

IMPACT OF TITANIUM OXIDE NANO ADDITIVES IN D. I. DIESEL ENGINE TO ANALYSE PERFORMANCE AND EMISSION CHARACTERISTICS BY USING ANISEED OIL BLENDED WITH DIESEL

Submitted in partial fulfillment 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 I 12B Status by UGC I Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

April – 2021



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **V. VINOTH KUMAR (37150217)** and **N. HARI PRASAD (37150071)** who carried out the project entitled “**IMPACT OF TITANIUM OXIDE NANO ADDITIVES IN D.I. DIESEL ENGINE TO ANALYSE PERFORMANCE AND EMISSION CHARACTERISTICS BY USING ANISEED OIL BLENDED WITH DIESEL**” under our supervision from November 2020 to March 2021.

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We **V. VINOTH KUMAR (37150217)** and **N. HARI PRASAD (37150071)** hereby declare that the Project Report entitled **“IMPACT OF TITANIUM OXIDE NANO ADDITIVES IN D.I. DIESEL ENGINE TO ANALYSE PERFORMANCE AND EMISSION CHARACTERISTICS BY USING ANISEED OIL BLENDED WITH DIESEL”** done by us under the guidance of **Dr. S. SIVASARAVANAN, M.B.A., M.E., Ph.D.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my sincere thanks to **Dr. S. Prakash, M.E., Ph.D.**, Dean, School of Mechanical Engineering and **Dr. G. Arun Kumar, M.E., Ph.D.**, Head of the Department, Dept. of Mechanical Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. S. SIVASARAVANAN, M.B.A., M.E., Ph.D.** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I also express my thanks to all Teaching and Non-teaching staff members of the Department of Mechanical Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

Energy request is the interesting issue of all creating and created nations. Consistently Energy request expansions in a major rate. Along these lines, it is important to discover an eco-accommodating elective arrangement, biodiesel is a promising elective answer for this issue. The main purpose of this paper is to test and compare the performance of diesel engine using Aniseed oil Biofuel blended with diesel, Titanium oxide is used as a catalyst. Aniseed oil were esterified using the transesterification method. Then samples S1, S2, S3, S4, and 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 S3 gives better performance than D100 and other biodiesel samples.

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LIST OF ABBREVIATIONS

AO	---	Aniseed 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
TiO ₂	---	Titanium oxide
CV	---	Calorific value
RPM	---	Revolution per minute
B20	---	Aniseed Oil 20% with diesel 80%
O ₂	---	Oxygen
PPM	---	Parts per million

CHAPTER 1

INTRODUCTION

Significant examination is centered around fuel utilization and outflow decrease in the previous few years. There is developing interest on elective energizes because of unpredictable non-renewable energy source cost and exhaustion. In numerous applications like Transportation, Power age, Marine applications and so on, diesel Engines are being utilized as a significant source. During a century ago, the employments of fossil assets are expanding because of critical development of populace and change in way of life. This causes emergencies of non-renewable energy source consumption for the diesel motors there is a dire requirement for reasonable elective powers. In this project we will examine the use of Aniseed oil in diesel four stroke engine. With diesel and different blends of Aniseed 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 nox emission. When biodiesel is used then there will be less emission compared to diesel. The impact of utilizing vegetable oil-based added substance joined with metal-put together added substance with respect to debilitate discharge of 4-Stroke diesel motor fuelled with biodiesel.

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. The original biofuels are created from grain crops (for example wheat, maize), oil crops (for example assault, palm oil) and sugar crops. Biodiesel is an original biofuel. Other original biofuels are bioethanol, biogas and straight vegetable oils. Second era biofuels are delivered from lignocellulosic materials. The syngas created by gasification of biomass is utilized as antecedent of second-age biofuels like Biomass to fluid (BTL), Bio Dimethylether/Methanol, Biosynthetic Natural Gas and biohydrogen. Bio- oil, created by pyrolysis of biomass, and cellulosic ethanol are additionally second-age biofuels.

1.2 BIODIESEL

The biodiesel alludes to methyl or ethyl esters acquired by transesterification of creature fats or vegetable oils. Biodiesel can be blended with Petrol diesel. In the case of mixtures, the respective proportion of biodiesel in Petrol diesel should be indicated. B20 means a mixture 20% biodiesel and 80% petroleum diesel. B100 is pure biodiesel. Two central social events of rough materials for production of biodiesel can be perceived: vegetable oil and waste cooking oil. The pre-owned cooking oil is a significant waste and it very well may be utilized for biodiesel creation. Be that as it may, the real inclination is the use of unadulterated vegetable oils developed for vivacious use. The primary crude materials to expound biodiesel are: · Conventional vegetable oils of sunflower, rapeseed, soybean, Aniseed oil coconut and palm.

1.2.1 Solid Bio-Fuels

The transformation of strong bio-energizes to energy is a significant conventional human action – from the fire utilized in pre-notable occasions to present day cooking ovens, and power age from biogenic deposits consumed to produce 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 one Medium-to-large cogeneration using bio-fuels is already in the market, and could benefit from gasification developments, 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. In a roundabout way, this will likewise couple the ware costs for customary agrarian and ranger service items with the energy area. 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. Different yields, which can be changed over into ethanol, are cassava, maize, potatoes, sorghum, sugar beet and wheat. The conversion of their starch content into sugar has a high process energy demand, so that the cost of the product is quite high.

Bio-diesel is another important liquid bio-fuel: oilseed-yielding plants like castor, cotton, jatropha, palm, rape, soy, etc. offer a feedstock from which Straight Vegetable Oils (SVO) can be derived by physical and chemical treatment (milling/refining). The SVO can then be processed further into Fatty Acid Methyl Esters (FAME), also known as bio-diesel. Concerning future market possibilities, more limited size bio-fuel cogeneration frameworks with diesel motors utilizing fluid bio-powers (SVO or FAME) as data sources become appealing extra choices, particularly for independent and small lattice applications in agricultural nations just as for "green" power age in industrialized countries. For non-industrial nations, it is conceivably significant that bio-diesel can likewise be gotten from plants like Jatropha, which show relatively low yields, however need just minor data sources so their general expenses may be

moderate if land and work 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: these days, it very well may be gotten from "current" bio-energy harvests like maize (or corn), wheat, and surprisingly more curiously from modern squanders just as from blended or twofold trimming cultivating frameworks which can incorporate different "old" plant assortments into their pivot, and give net energy yields similar to the best palm oil, or sugarcane manors. 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 programme of biogas installations proved success of their technology.

1.3 BIODIESEL PRODUCTION

The business technique utilized for the biodiesel creation is the transesterification (additionally called alcoholysis). The transesterification comprises on the response of oils or fats (fatty oils somewhere in the range of 15 and 23 iotas, being the most well-known with 18) with a liquor of low sub-atomic weight (generally ethanol or methanol) with the presence of an antacid impetus (typically NaOH or KOH) to deliver esters and glycerin. Normally, the reaction takes place at atmospheric pressure and 65°C of temperature. The cycle utilizes steady tumult, during a time frame between one or twelve hours. The transesterification comprises of three successive and reversible responses (Figure 1). The stoichiometric proportion for the transesterification response is three moles of liquor and one mole of fatty substance (Figure 2). An extra proportion of alcohol is incorporated solicitation to move the reaction to the methyl esters plan. Glycerin is furthermore outlined in the reaction.

1 oil/fat + 3 methanol = 3 methyl esters + 1 glycerin Figure 2. Transesterification reaction

1.4 BIODIESEL FEATURES

The biodiesel properties rely upon the pre-owned feedstock (new vegetable oil, squander cooking oils, creature fats, and so forth) Significant properties of the biodiesel are:

- It can be utilized unadulterated or mixed with petrodiesel in motors
- It can be utilized in the diesel motor with no changes.
- it very well may be capacity in similar compartments than Petro diesel
- It can drag out motor life because of the greater oil limit
- It improves burning interaction. The biodiesel contains in any event 11% oxygen. Biodiesel consumes better (more totally with few fuel unburned outflows) than petrol diesel. Less smoke is created. The utilization of biodiesel can lessen the emanations of unburned hydrocarbons (HI) in a 90%.
- It creates business
- It greases up moving motors
- It is Biodegradable
- It doesn't contain sulfur. No sulfur outflows are transmitted during the burning
- It is less inflammable contrasted and Petro diesel.
- During the burning biodiesel emanates less unsafe gases into the climate contrasted and Petro diesel. Biodiesel lessens the wellbeing chances related with petrol diesel. The utilization of biodiesel diminishes discharge of PAH (distinguished as malignancy causing). Biodiesel is nontoxic.

Ozone depleting substance advantage. During the burning of biodiesel, the CO₂ cycle is shut. The CO₂ delivered during the burning is the measure of CO₂ which the plants can process through photosynthesis during development. In addition, this interaction infers low outflows of CO₂, because of the medium substance carbon for plants is 77.8% and for creature fats is 76.1%. While, the substance carbon for fossil diesel is 86.7%. The utilization of biodiesel can lessen the CO₂ discharges up to half in contrast with the utilization of oil diesel.

- The biodiesel transport and its stockpiling are less risky than the petrol diesel, on the grounds that biodiesel has a flashpoint temperature of about 170°C in examination of 60 to 80 °C for petrol diesel.
- It is non-irritating to the skin
- It has a charming fragrance.

Besides, those benefits additionally other financial angles can be considered: a) Biodiesel add to enhancement of fuel sources. It is a significant angle for nations without petroleum product sources. b) The biodiesel adds to horticultural and rustic turn of events. The most significant biodiesel drawbacks, in correlation with the petroleum product, are: 1) The expense. The biodiesel creation is today costly contrasted and Petro diesel. 2) The biodiesel needs more added substances, fundamentally in cool nations, because of its high cloud point. 3) Lower long-term capacity steadiness. The biodiesel gets smelly because of oxidation and bacterial air. This rancidity cycle produces aldehydes, ketones and acids, which have solid and horrendous scents. 4) It is required 1.1 liters of biodiesel to supplant one liter of oil diesel, as a result of their lower calorific force. 5) High percent mixes of biodiesel can relax and debase particular sorts of elastomers and normal rubbers. For this situation, safety measures must be taken concerning the materials in fuelling framework. 6) Biodiesel may weaken the greasing up oil of motors. 7) The biodiesel creates more NO_x discharges than Petro diesel- a correlation of the outflows from biodiesel and Petro diesel is appeared in table 4.

1.5 ADVANTAGES OF BIO-DIESEL

Biofuels are viewed as a more maintainable option in contrast to regular petroleum and diesel got from petroleum products since they come from inexhaustible sources, which likewise ingest carbon dioxide (CO₂), despite the fact that CO₂ will be discharged as a result of energy utilized in the collecting and creation measure. Studies demonstrate that the general CO₂ reserve funds from biofuels contrasted with customary petroleum and diesel fluctuate between 20% to 70% contingent upon the kind of yield and the energy devoured in developing, collecting, shipping and handling the harvest into a fuel. Biodiesel is the comparatively very clean and environmentally friendly only alternative fuel.

- Biodiesel is the relatively perfect and harmless to the ecosystem just elective fuel
- Biodiesel runs in any regular unmodified diesel motor. It very well may be put away anyplace that petrol diesel fuel is put away..

- Studies have tracked down that the lifecycle creation and utilization of biodiesel delivers roughly between 80-100% less carbon dioxide and practically 100% less Sulfur dioxide discharges.
- β Combustion of biodiesel alone provides over a 90% reduction in total unburned hydrocarbons and a 75-90% reduction in aromatic hydrocarbons.
- Biodiesel further gives huge decreases in particulates and carbon monoxide than oil diesel fuel.
- Based on Ames Mutagenicity tests, biodiesel gives a 90% decrease in disease hazards.
- Biodiesel is 11% O₂ by weight and contains no sulfur. The utilization of biodiesel can broaden the existence of diesel motors since it is more greasing up than petrol diesel fuel while fuel utilization, start, power yield and motor force are unaffected.
- Biodiesel is protected to deal with and transport since it is pretty much as biodegradable as sugar, multiple times less harmful than table salt and has a high flashpoint of about 125C contrasted with petrol diesel fuel, which has a glimmer point of 55C.
- Biodiesel can be produced using sustainable oilseed yields like soybeans, rapeseed, cottonseed and mustard seed and non-eatable oilseeds.

1.6 PROCESS DESCRIPTION

The biodiesel is delivered by transesterification of oil utilizing methanol (liquor) and NaOH (impetus). The cycle steps are:

- 1) The vegetable and waste cooking oils are gotten. They are moved to the plant with trucks.
- 2) The oils are put away in external tanks of the plant.
- 3) Drying and pretreatment of the oil.
- 4) The oil transesterification. The reactor is planned by 8000 hours out of each year, with an every day biodiesel creation of 200 tons each day. The interaction begins with the refined oil. In the reactor, the oils are blended in with the methanol, in abundance, NaOH (impetus)

5) The response items are killed with a mineral corrosive. Methanol in abundance is vanished, and afterward dense and put away to be reused in the following cycle.

6) The biodiesel is put away in tanks with nitrogen inclusion to evade its oxidation. The truck load is performed under nitrogen infusion to stay away from its debasement in transport.

1.7 ESSENTIAL OILS

Fundamental oils are the concentrated fragrant oils of plant leaves, blossoms, seeds, bark, roots, and the skins of certain natural products. They fluctuate in strength however are in every case exceptionally intense, and frequently smell best when weakened (as in different oils, colognes, and shampoos). Those fundamental oils acquired from trees are for the most part delivered by a protracted steam refining measure applied to either the slashed wood or the leaves and branch finishes of the tree.

1.8 ESSENTIAL OIL SCENT CATEGORIES

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

1.8.1 Camphoraceous

A camphoraceous fragrance is one that is like camphor; an emphatically sweet-smelling, practically therapeutic aroma. Camphoraceous fundamental oils incorporate eucalyptus, frankincense, hyssop, marjoram, rosemary, sage and, obviously, camphor.

1.8.2 Floral

Fundamental oils got from blossoming organic sources are alluded to as flower aromas. These fundamental oils incorporate clary sage, chamomile, geranium, jasmine, juniper berry, lavender, rose, and ylangylang.

1.8.3 Mint

Spices in the mint family are unequivocally sweet-smelling, and the fragrance has for some time been venerated by cultivators. Indeed, in Greek folklore, mint is alluded to as "the spice of neighborliness." One of the initially referred to employments of mint was as an air deodorizer. Fundamental oils with a mint fragrance incorporate pennyroyal, peppermint, spearmint and wintergreen, among others.

1.8.4 Musky

Musky essential oils have robust, earthy scents that are particularly penetrating and titillating to our sense of smell. These include myrrh, patchouli and citronella.

1.8.5 Spicy

Sweet-smelling and strengthening, zesty fundamental oils can be livening up any room. Fundamental oils with this kind of aroma incorporate anise, basil, cinnamon, ginger, nutmeg, oregano, tea tree, thyme, and then some.

1.8.6 Sweet

Quite possibly the most well known aroma classes, our pleasant smelling oils incorporate citronella, grapefruit, lemongrass, lemon, lime, orange and tangerine..

1.9 COMMONLY USED TYPES

Of the hundreds of oils available, some of the most popular essential oils include:

1.9.1 Clary Sage

May assist with calming hot glimmers and advance rest.

1.9.2 Eucalyptus

An ingredient in steam inhalations to clear congestion and colds.

1.9.3 Lavender

Often used for relaxation and to improve sleep.

1.9.4 Lemon Oil

Lemon oil is usually utilized in the sorts of industrially accessible items you experience each day. In the event that you stroll down the paths of any supermarket, you'll discover everything from family cleaner to hand cleanser to seasoned shining water with the pith of lemon. Similar to the case with numerous citrus oils, the aroma intently mirrors that of the natural product from which it's inferred: splendid, light, fiery, and clean.

1.9.5 Peppermint

Used for headaches and other types of pain.

1.9.6 Sweet orange oil

In examinations, it decreased nervousness when it was breathed in, and when applied topically, it hindered members' heartbeat rates and breathing rates, while they additionally announced inclination more lively and fiery.

1.9.7 Rosemary

A stimulating scent said to boost attention and focus.

1.9.8 Tea Tree

Used as for fungal skin infections and as a spot treatment for acne.

1.9.9 Cinnamon oil

On the off chance that lemon oil is splendid, cool, and stimulating, cinnamon oil is its inverse: sweet and zesty, musky and warm. As far as I might be concerned, cinnamon invokes a particular combination of provocative colorfulness and comfortable commonality, which bodes well since it's both a Far East import and a zest cabinet pillar.

Texas Oil is the normally happening fundamental oil from the wood of the local Texas Cedar (*Juniperus Mexicana*). The oil is recuperated through the actual partition cycle of halfway pressing factor steam refining

1.10 TRANSESTERIFICATION

This cycle changes the sub-atomic design of lipid particles and consequently the actual properties. Albeit even refined unadulterated plant oil (PPO) can be straightforwardly utilized in refitted diesel motors, biodiesel, which is made by a transesterification step, is very much like fossil diesel and along these lines can be burned-through in like manner diesel motors which are refitted with just little endeavors.

Transesterification is additionally called alcoholysis, is the cycle by which the refined oil atom is "broke" and the glycerine is eliminated, bringing about glycerine cleanser and methyl or ethyl esters (biodiesel). Natural fats and oils are fatty substances which are three hydrocarbon chains associated by glycerol. The bonds are broken by hydrolyzing them to frame free unsaturated fats. These unsaturated fats are then blended or responded with methanol or ethanol shaping methyl or ethyl unsaturated fat esters (monocarbon corrosive esters).

The blend isolates and settles out leaving the glycerine on the base and the biodiesel (methyl-, ethyl ester) on the top. Presently the partition of these two substances must be led totally and rapidly to dodge a turned around response. These transesterification responses are frequently catalyzed by the expansion of a corrosive or base. For the transesterification interaction, fundamentally the alcohols

methanol and ethanol are utilized. Hypothetically, transesterification can be likewise handled with higher or optional alcohols.

Thinking about wide assortment of oils and fats that can be utilized to create biodiesel, there is a more noteworthy reach in the qualities of biodiesel energizes than for ethanol fuel. Ethanol is really one unmistakable atom, while biodiesel is a blend of particles that differs to some degree, contingent upon the underlying oil or fat source used to deliver the fuel.

1.11 ANISEED OIL

Aniseed or anise fundamental oil is gotten from the perpetual home grown plant that is generally known as anise or aniseed. It is likewise experimentally known as *Pimpinella anisum*. Usually, this oil is mistaken for star anise fundamental oil however that oil comes from star anise plant, logically known as *Illicium verum*. The plant is pervasive in the Mediterranean areas and it without a doubt has a long recorded. Indeed, it was acquainted with northern Europe by the Romans after they found that the aniseed spice could be utilized as a stomach related, explicitly added to cakes which contained other stomach related seeds like cumin and fennel, eaten after suppers. Early pilgrims carried it to North America.



Fig:1.11 Aniseed raw Materials

1.12 MAIN ANISEED OIL EXTRACTION PROCESS

A few procedures had been executed for the extraction of oils like super refining, very basic liquid extraction, Solvent extraction, hydro refining, utilization of superheated and supercritical water and other, for example, microwave helped measures, Steam refining and so forth. Out of these strategies the Steam refining is one of the promising procedures for extraction of oil.

1.12.1 Extraction using steam distillation

The device comprises of a steam generator associated with the round base flask through a glass bay cylinder. The cup is associated with a water condenser through a glass outlet tube. Condenser is additionally connected to a beneficiary through a connector. Take around 750 ml of water in the steam generator and begin warming to deliver steam. In the round base flask take around 75gm of squashed saunf. A fiery current of steam from steam generator is gone through the round base flask. A piece of the steam consolidates in the round base flask. As increasingly more steam is passed, the steam unstable parts of saunf go through the condenser alongside steam. These substance on build up are gathered in the recipient. The substance in the round base jar might be warmed by a bunsen burner to forestall extreme buildup of steam. The interaction of steam refining is proceeded for about 30 minutes. Move the distillate to an isolating pipe and concentrate with 20 ml segments of petrol ether multiple times.

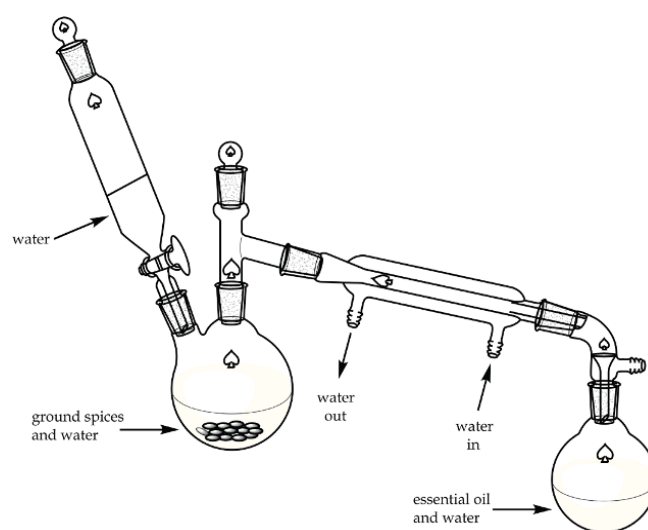


Fig 1.12.1 The Extraction Process of Aniseed oil

1.13 ADVANTAGES OF STEAM DISTILLATION TECHNOLOGY

It was seen that less work was done in getting Oil from Aniseed by Steam refining strategy. Volume of Fundamental Oil increments with expansions on schedule of warming keeping the temperature steady. On diminishing the pressing factor we can extricate Essential Oils at moderately less temperature and inside less season of warming. The extraction process is cut off from the air, which can avoided oxidation reaction of special materials and help getting high grade oil products just as supercritical extraction. But the extraction pressure is much lower than supercritical extraction, which is a good thing that makes the equipment price is much lower and also make it feasible for industrialization scale production.

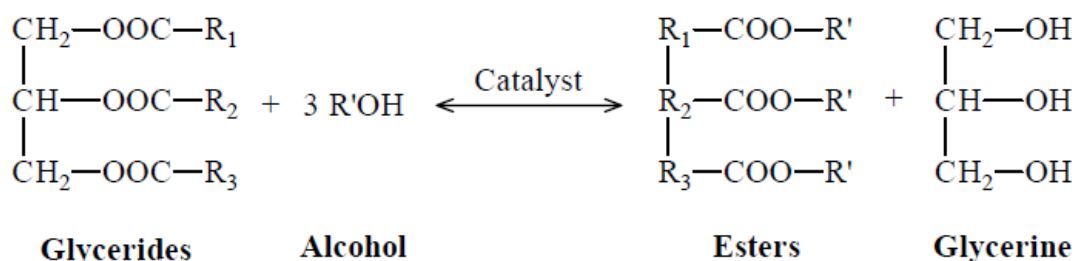
1.14 WHY ANISEED OIL

The primary utilization of Aniseed is removing oil. The oil substance of Aniseed is 8%~13%. Aniseed oil is plentiful in nutrient E, linoleic corrosive, linolenic corrosive, 28 carbon liquor and an assortment of physiological movement parts. Also, its characteristic nutrient E content is the ruler of all vegetable oil. It likewise assumes a significant part in the guideline of body electrolyte equilibrium and pulse, lower cholesterol, forestall sickness of heart head vein. It has perceived as a sort of "brilliant oil" for nutritive wellbeing.

The blend of biodiesel fuel from the farming oils of Aniseed oil and dark seed oil happened through four fundamental advances. At first, the Aniseed oil and dark seed oil were gotten through a transesterification cycle to create Aniseed methyl ester and dark seed methyl ester. Furthermore, any climatic oxygen was eliminated from the unsaturated fat methyl esters (FAMES) through vacuuming and a freeze-siphon defrost cycle. At that point, the examples went through pyrolysis by warming in a heater set at 675°C (948.15K) for time spans of one or the other 15, 30, 60, or 120 minutes. At long last, the examples were examined by means of gas chromatography/mass spectrometry (GC/MS) to identify hydrocarbons numbers and percent arrangement.

1. Unsaturated fat Methyl Ester Initially, a similar cycle is used to change over the fatty oils in Aniseed and dark seed oils to their unsaturated fat methyl-ester subordinates. Transesterification includes a fatty oil responding with methanol and

potassium hydroxide impetus to create glycerol and methyl ester, as shown by Equation 1



A example size of 10 mL was pipetted into a dry 50 mL glass flagon previously containing an attractive stirrer. The 50 mL cup and its substance were then settled on top of an aluminum stand which was set on a hot plate stirrer. The aluminum stand likewise contained a thermometer to precisely gauge temperature. A water-coat condenser was then connected to the 50 mL flagon (see Figure 1). Dryness is significant as any dampness in the framework will burn-through a portion of the impetus and diminishing the pace of the transesterification. In another 10 mL volumetric carafe, 0.1 grams of KOH (going about as impetus) was blended in with roughly 2 mL of methanol until the entirety of the KOH disintegrated. The methanol/KOH combination was immediately added to the oil and blended overwhelmingly for 30 minutes at 55°C utilizing the hot plate stirrer. All the fluid in the flagon was then moved to a 15 mL rotator tube, covered, and centrifuged for 20 minutes. The transesterification response created two noticeable layers, with the base layer containing glycerin, and the top layer containing the methyl ester (biodiesel) (See Figure 2). The top layer, which contained the biodiesel, was poured into another 50 mL flask and heated for 30 minutes at 70°C, followed by a 20 minute centrifugation. The top layer was then separated again and placed in a vial to prepare for the freeze-pumpthaw cycle (Karaosmanoglu et al., 1996; Lang et al., 2001; Kondamudi et al., 2009).

1.15 ENGINE EXHAUST EMISSOIN PARAMETER

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

- d) Oxides of Sulphur
- e) Particulates, soot and smoke

The initial four are regular to both SI and CI motors and the last two principally from CI motors. The primary non-exhaust discharge is the unburnt hydrocarbons from gas tank and crankcase pass up.

For $\Phi < 0.8$, HC discharges additionally increment because of helpless ignition and fizzle. The age of nitrogen oxide discharges is a component of the ignition temperature, most elevated close to stoichiometric conditions when temperatures are at a pinnacle esteem. Greatest NO_x discharges happen at somewhat lean conditions, where the burning temperature is high and there is an abundance of oxygen to respond with the nitrogen

1.15.1 Hydrocarbon (HC)

CI motors work with a general fuel lean proportionality proportion; CI motors have just around one-fifth the HC emanations of a SI motor. Diesel fuel has a higher sub-atomic load on a normal when contrasted with gas mix. Some HC particles consolidate s onto the outside of the strong carbon ash that is produced during ignition, a large portion of this is scorched as blending proceeds and the burning cycle continues. The HC segments dense on the outside of the carbon particles notwithstanding the strong carbon particles themselves, add to HC discharges of the motor. CI motor has a burning proficiency of just 2% of HC fuel being radiated. CI motors likewise have HC outflows for a portion of similar reasons as SI motors do, for example, divider store ingestion, oil film retention, fissure volume.

1.15.2 Carbon monoxide (CO) emission

Gas however a toxic gas. It is created in a motor when it is worked with a fuel - rich equality proportion. When there isn't sufficient oxygen to change all carbon-over to carbon di oxide, some fuel isn't scorched, and some carbon winds up as Carbon monoxide. CO is viewed as an unfortunate emanation, yet it is likewise addressing lost compound energy.

Most extreme CO is produced when a motor runs rich. Helpless blending, neighborhood rich reasons, and fragmented ignition will likewise be the hotspot for CO discharges.

Oxides of Nitrogen (NOx)

Exhaust gases of an engine can have up to 2000 ppm of oxides of nitrogen. Released NOx reacts in the atmosphere to form ozone and is one of the major causes of photochemical smog. NOx is created mostly from nitrogen in the air. Nitrogen can also be found in the fuel blends. There are number of possible reactions that form NO. All the restrictions are probably occurring during the combustion process. Gases that are stable at low temperatures but become reactive and contribute to the formation of NOx at high temperatures include oxygen and water vapor. In addition to temperature, the formation of NOx 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. This outcomes in a nearer contact between the particles of fuel and oxygen diminishing the response time.

1.16.2 Engine speed

The postpone period could be given either in the details of total time or in the provisions of wrench point degree. Lessening in defer period as far as wrench point degree with expansion in the motor speed in a variable speed activity with a given fuel. In levels of wrench travel in defer period increments as the motor works at higher rpm. The fuel siphon is outfitted to the motor, and thus measure of fuel infused during the postpone period relies upon the crank angle.

1.16.3 Output

With an expansion in motor yield the air fuel proportion diminishes, working temperature increment and consequently defer period diminishes.

1.16.4 Injection timing

The impact of infusion advance on the pressing factor variety for three infusion advance timings of 9, 18, 27 degrees before TDC. The infused nature of fuel per cycle is steady, which relies on the starting pressing factor and temperature of the infusion.

1.16.5 Quality of fuel

Self-ignition temperature is the main property of fuel, which influences the defer period. What's more, energizes with higher cetane number give lower defer period and smoother motor activity. Different properties of the fuel, which influence the defer period, are instability, idle warmth, consistency and surface pressure.

1.16.6 Engine Brake power

Engine brake power (P) is given by motor and assimilated load. It is the result of force and precise motor speed where P is motor brake power in kW; N is rakish speed of the motor in rpm as:

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

1.16.7 Brake specific fuel consumption

Brake specific fuel consumption (BSFC) is the examination of motor to show the productivity of the motor against with fuel utilization of the motor in kg/kW/hr. where (mf) is the fuel utilization rate in kg/hr. as:

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

1.16.8 Break thermal efficiency

The level of brake warm productivity of the motor is identified with motor brake force and all out energy contribution to the motor.

$$\text{Efficiency} = \frac{\text{Brake power} \times 3600}{\text{Fuel consumption rate} \times \text{Higher calorific value}}$$

1.16.9 Intake pressure and temperature

Expansion in consumption temperature expands the packed air temperature bringing about decreased postpone period.

1.17 NOISE PARAMETER

1.17.1 Exhaust system noise

The fumes framework commotion incorporates the clamor from fumes gas beats leave the suppressor or trail line and clamor transmitted from vibrating surface of the fumes framework part. Commotion discharged from the outside of exhaust framework part result from two distinctive sort of excitation power. Those created by the throbbing fumes Gas stream and in this manner sent from the vibrating motor to deplete framework part.

1.17.2 Intake System Noise

Admission framework commotion incorporate produced by the progression of air through the framework air delta and clamor radiated from the vibrating surface segment. In many example in motor air cleaner will give huge lessening of admission air clamor. On the off chance that extra lessening required, an admission air silencer can be added to the framework. To limit consumption framework surface emanated clamor, appropriate plan, determination and mounting admission framework segment are fundamental.

1.17.3 Engine Surface of Noise

Motor surface clamor alludes to sound discharged from vibrating surface of motor segment and adornments and other accordingly thing remembered for the motor exhaust. Admission and cooling framework strategies used to diminish motor surface transmitted commotion remember a decrease for running leeway and machining resistances of the motor. Part acoustical therapy or upgrade of motor segment utilization of acoustic treated safeguards and vibrating separation and damping of motor covers and diesel motor than for gas motor super charging of a diesel motor can bring about some decrease of motor surface transmitted commotion at high motor burden.

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 fuelled 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 fuelled 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 fuels 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 lemongrass on essential oil, chemical composition and citral contents. The lemongrass 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 lemon grass (cymbopogon citratus) is discussed as source of oil for bio-diesel production. The bio-diesel that is produced from Lemon grass through Transesterification 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 Lemon grass oil. To select the suitable mixing proportion of Lemon grassoil blends with diesel fuel. The physical properties of the lemongrass oil biodiesel blends are shown. To select the suitable injection pressure for enhance the diesel engine performance and emission. The biodiesel was extracted through transesterification process. The physical and chemical properties of the Lemon grass oil bio-diesel were tested through ASTM standards and compared with diesel fuel. The lemongrass 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 Lemon grass biodiesel and found that optimum blend for further investigations. In Phase II the optimum blend of Lemon 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 Titanium 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 Aniseed oil mixed separately with Titanium Oxide using AVL 5 di-gas analyze

CHAPTER 4

MATERIALS AND METHODS

4.1. MATERIALS

The crude Aniseed oil collected from a local supplier to produce biodiesel. Table 4.1 shows property of CI Crude oil and CIME Biodiesel.

The Nano additives used in this study were Titanium oxide (TiO_2). The chemicals used for transesterification process are methanol, sulphuric acid as acid catalyst and potassium hydroxide as alkali catalyst.

4.2. BIODIESEL PRODUCTION

CI 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 transesterification 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 transesterification 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 transesterification 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, Aniseed Oil, Titanium oxide Nano powder, and pure Diesel. The below table.1 shows the properties of Aniseed oil. And the table 4.2 shows transesterification results.

Table 4.1: The Values of Raw Aniseed Oil

S.NO	PROPERTIES	ANISEED OIL
1	Density	0.714g/cc
2	Kinematic viscosity	0.688cst
3	Moisture content	0.044%
4	Flash point	74°C
5	Fire point	83°C
6	Calorific value	5678.80cal/gm

Table 4.2: Transesterification Report of Aniseed 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	92.9%

4.3 PREPARATION OF NANOPARTICLE

Ultrasonicator is used to mix thoroughly the nanoparticles (TiO_2) with the biodiesel from Aniseed oil. The Titanium oxide nanoparticles of an average size of 20 nm were used for this investigation. This Ultrasonicator technique is used to disperse the nanoparticles in the biodiesel mixture. 100 ppm Titanium oxide nanoparticle was weighed by using electronic weighing machine with an accuracy of 0.02 mg. This nano additive added biodiesel mixture were kept in the Ultrasonicator about 30 min and ensured that there is no deposits of power at the bottom of the beaker.



Fig:4.3 Titanium oxide

4.3.1 Titanium Oxide (TiO_2).

Titanium oxide (TiO_2) is accessible as nanocrystals or nanodots having a high surface territory. They show attractive properties. Titanium has a place with Block D, Period 4 while oxygen has a place with Block P, Period 2 of the intermittent table. Titanium oxide is otherwise called flamenco, rutile, titanium dioxide and dioxotitanium. Titanium oxide nanoparticles are known for their capacity to restrain bacterial development and forestall further arrangement of cell structures. Titanium oxide shows great photograph reactant properties, consequently is utilized in disinfectant and antibacterial creations Corrupting natural impurities and germs As an UV-safe material Assembling of printing ink, self-cleaning earthenware production and glass, covering, and so on Making of restorative items, for example, sunscreen creams, brightening creams, morning and night creams, skin milks, and so forth Utilized in the paper business for improving the darkness of paper.

4.3.2 Properties of Titanium Oxide (TiO₂).

Table 4.3: Properties of Titanium Oxide (TiO₂).

Compound Formula	TiO ₂
Molecular weight	79.69
Appearance	White Powder
Melting Point	1843°C (3349°F)
Boiling Point	2,972° C (5,382° F)
Density	4.23 g/cm ³
Solubility in H ₂ O	N/A
Exact Mass	79.9303
Monoisotopic Mass	79.9303

4..4 EXPERIMENTAL SETUP

Aniseed oil is blended with diesel separately. Here in this investigation Titanium 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 4.4: Ultrasonicator Device

4.5 Blends

Table 4.5 Blending (ml) of fuel mixtures

Samples	Aniseed Oil	Diesel	Nano Additives
S1	50ml (10%)	450ml (90%)	100 PPM
S2	75ml (15%)	425ml (85%)	100 PPM
S3	100ml (20%)	400ml (80%)	100 PPM
S4	125ml (25%)	375ml (75%)	100 PPM
S5	150ml (30%)	350ml (70%)	100 PPM

4.6 METHODOLOGY

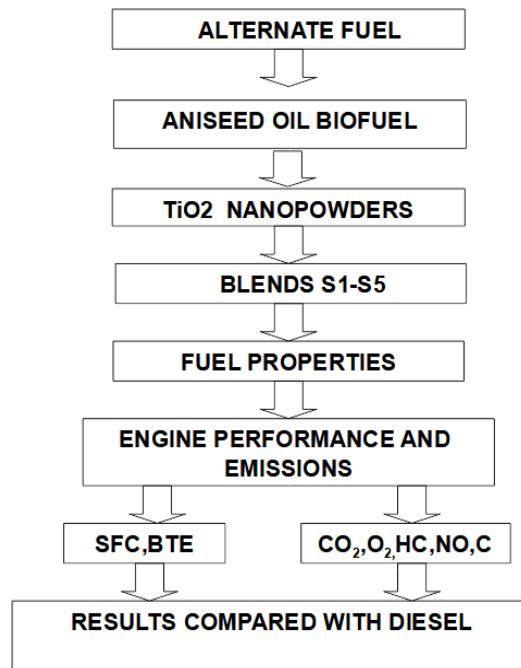


Fig 4.6: Methodology flow chart

4.7. ENGINE SETUP

A solitary chamber has 4-stroke, direct infusion Kirloskar TV1 diesel motor with a greatest evaluated yield of 5.20 kW at 1500 rpm was used to acquire the arrangement of test information required. The motor has a pressure proportion of 17.5. The motor has a cleared volume of 661.45 (cc), bore breadth of the motor is 87.50 mm and stroke length of 110.00 mm. Infusion pressure is 210 bar kept up continually all through the cycle.

The Kirloskar tv1 model single cylinder four-stroke water-cooled diesel is the test engine developing 3.5 KW at a speed of 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: 4.7 Constant speed diesel engine

Table 4.7: Engine Specifications:

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

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:4.8 AVL Gas Analyser

AVL gas analyzer for estimation of CO HC CO₂ O₂ and lambda. Contamination testing machines. Our clients are workshops, car designing universities its nits all motor maker. It is convenient sort and used to quantify centralization of SO₂, NO, CO, CO₂ and O₂ from stack or evaporator emanation gases, in which SO₂, NO, CO and CO₂ are estimated by miniature stream infrared sensors and O₂ by electrochemical sensor, with discretionary gas temperature, pressure, speed and so on, ascertaining ignition productivity, lambda, and so forth.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 SPECIFIC FUEL CONSUMPTION (SFC).

BP (KW)	BP (%)	D 100	S1 (B10+TiO ₂)	S2 (B15+TiO ₂)	S3 (B20+TiO ₂)	S4 (B25+TiO ₂)	S5 (B30+TiO ₂)
0.	0%	2.48	8.04	7.65	6.55	6.82	7.41
0.87	25 %	0.52	0.59	0.53	0.52	0.52	0.51
1.74	50 %	0.38	0.38	0.36	0.33	0.35	0.41
2.76	75 %	0.29	0.30	0.33	0.32	0.31	0.32
3.5	100 %	0.2	0.24	0.26	0.29	0.22	0.19

Table 5.1: Specific fuel consumption in Kg/kWh.

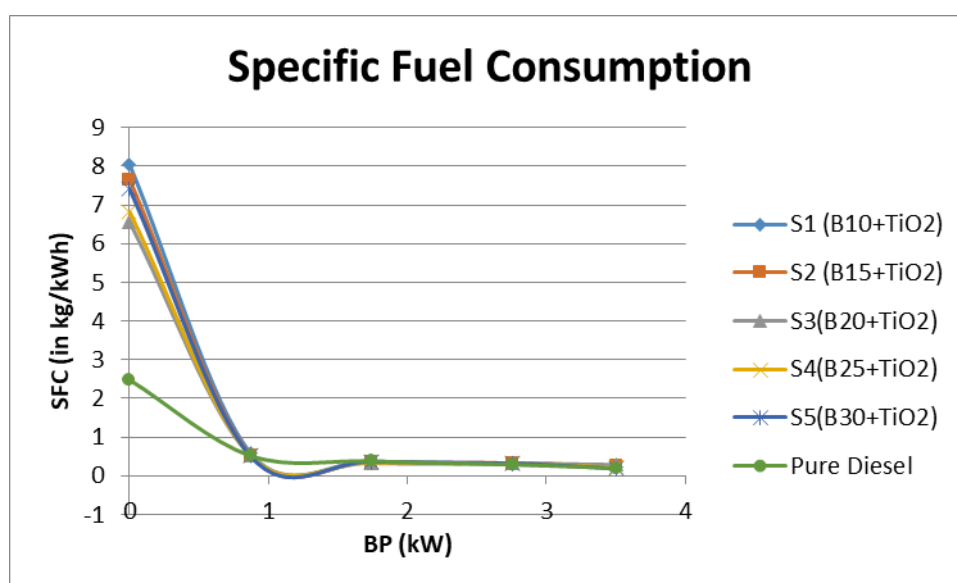


Fig 5.1: Specific fuel consumption in Kg/kWh.

The above bar chart compares the specific fuel consumption of Aniseed and biodiesel with pure diesel at different break powers. There is a small deviation in specific fuel consumption of Aniseed oil bio diesels and D100 at null break powers. Other than that everything seems to be similar so, we can conclude from the bar chart that both Aniseed oil with biodiesels and pure diesel has almost same specific fuel consumption.

5.2 BRAKE THERMAL EFFICIENCY (BTE).

BP (KW)	BP (%)	D 100	S1 (B10+TiO2)	S2 (B15+TiO2)	S3 (B20+TiO2)	S4 (B25+TiO2)	S5 (B30+TiO2)
0	0%	2.45	1.07	1.28	1.31	1.52	1.16
0.87	25 %	16.49	14.49	15.33	16.35	16.58	16.89
1.74	50 %	22.75	22.61	23.88	25.81	24.74	23.31
2.76	75 %	31.71	28.44	28.52	26.76	26.78	26.99
3.5	100 %	32.59	32.52	30.98	29.14	29.46	31.71

Table 5.2: Brake thermal efficiency in %.

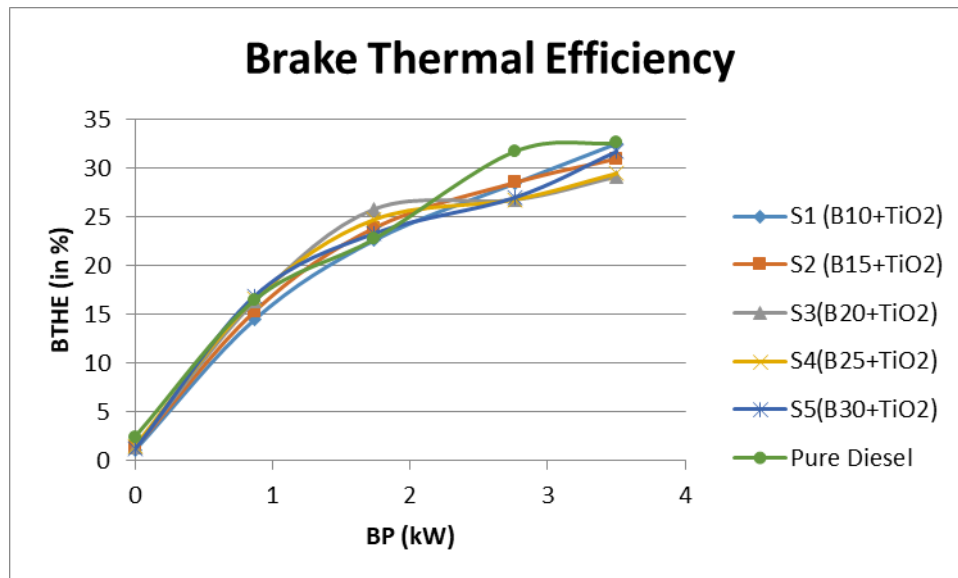


Fig 5.2: Brake thermal efficiency in %.

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. Efficiency is measured as a ratio of the measured performance to the performance of an ideal machine is given as an input to the device into an output force and movement. Hence, mechanical efficiency indicates in converting the indicated power to useful power. All samples give show similar efficiency in comparison with D100, Hence we can conclude that Brake thermal Efficiency of Aniseed Oil with Diesel is similar to D100.

5.3 NO_x EMISSION.

BP (kw)	BP (%)	D 100	S1 (B10+TiO ₂)	S2 (B15+TiO ₂)	S3 (B20+TiO ₂)	S4 (B25+TiO ₂)	S5 (B30+TiO ₂)
0.	0%	209	93	89	84	84	82
0.87	25%	338	128	127	124	123	123
1.74	50%	681	280	265	222	235	242
2.76	75%	868	398	356	338	329	322
3.5	100%	1338	595	573	559	555	550

Table 5.3: NO_x Emission in ppm.

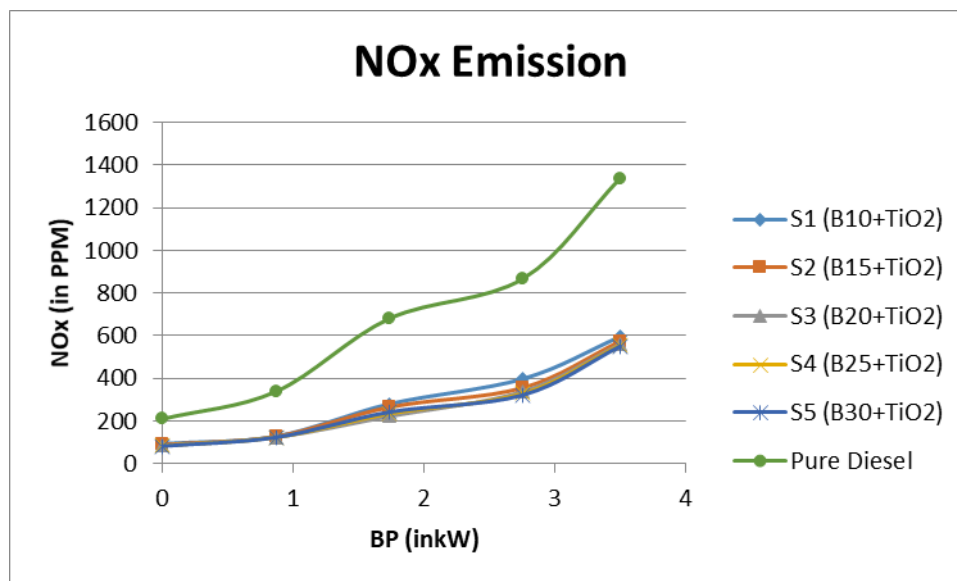


Fig 5.3: NO_x Emission in ppm.

The above bar chart compares NO_x emission of both and Aniseed biofuel with pure diesel at all break powers. All the Aniseed oil Biodiesel blends produces very less amount of NO_x as emission. That to, when we compare the D100 with Biodiesel blends for 100% brake power, Biodiesel produces twice less amount of NO_x than D100.

5.4 CO₂ EMISSION.

BP (kw)	BP (%)	D 100	S1 (B10+TiO ₂)	S2 (B15+TiO ₂)	S3 (B20+TiO ₂)	S4 (B25+TiO ₂)	S5 (B30+TiO ₂)
0.0	0%	2.34	1.14	1.08	1.07	1.09	1.06
0.87	25%	3.06	1.48	1.33	1.23	1.35	1.46
1.74	50%	3.91	1.74	1.52	1.58	1.68	1.95
2.76	75%	4.59	2.07	2.05	1.78	1.83	2.09
3.5	100%	5.66	2.46	2.44	2.41	2.43	2.54

Table 5.4 CO₂ Emission in ppm.

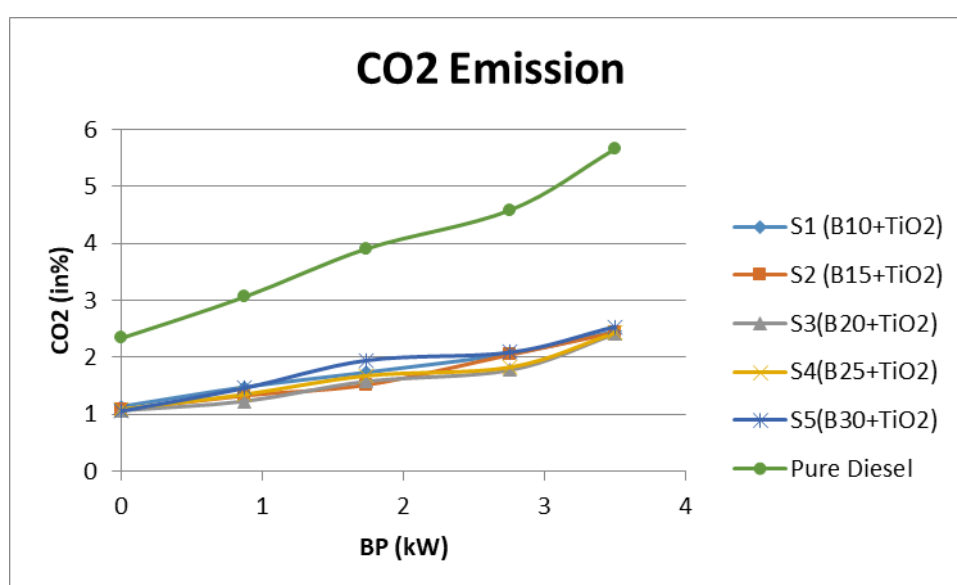


Fig 5.4: CO₂ Emission in ppm.

Above bar chart compares CO₂ emission of both biodiesel blends with Aniseed oil and diesel. CO₂ emission is one of the dangerous gas released during combustion, so it is important to reduce the CO emission. Our experiment shows that all our bio diesel produces far less percentage of CO emission than D100.

5.5 HC EMISSION.

BP (Kw)	BP (%)	D 100	S1 (B10+TiO ₂)	S2 (B15+TiO ₂)	S3 (B20+TiO ₂)	S4 (B25+TiO ₂)	S5 (B30+TiO ₂)
0.0	0%	30	5	5	4	4	3
0.87	25%	38	8	7	6	5	5
1.74	50%	42	10	9	9	8	9
2.76	75%	46	13	12	10	10	11
3.5	100%	51	15	14	14	12	12

Table 5.5 HC Emission in %

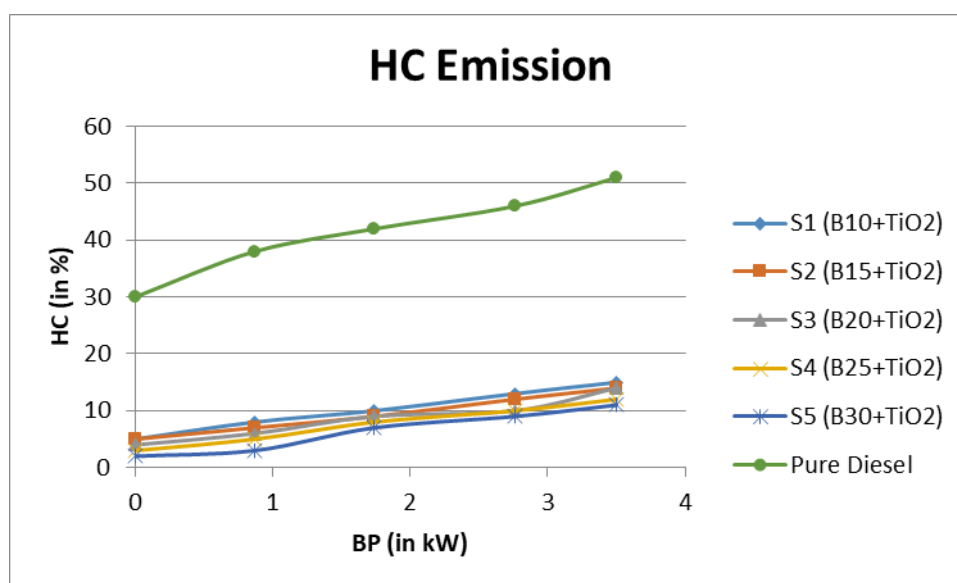


Fig 5.5: HC Emission in ppm.

This chart compares the emission of HC of Aniseed 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 Aniseed biodiesels there is significant change in HC emission. All samples produce far low percentage of HC in the emission smoke than D100. For more accurate precise results B30 produces very less amount of HC.

5.6 CO EMISSION.

BP (kw)	BP (%)	D 100	S1 (B10+TiO ₂)	S2 (B15+TiO ₂)	S3 (B20+TiO ₂)	S4 (B25+TiO ₂)	S5 (B30+TiO ₂)
0	0%	0.058	0.041	0.041	0.04	0.039	0.038
0.87	25%	0.057	0.039	0.038	0.035	0.034	0.033
1.74	50%	0.055	0.035	0.035	0.033	0.03	0.031
2.76	75%	0.05	0.033	0.032	0.03	0.029	0.028
3.5	100%	0.047	0.03	0.029	0.028	0.027	0.025

Table 5.6 Emission in CO %.

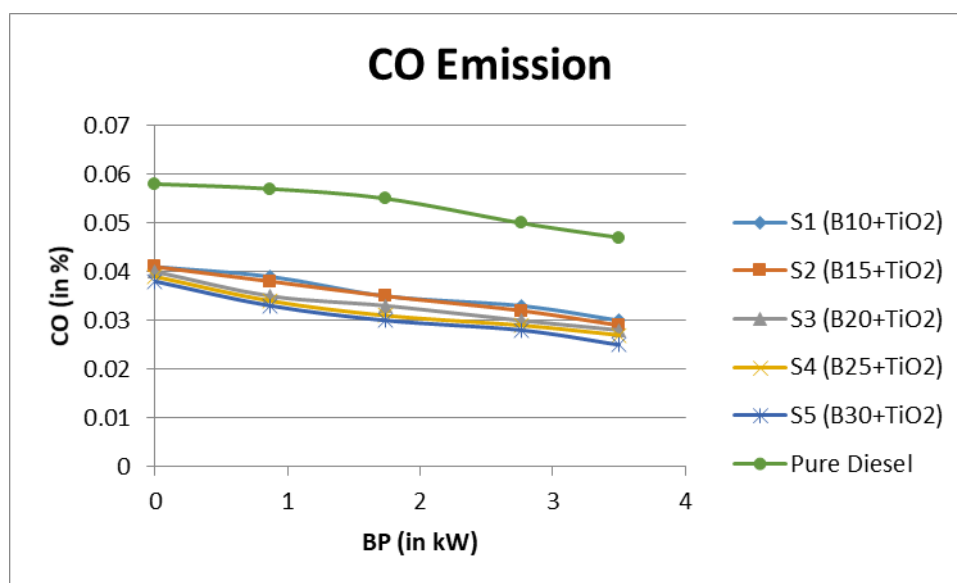


Fig 5.6: CO Emission in %

From fig 5.6, the average of CO% in all the blends under varying brake power is comparatively lower than diesel. This is due to the oxygen contents in the biodiesel which makes easy burning at higher temperature in the cylinder. Almost all the blends of biodiesel produces similar percentage of CO emission.

5.7 O₂ EMISSION.

BP (KW)	BP (%)	D100	S1 (B10+TiO ₂)	S2 (B15+TiO ₂)	S3 (B20+TiO ₂)	S4 (B25+TiO ₂)	S5 (B30+TiO ₂)
0	0	17.03	18.88	18.75	18.98	18.48	18.83
0.87	25%	15.86	18.08	18.18	18.39	18.22	18.09
1.74	50%	14.79	17.62	17.5	17.87	17.58	17.45
2.76	75%	13.59	17.07	17.33	17.29	17.15	16.89
3.5	100%	12.12	16.49	16.58	16.64	16.55	16.39

Table 5.7 Emission in O₂ %.

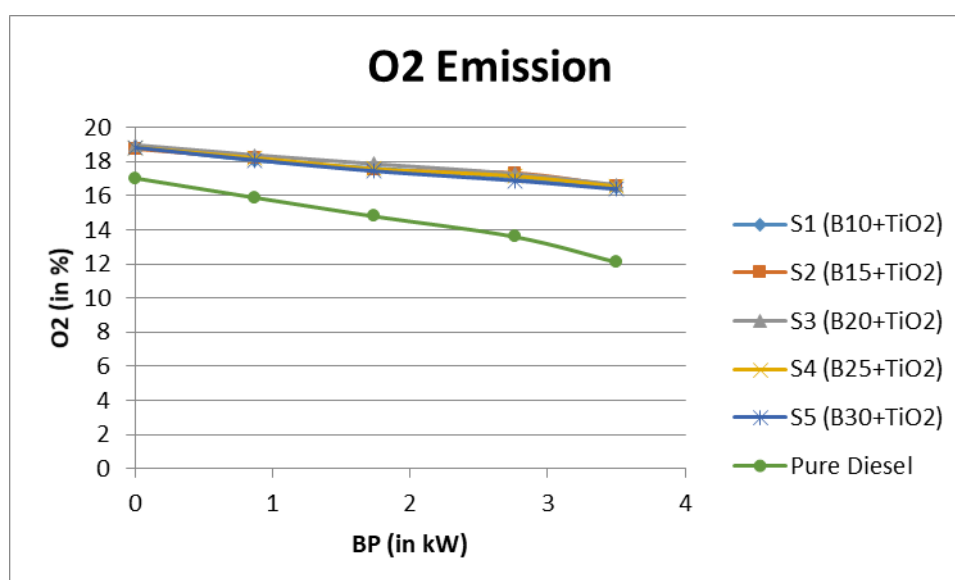


Fig: 5.7 Emission in O₂ %.

The above graph is the comparison of O₂ Emission in both Biodiesel blends of Aniseed oil and D100. It is clear that bio diesel blends produces more amount of O₂ emission, this is because the oxygen present in biodiesel which was responsible for burning of mixture, left as oxides.

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.

BTE of D100 compared with S1, S2, S3, S4 and S5. And finally can be concluded that aniseed oil blends produce similar results with D100.

For Better Specific fuel consumption, the results show that almost all the sample having same specific fuel consumption for varying Brake power except D100.

For Lower HC, the result shows that there is far significant change in HC emission of aniseed oil blends than pure diesel.

For lower CO and CO₂, D100 is compared with Biodiesel blend samples. The result shows that all samples reduces CO and CO₂ emission compared to D100.

For lower NO_x, bio diesel produces far lower NO_x than D100. And that too for 100% brake power, D100 produces more than twice the amount of biodiesel.

For O₂ emission, the result is different as D100 produces a little lower than biodiesel blends.

CHAPTER 7

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