated that investigation test were carried out to examine the performance and emissions of a direct injection diesel engine blended with Jatropa bio-diesel prepared with methanol to get jatropa oil methyl ester (JOME). Venugopal et al., (2014) found that plant species, like Ginger grass (*Cymbopogon citratus*) is discussed as source of oil for bio-diesel production. The bio-diesel that is produced from Ginger grass through Trans-esterification process is used as a fuel. Performance test was conducted and compared with diesel.

6. AvinashAlagumalai., (2015)

stated that the development of alternate fuels for use in internal combustion engines has traditionally been an evolutionary process in which fuel-related problems are met and critical fuel properties are identified, and their specific limits defined to resolve the problem. Murat KadirYesilyurt., (2019) found that the effect of fuel injection pressure on the performance and emission characteristics of a diesel engine fuelled with waste cooking oil biodiesel (WCOB) and its 5-30% (v/v) blends with diesel fuel were investigated and compared with diesel fuel. Materials and methods To select the suitable non edible oil for the experimental investigation. To select the suitable method for convert the biodiesel from Ginger grass oil. To select the suitable mixing proportion of Ginger grass oil blends with diesel fuel. The physical properties of the Gingergrass oil biodiesel blends are shown. To select the suitable injection pressure for enhance the diesel engine performance and emission. The biodiesel was extracted through trans-esterification process. The physical and chemical properties of the Ginger grass oil bio-diesel were tested through ASTM standards and compared with diesel fuel. The Gingergrass oil biodiesel was blended with diesel by various proportions such as B20, B40, B60, B80 and B100. The injection pressure was changed with 200, 210, 230, 240 bar and experimentally investigated the performance and emission characteristics. The experimental investigation were conducted on a single cylinder, water cooled, four stroke, Kirloskar TV-I diesel engine. In phase I, the investigations were conducted with various blends of Ginger grass biodiesel and found that optimum blend for further investigations. In Phase II the optimum blend of Ginger grass oil biodiesel (B20) was investigated with changing injection pressure and studied the performance, emission characteristics of test engine. The investigations were conducted with different loads and maintained 1500 rpm constant speed of the engine.

CHAPTER 3

AIM AND SCOPE OF WORK

3.1 AIM

To compare the performance and emission characteristics of DI engine using Nano-additives (nickel oxide) and (cerium oxide) as a catalyst in biodiesel blends with pure diesel and to determine the best combination of biodiesel blend for optimum performance and Emission.

3.2 SCOPE OF WORK

To Determine the parameters such as total fuel consumption and brake thermal efficiency and emission characteristics such as Nitric-Oxide, Oxygen, Carbon-dioxide, Hydrocarbon, Carbon-mono oxide and smoke density at different loads and brake power for pure diesel and various combination of Ginger grass oil mixed separately with CeO₂ and CeO₂ using AVL 5 di-gas analyze

CHAPTER 4

MATERIALS AND METHODS

4.1. MATERIALS

The crude Ginger grass oil collected from a local supplier to produce biodiesel. Table.1 Shows property of CI Crude oil and CIME Biodiesel.

The Nano additive used in this study were cerium oxide (CeO_2). The chemicals used for trans-esterification process are methanol, sulphuric acid as acid catalyst and potassium hydroxide as alkali catalyst. Table 1 shows the properties of diesel, crude CI and CIME.

4.2. BIODIESEL PRODUCTION

Crude oil contains 13.2% FFA by weight shows in table.1, so it cannot be directly treated with alkali-based catalyst and a 2-stage trans-esterification is required.

4.2.1. Stage 1: Esterification using acid catalyst

In this stage, the C.I oil having free fatty acid of triglycerides reacts with methanol and acid catalyst (sulphuric acid) to produce the ester. This stage of trans-esterification is carried out with a 16:1 M ratio of methanol to C.I oil along with 1% by weight of concentrated sulphuric acid at a temperature of 60 C. The reaction is performed for 60 min at a constant stir rate.

4.2.2. Stage 2: Esterification using alkali catalyst

In first stage itself, the concentration of FFA in the C.I oil is reduced to well below 0.5% by weight value, hence the second stage of trans-esterification is performed with alkali catalyst (potassium hydroxide). In this stage, a 6:1 M ratio of methanol to oil along with 1% by weight of concentrated potassium hydroxide at a temperature of 65 C is performed for 60 min duration at a constant stirring rate. In the second stage of esterification, there was an increase in the yield of CIME and formation of soap is reduced to a great extent. During the trans-esterification reaction, the methanol gets trapped with the ester formed and this should be removed in order to increase the yield of CIME and this process is done by purification. In the purification process, the biodiesel is heated at 75 C for about 30 min duration to remove the trap.

The following materials used for this research, Ginger grass Oil, cerium oxide Nano powder, and pure Diesel. The below table.1 shows the properties of Ginger grass oil. And the table.2 shows trans-esterification results

Table 4.1: The Values of Raw Gingergrass Oil

S.NO	PROPERTIES	GINGER GRASS OIL
1	Density	0.855g/cc
2	kinematic viscosity	4.1cst
3	moisture content	0.013%
4	flash point	66.67°C
5	fire point	58°C
6	calorific value	36.279mj/kg

Table 4.2: Trans-esterification Report of Ginger Grass Oil

S.NO	PARAMETERS	RESULTS
1	Free fatty acid	0.33
2	Catalyst (NaOH) quantity	5grms
3	Oil to Methanol molar ratio	1:6
4	Temperature	60°C
5	Reaction time	90minutes
6	Yield	94.1%

4.3 PREPARATION OF NANOPARTICLE

Ultrasonicator is used to mix thoroughly the nanoparticles (CeO₂) and CeO₂ with the biodiesel from Ginger grass oil. The cerium oxide nanopartilces of an average size of

20 nm were used for this investigation. This Ultrasonicator technique is used to disperse the nano particles in the biodiesel mixture. 50 ppm cerium oxide and nickel oxide nano particle was weighed by using electronic weighing machine with an accuracy of 0.02 mg. This nano additive biodiesel mixture was held in the Ultrasonicator for about 30 minutes to ensure there were no power deposits at the bottom of the beaker.

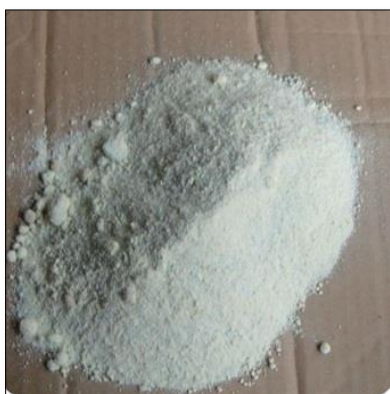


Fig:4.1 cerium oxide

4.3.1 Cerium Oxide (CeO₂)

Cerium Oxide is an oxide of Rare-earth metal, which has the chemical formula of CeO₂ and has the colour of pale yellow-white powder.

It's a valuable commercial product and it is also acts as an intermediate in the purification of the element from the ores.

The typical property of this material is its reversible conversion to a nonstoichiometric oxide

4.3.2 Properties of Cerium Oxide (CeO₂)

Chemical formula	CeO ₂
Molar mass	172.115 g/mol
Appearance	White or pale-yellow solid
Density	686 g/cm ³
Melting point	2600 °C
Boiling point	3468 °C
Solubility in water	Insoluble
Refractive index	2.2

Table 4.3: Properties of Cerium Oxide (CeO₂)

4.4 EXPERIMENTAL SETUP

Ginger grass oil is blended with diesel separately. Here in this investigation cerium oxide and nickel oxide is taken as Nano additives added separately. The engine loads at which the experiment will be conducted for 0% ,25%, 50%, 75%, 100%.



Fig 4.2: Ultrasonicator Device

4.5 BLENDS

S1=360ml diesel+40ml Ginger grass oil+30ppm ceo₂

S2=340ml diesel+60ml Ginger grass oil+30ppm ceo2

S3=320ml diesel+80ml Ginger grass oil+30ppm ceo2

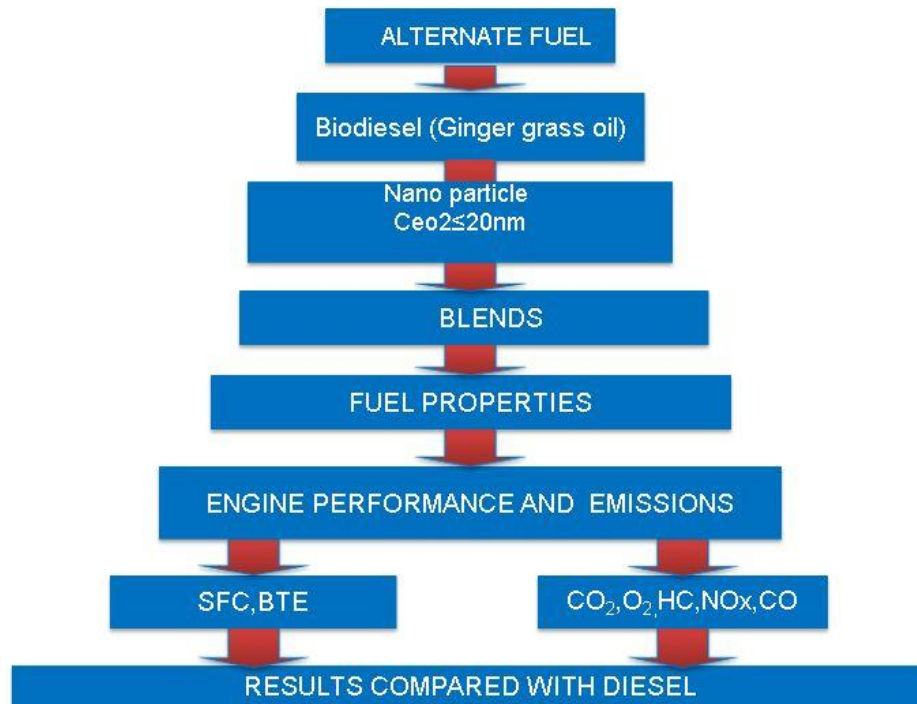
S4=300ml diesel+100ml Ginger grass oil+30ppm ceo2

S5=280ml diesel+120ml Ginger grass oil+30ppm ceo2

S.N O	PARAMETERS	S1	S2	S3	S4	S5
1	Density(g/cc)	0.818	0.845	0.834	0.836	0.902
2	Kinematic Viscosity@ 40°C (cSt)	1.32	1.44	1.39	1.43	1.49
3	Flash point by PMCC method (° C)	89	91	92	92	96
4	Fire point by PMCC method (° C)	102	104	105	106	109
5	Cloud point (° C)	1	1	2	-2	-3
6	Pour point (° C)	-15	-14	-15	-16	-17
7	Moisture content (%)	0.011	0.010	0.09	0.08	0.01
8	Calorific value (cal/g)	8815.556	8956.264	9062.324	9161.151	8991.698

Table 4.4 Properties of all sample

4.6 METHODOLOGY



4.7. ENGINE SETUP

The required collection of experimental data was obtained using a single-cylinder, 4-stroke, direct injection Kirloskar TV1 diesel engine with a maximum rated output of 5.20 kW at 1500 rpm. The compression ratio of the engine is 17.5. The engine has a swept volume of 661.45 cubic centimetres (cc), a bore diameter of 87.50 millimetres, and a stroke length of 110.00 millimetres. The injection pressure is held constant at 210 bar.

The test engine is a single cylinder four-stroke water-cooled diesel engine from Kirloskar TV1 Model that produces 3.5 KW at 1500 rpm. This engine is directly coupled to a water-cooled eddy-current dynamometer with a control system. “EnginesoftLV” an engine performance analysis software package is used for online performance evaluation. The exhaust gas temperature is measured by a K- type thermocouple in conjunction with a digital temperature indicator.



Fig:4.3 constant speed diesel engine

Engine model	Kirloskar TV1
Power	5.20 kW
Speed	1500 rpm
Number of cylinders	Single Cylinder
Number of strokes	4 strokes
Cooling system	Water Cooled
Cylinder Bore	87.50(mm)
Stroke Length	110.00(mm)
Compression Ratio	17.50
Swept volume	661.45 (cc)
Injection pressure	210 Bar

Table 4.5: Engine Specifications

On volume basis using a burette and stopwatch, the fuel flow rate is measured. The AVL 444 DI gas analyser is used to measure the exhaust emissions HC (hydrocarbon), CO (carbon monoxide).

4.7. AVL Gas Analyser



Fig:4.4 AVL Gas Analyser

AVL gas analyzer for CO, HC, CO₂, O₂, and lambda measurements. Pollution testing machines. Our customers are workshops, automobile engineering colleges IITs NITs RTA all engine manufacturer. It is a portable type that is used to calculate SO₂, NO, CO, CO₂, and O₂ concentrations in stack or boiler emission gases, with SO₂, NO, CO, and CO₂ measured by micro-flow infrared sensors and O₂ measured by an electrochemical sensor, with optional gas temperature, strain, velocity, and other parameters for measuring combustion efficiency, lambda, etc.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 SPECIFIC FUEL CONSUMPTION (SFC).

BP (%)	BP (KW)	D 100	S1 (B10+CeO ₂)	S2 (B15+CeO ₂)	S3 (B20+CeO ₂)	S4 (B25+CeO ₂)	S5 (B30+CeO ₂)
0	0%	2.48	7.12	6.84	5.99	4.9	4.06
0.87	25%	0.52	0.55	0.57	0.52	0.56	0.56
1.74	50%	0.38	0.38	0.37	0.38	0.38	0.40
2.76	75%	0.29	0.31	0.32	0.32	0.33	0.32
3.5	100%	0.2	0.26	0.1	0.19	0.19	0.26

Table 5.1: Specific fuel consumption in Kg/kWh.

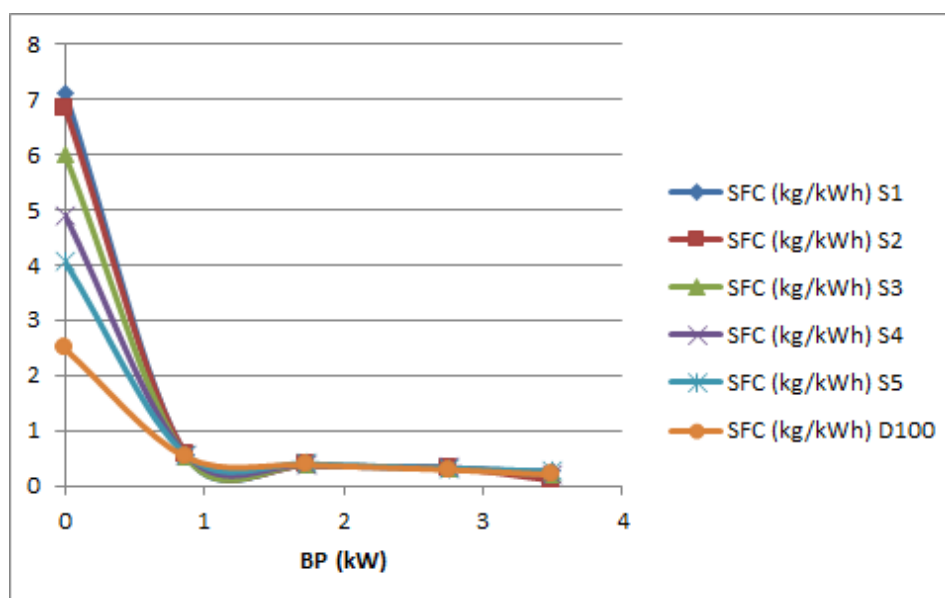


Fig 5.1: Specific fuel consumption in Kg/kWh.

The above bar chart compares the specific fuel consumption of Ginger grass and biodiesel with pure diesel at different break powers. there is no significant change in specific fuel consumption of both Ginger grass oil bio diesels and all the break powers. so, we can conclude from the bar chart that both Ginger grass oil with biodiesels and pure diesel has almost same specific fuel consumption.

5.2 BRAKE THERMAL EFFICIENCY (BTE).

BP (%)	BP (KW)	D 100	S1 (B10+CeO ₂)	S2 (B15+CeO ₂)	S3 (B20+CeO ₂)	S4 (B25+CeO ₂)	S5 (B30+CeO ₂)
0	0%	2.45	1.2	1.25	1.43	1.50	1.72
0.87	25%	16.49	15.73	15.12	16.5	16.72	16.93
1.74	50%	22.75	22.71	22.9	22.82	22.91	22.98
2.76	75%	31.71	27.23	26.84	26.87	26.97	27.72
3.5	100%	32.59	30.89	30.12	32.75	32.86	32.89

Table 5.2: Brake thermal efficiency in %.

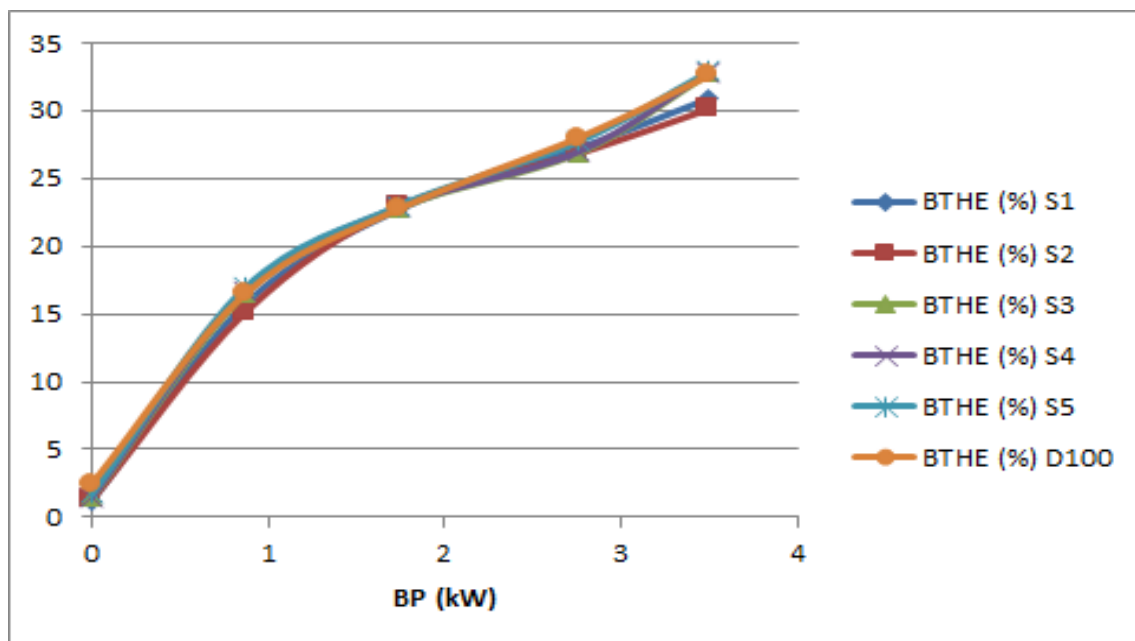


Fig 5.2: Brake thermal efficiency in %.

The effect of varying brake power on brake thermal efficiency is shown in Fig. 5.2. Indicated power and engine friction are essential for calculating the Brake thermal efficiency of the engine. The ratio of calculated performance to the performance of an ideal machine is used to calculate efficiency and it is fed into the computer as an input and converted into a force and movement output. As a result, mechanical efficiency shows how well the indicated power is converted into usable power. Sample (S2) gives the maximum Brake thermal efficiency for the maximum brake power. Sample (S3) also gives more brake thermal efficiency than Diesel at same brake power. But other two blends (S2 & S3) are had lower brake thermal efficiency than diesel.

5.3 NO_x EMISSION.

BP (%)	BP (KW)	D 100	S1 (B10+CeO ₂)	S2 (B15+CeO ₂)	S3 (B20+CeO ₂)	S4 (B25+CeO ₂)	S5 (B30+CeO ₂)
0	0%	138	82	75	57	49	36
0.87	25%	235	137	129	101	88	56
1.74	50%	432	223	200	174	151	120
2.76	75%	603	365	326	283	241	199
3.5	100%	1151	533	491	490	478	462

Table 5.3: NO_x Emission in ppm.

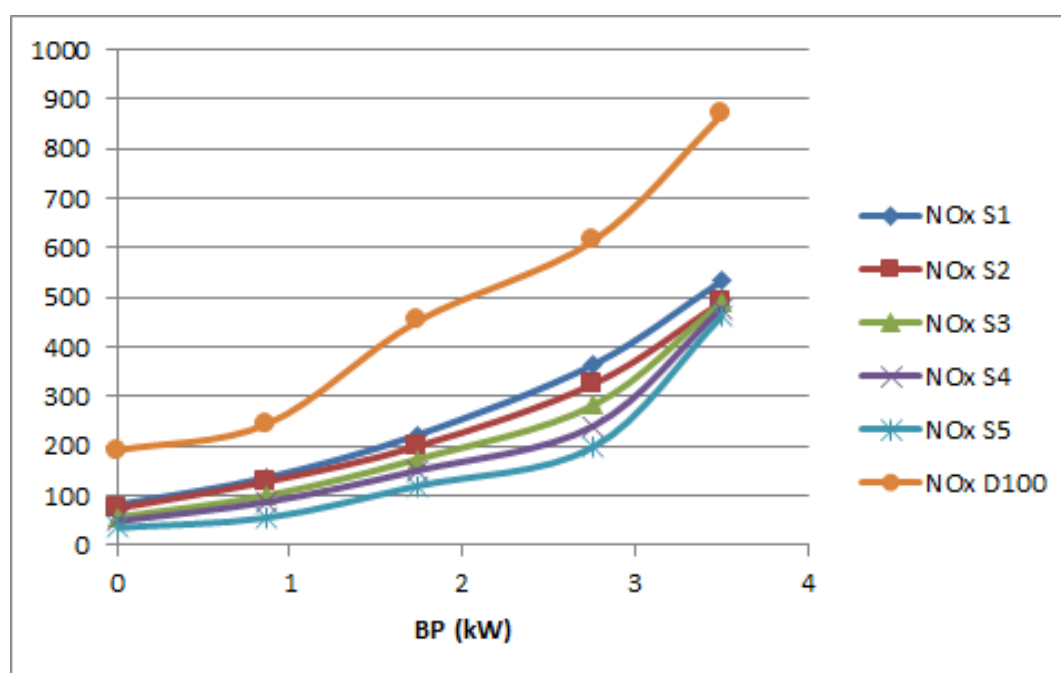


Fig 5.3: NO_x Emission in ppm.

The above bar chart compares NO_x emission of both and Ginger grass biofuel with pure diesel at all break powers. A30 and C30 produces NO_x lesser Than D100. A10 produces higher NO_x more than 1100 ppm. C10 A20 and produces NO_x very similar to D100 at 3.1kw break power.

5.4 CO₂ EMISSION.

BP (%)	BP (KW)	D 100	S1 (B10+CeO ₂)	S2 (B15+CeO ₂)	S3 (B20+CeO ₂)	S4 (B25+CeO ₂)	S5 (B30+CeO ₂)
0	0%	2.09	1.19	1.06	1.04	1.03	1.01
0.87	25%	2.73	1.59	1.37	1.23	1.12	1.06
1.74	50%	3.61	1.77	1.71	1.91	1.97	2.02

2.76	75%	3.69	2.25	2.07	2.05	2.02	2.06
3.5	100%	5.32	2.62	2.57	2.65	2.63	2.65

Table 5.4 CO₂ Emission in ppm.

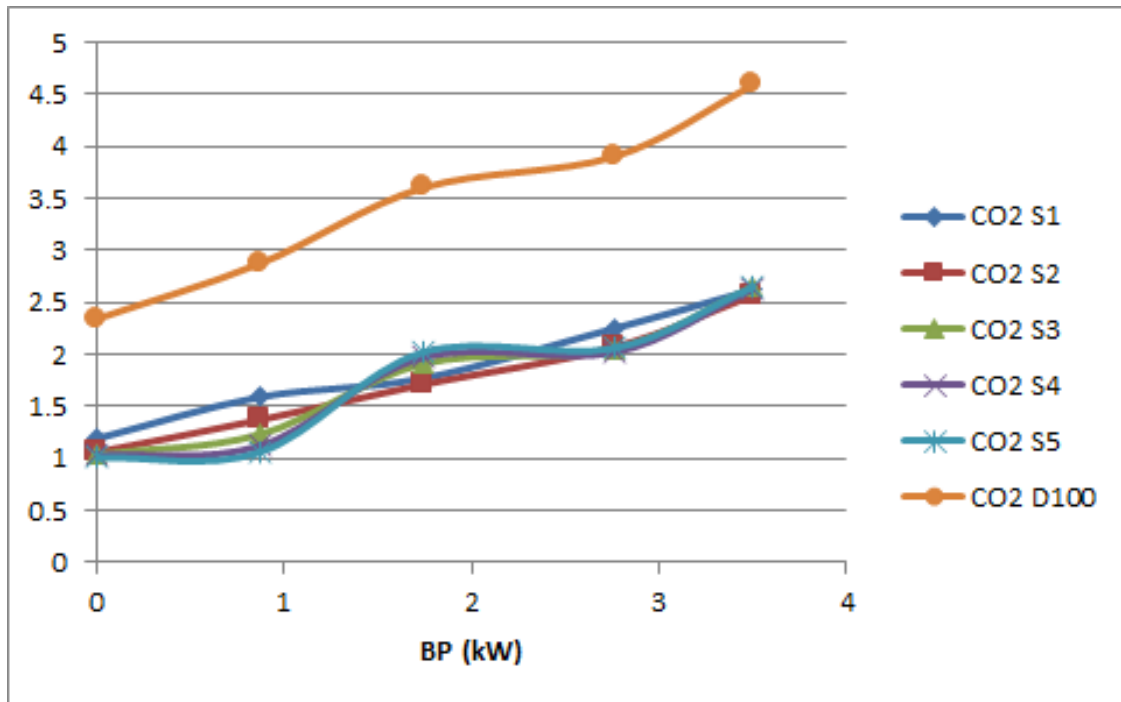


Fig 5.4: CO₂ Emission in ppm.

Above bar chart compares CO₂ emission of both biodiesel blends with Ginger grass biodiesel blends. CO₂ emission is one of the dangerous gas released during combustion, so it is important to reduce the CO emission. Our experiment shows that S1, S2, S3, & S4 produces less CO emission than D100 but C10 and A30 produces little high emission than D100 at 3.10kw brake power.

5.5 HC EMISSION.

BP (%)	BP (KW)	D 100	S1 (B10+CeO ₂)	S2 (B15+CeO ₂)	S3 (B20+CeO ₂)	S4 (B25+CeO ₂)	S5 (B30+CeO ₂)
0	0%	30	3	4	4	5	6
0.87	25%	35	7	7	8	8	9
1.74	50%	38	10	11	12	13	14
2.76	75%	44	13	15	16	16	17
3.5	100%	49	17	19	20	21	23

Table 5.5 HC Emission in %

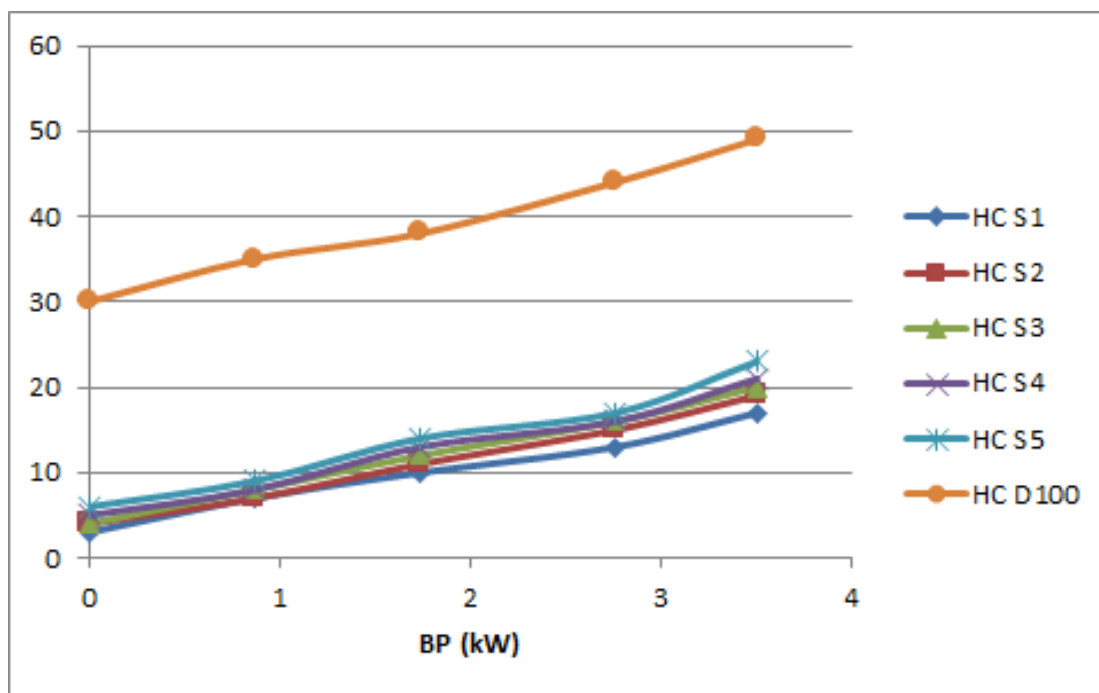


Fig 5.5: HC Emission in ppm.

This chart compares the emission of HC of Gingergrass oil biodiesel blends with D100. Unburnt fuel from the engine comes out as an emission which should be reduced to save the environment. In and Gingergrass biodiesels there is no significant change in HC emission. S2 and S3 produces little higher emission than D100. S2 produces higher HC than all the blends.

5.6 CO EMISSION.

BP (%)	BP (KW)	D 100	S1 (B10+CeO ₂)	S2 (B15+CeO ₂)	S3 (B20+CeO ₂)	S4 (B25+CeO ₂)	S5 (B30+CeO ₂)
0	0%	0.073	0.041	0.04	0.038	0.036	0.034
0.87	25%	0.075	0.039	0.038	0.036	0.034	0.032
1.74	50%	0.07	0.036	0.035	0.032	0.031	0.029
2.76	75%	0.067	0.033	0.031	0.029	0.027	0.025
3.5	100%	0.058	0.03	0.029	0.027	0.025	0.022

Table 5.6 Emission in CO %.

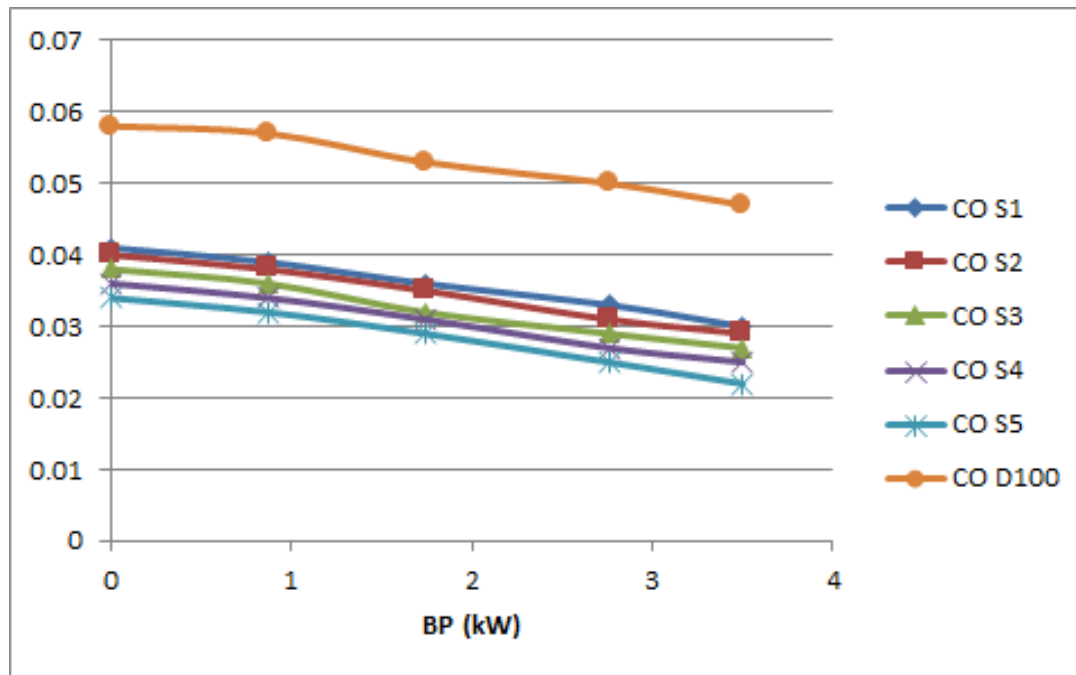


Fig 5.6: CO Emission in %

From fig 5.6, the average of CO% in all the six blends under varying brake power is comparatively lower than diesel, Blend 1(BL1) 4.67% lower than diesel, Blend 2(BL2) 4.13% is lower than diesel and Blend 3(BL3) 4.62% lower than that of diesel and Blend 4 (BL4) 4.25% is also lower than diesel. This is due to the biodiesel's high oxygen content, which allows for fast combustion at higher temperatures in the cylinder.

5.7 O₂ EMISSION.

BP (%)	BP (KW)	D 100	S1 (B10+CeO ₂)	S2 (B15+CeO ₂)	S3 (B20+CeO ₂)	S4 (B25+CeO ₂)	S5 (B30+CeO ₂)
0	0%	0.073	18.81	18.8	18.9	19.0	19.2
0.87	25%	0.075	18.06	18.27	18.37	18.45	18.56
1.74	50%	0.07	17.64	17.63	17.58	17.54	17.51
2.76	75%	0.067	17.03	17.06	17.13	17.15	17.20
3.5	100%	0.058	16.4	16.39	16.44	16.46	16.50

Table 5.6 Emission in O₂ %.

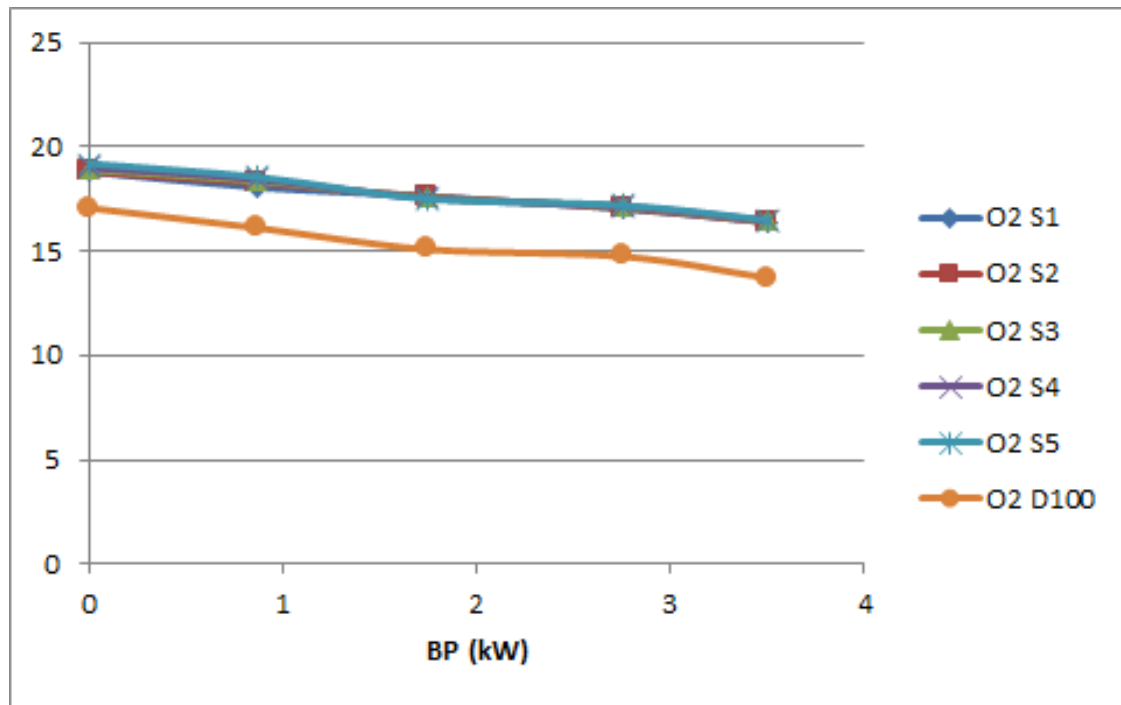


Fig. 5.7: O2 Emission in %

From fig 5.7, the average of O2% in all the size blends under varying brake power is comparatively lower than diesel, Blend 1(BL1) 4.67% lower than diesel, Blend 2(BL2) 4.13% is lower than diesel and Blend 3(BL3) 4.62% lower than that of diesel and Blend 4 (BL4) 4.25% is also lower than diesel.

CHAPTER 6

SUMMARY AND CONCLUSIONS

From this experiment it is seen that biodiesel is going to be the natural choice for our future transport fuel. The foregoing combination of experience and reasoning it is possible to distil some conclusions about biodiesel as an automotive fuel particularly in a developing country like India. The facts have been following established through the present work.

For Better BTE, BTE of D100 compared with S1, S2, S3, S4 and S5 Finally C10 produces 5% more BTE than D100. Hence has more BTE than Ginger grass oil and D100

For Better Specific fuel consumption, the results show that almost all the sample having same specific fuel consumption. there is no significant changes at all break powers

For Lower HC, the result shows that there is no significant change in HC emission at all break powers.

For lower CO, D100 is compared with Biodiesel blend samples. the result shows that S4 & S5 reduces CO emission compared to D100 and other sample blends.

For lower NO_x, bio diesel produces lower NO_x than Ginger grass oil. but when compared with D100 S5 produces less NO_x at higher break power.

CHAPTER 7

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