

EMISSION CHARACTERISTICS OF SPIRULINA MICROALGAE BIODIESEL BLEND USING NANO PARTICLE

Submitted in partial fulfilment of the requirements for the award of

Bachelor of Engineering degree in
Mechanical Engineering

By

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(DEEMED TO BE UNIVERSITY)

Accredited with grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of HRITHIK M (Reg. No. 38150036) and ARAVIND K (Reg. No. 38150013) who carried out the project entitled **"EMISSION CHARACTERISTICS OF SPIRULINA MICROALGAE BIODIESEL BLEND USING NANO PARTICLE"** under our supervision from September 2019 to April 2020.

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We, HRITHIK M (38150036) and ARAVIND K (38150013) hereby declare that the Project Report entitled "EMISSION CHARACTERISTICS OF SPIRULINA MICROALGAE BIODIESEL BLEND USING NANO PARTICLE" done by me under the guidance of Mr. S. VENKATESH, ME, (Ph.D.), is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Aeronautical Engineering.

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ABSTRACT

The world depends on fuels. Microalgae *Scenedesmus dimorphous* is a fresh water unicellular green alga. This paper elaborate about emission trait of spirulina microalgae biodiesel by adding tiny dosage of nano particles boost for the ameliorate performance all inclusive. The nano particles taken as 0. 9 (cao) calcium oxide + (Al_2O_3) aluminium oxide in *Scenedesmus dimorphous* microalgae were analysed by different experimental method. In a internal combustion engine (IC)_having power 3.50KW and 1500rpm which is single cylinder four stroke constant speed, water cooler diesel engine with cylinder bore 87.50(mm), stroke length 110.0(mm) , connecting rod length 234.00(mm), compression ratio. 00, swept volume 661.45(cc) .the engine accommodate different loads of 0% , 25%, 50%, 75%, or 80% and 100% and also different blend such as (B20% *Scenedesmus dimorphous*% diesel), (B20% *Scenedesmus dimorphous* +80% diesel + cao 50ppm + Al_2O_3 50ppm) and with pure diesel nanoparticle were sonicated to appraisal the combustion performance and emission trait. The performance quality of bio fuel such as Hydro Carbone (Hc), carbon monoxide (co), carbon dioxide (CO_2), oxygen (O_2) and nitrogen oxide (NO_x) emission. The simulation was carried out for evaluating the parameter such as cylinder pressure, exhaust gas temperature and brake thermal efficiency, brake specific fuel consumption, brake power., microalgae biodiesel is an accelerating energy and costly manageable, algae is an 3rd generation bio fuels. Biodiesel will reduce CO_2 emission and it is renewable. algae has capture ability of CO_2 . As, result using of biodiesel in an engine there is a significant reduction in the harmful pollutants in the environment.

TABLE OF CONTENTS

Chap No	TITTLE	Page No
	ABSTRACT	v
	LIST OF FIGURES	ix
	LIST OF TABLES	xi
	LIST OF SYMBOLS AND ABBREVIATIONS	xii
1	INTRODUCTION	10
	1.1 FOSSIL FUEL DEPLETION	10
	1.2 ALTERNATE FUEL	11
	1.2.1 Biomass	12
	1.2.2 Biodiesel	12
	1.2.2.1 <i>First generation biofuel</i>	12
	1.2.2.2 <i>Second generation biofuel</i>	13
	1.2.2.3 <i>Third generation biofuel</i>	14
	1.3 BIOFUEL PROPERTIES	14
2	LITERATURE SURVEY	16
3	METHODOLOGY	20
4	BIODIESEL MATERIALS	21
5	TRANSESTERIFICATION PROCESS	22
6	ULTRASONICATION	23
7	ENGINE SPECIFICATION	24
	7.1 ENGINE DETAILS	24
	7.2 COMBUSTION PARAMETERS	25
	7.3 PERFORMANCE PARAMETERS	25
8	RESULTS AND DISCUSSION	26
9	CONCLUSION	36
	Reference	37

LIST OF FIGURES

FIGURE No	TITLE	PAGE No.
6.1	MIXING OF ALGAE WITH DIESEL	22
6.2	ULTRASONICATION BATH	23
6.3	BLEND OILS	23
7.1	SINGLE CYLINDER WC DIESEL ENGINE	25
7.2	EMISSION TESTER	25

LIST OF TABLES

TABLE No	TITLE	PAGE No.
8.1	OBSERVATION DATA	32
8.2	RESULT DATA	33

LIST OF SYMBOLS AND ABBEREVIATIONS

V_c	Cutting speed (mm/sec)
N	Spindle speed (rpm)
V_c	Penetration rate (mm/sec)
F_n	Feed per revolution (mm/rev)
MRR	Metal Removal Rate (Q)
M_c	Torque (N/m)
T_c	Machining Time (sec)
A_e	Axial depth of cut (mm)
A_p	Radial depth of cut (mm)
R_a	surface roughness factor
L	length of cut (mm)
D	diameter (mm)
F_x	Tangential Force (N)
F_t	Thrust Force (N)

CHAPTER 1

INTRODUCTION

1.1. FOSSIL FUEL DEPLETION

It is the hydrocarbon-rich leftovers of deceased plants and animals buried underground that people retrieve and use as fuel. Miners and drillers extract coal, petroleum, and natural gas, which are the three primary fossil fuels. There are a variety of ways in which fossil fuels can be used to generate heat (e.g., for cooking), power engines (such as those in automobiles), or generate electricity. Fossil fuels are derived mostly from the anaerobic breakdown of long-dead animals, which contains molecules formed during ancient photosynthesis and so contain organic molecules. A geological process of millions of years is often required to transform these materials to high-carbon fossil fuels, and in certain cases, more than 650 million years. The refining and chemical industries can turn fissile fuels into other chemicals or derivatives. For example, the most popular refined fossil fuels are kerosene (petrol), gasoline, and propane, and the most common chemical products include most plastics, as well as fertilisers and pesticides for farming. Fossil fuels provided 84% of the world's main energy usage and 64% of the world's power in 2019. When fossil fuels are used in any way, they harm the environment and the people who live nearby. This is true for the extraction process, transportation, and consumption itself. Burning fossil fuels accounts for more than 80 percent of the carbon dioxide (CO₂) generated by humans each year, compared to about 4 billion tonnes from land use change. There is a net increase of many billion tonnes of CO₂ in the atmosphere every year due to natural processes on Earth, such as ocean absorption. Methane leaks are also a big factor. Because carbon dioxide and methane retain heat in the atmosphere, these gases have been linked to climate change. For global warming and ocean acidification, fossil fuel emissions are the primary source. Fossil fuel particles and toxic gases are responsible for the majority of air pollution-related deaths. This pollution costs the world economy approximately 3% of GDP, and eliminating fossil fuels would save millions of lives each year. There has been a dramatic shift in legislation and activism in favour of renewable energy as a result of the growing awareness of the climate catastrophe, pollution, and other negative affects produced by fossil fuels. There will be

huge economic ramifications, however, because the fossil fuel industry is massively subsidised and integrated into the global economy. According to many stakeholders, this transition must be fair and policy must address the social constraints caused by fossil fuel industry's stranded assets. In the shape of SDG 7: Affordably and Cleanly Produced Energy, SDG 13: Climate Action, and the Paris Climate Agreement, international policy seeks to promote this worldwide shift. The International Energy Agency concluded in 2021 that if the world economy and society are to escape the worst impacts of climate change and reach international targets for climate change mitigation, no new fossil fuel extraction projects can be started in that year.

1.2. ALTERNATE BIOFUEL

It's a phrase for any element or substance that can be used as a fuel instead of traditional fuels like petroleum (oil), coal, and natural gas; uranium and thorium; and artificial radioisotope fuels created in nuclear reactors. Bio-diesel and bio-alcohol (such as methanol and ethanol, as well as propane), refuse-derived fuels, chemically stored electricity (such as in batteries and fuel cells), hydrogen, and other biofuels are a few well-known alternative fuels. A fuel is any substance that may be made to react chemically with other substances to release heat or mechanical energy. The basic purpose of fuel is to store energy, which must be preserved in a form that is both stable and portable to its ultimate use place. Chemical energy is the source of nearly all forms of energy. This fuel, for example, can be used to power an engine and generate heat. It can also be used to generate energy for heating, lighting, and other purposes. Biofuels are an example of renewable resources. Even though renewable energy is largely used to generate electricity, it is commonly assumed that some form of renewable energy, or at least a fraction of it, is used to make alternative fuels. Researchers are always on the lookout for novel biofuel crops and techniques to boost oil production. If current yields hold, producing enough oil to replace all fossil fuel consumption would need a massive quantity of land and freshwater.

1.2.1. Biomass

The term "biomass" refers to a wide range of living and recently deceased biological elements that can be burned as fuel or used in industrial manufacturing. Switching coal power plants to biomass has proven to be a popular way to generate renewable energy without wasting existing infrastructure and plant. Plants and plant-based substances that are not used for food or feed are referred to as nitrocellulose biomass in the context of biomass. Biomass can be burned directly for heat or transformed into a variety of biofuels that can then be used to produce electricity. Renewable biofuels, such as those derived from algae, have been touted in the media as a possible solution to the transportation challenges posed by crude oil. Each acre of algae may provide more than 2000 gallons of fuel each year. The U.S. Navy has successfully tested algae-based fuels. It is anticipated that the price per pound of algal plastic will be lower than that of ordinary plastics, and thus has the potential to reduce waste..

1.2.2. Biodiesel

Vegetable oils such as canola, sesame, cottonseed, and sunflower oil are used in the production of bio-diesel. Animal fats are also used in the production of bio-diesel. When these hydrocarbons are removed from these fats or oils and then mixed with an alcohol like methanol, diesel is formed. It is possible to mix these raw components with pure diesel to make various amounts, or to use them as a standalone product. Because it burns more cleanly and effectively, biodiesel releases fewer pollutants (such as carbon monoxide particulates and hydrocarbons) than traditional diesel. Sulfur-free biodiesel still outperforms ordinary diesel, even with LSD (ultra-low sulphur diesel) reducing the sulphur content.

1.2.2.1. First-generation Biofuels

First-generation biofuels, such as ethanol and biodiesel, are generated from edible biomass. *Saccharomyces cerevisiae*, a traditional or GMO yeast strain, is often used to ferment C6 carbohydrates (mainly glucose) into ethanol. Only a few different feedstocks, such as sugarcane or corn, are used in the production of first-generation bioethanol.

Whey, barley, potato wastes, sugarbeets, and other marginal feedstocks are examples of first-generation bioethanol feedstocks. Brazil is one of the most popular suppliers of sugarcane for biofuel production in the world. A simple process can be used to produce ethanol from sugarcane. Sugarcane sucrose is extracted by crushing it in water, and the sucrose is processed to produce raw sugar. Increases in sugar prices, while favourable to growers, represent a substantial threat to the profitability of the bioethanol business. Biodiesel is the only other industrially manufactured biofuel. This biofuel's production method differs greatly from that of ethanol in terms of chemistry. Aside from biomass (oily plants and seeds), the process of manufacturing biodiesel relies on transesterification, which requires replacing methanol for glycerol to break the bonds between long-chain fatty acids and glycerol.

1.2.2.2. Second-generation Biofuel

Non-edible cellulosic biomass is the most frequent feedstock for second generation biofuels, but it is by no means the only one. According to Lavoie et al., biomass is typically divided into three categories for the production of second generation biofuels: homogeneous, such as white wood chips with a price value of up to US\$120/t; quasi-homogeneous, such as agricultural and forest residues priced between \$60 and \$80/t; and non-homogeneous, such as municipal solid wastes (between US\$0 and US\$60/ton) (2011). The cost of using this biomass is far cheaper than the cost of using vegetable oil, corn, or sugarcane, for example. This sort of biomass, on the other hand, is more difficult to convert, and its production is dependent on the development of new technology. In order for the biofuel sector to remain profitable, the cost of converting the original feedstock to the final product must be as low as possible. While many biomasses (such as corn, which may be used for both ethanol and livestock feed) have a restriction on the number of products that can be created from a single source, the word "biorefinery" can be used to describe those that do. For the production of second-generation fuels, both "thermal" and "bio" techniques can be employed to convert biomass into biofuels. This simplified schematic depicts second-generation biofuel manufacturing routes.

1.2.2.3. Third-generation Biofuels

It's widely believed that algal biomass, which has a much higher growth rate than lignocellulosic biomass, is the primary source for third-generation biofuels. The lipid content of microorganisms is often used to produce biofuels from algae. It is common practise to target *Chlorella* species due to the high lipid content and high productivity they provide. Algae biomass presents a wide range of obstacles, some of which are geographic and some of which are technical. In optimal conditions, algae typically produce between 1 and 7 grammes of biomass per litre of water every day. For nations like Canada where winter temperatures drop to minus 0 degrees Celsius for long periods of time, this means that vast amounts of water are needed to operate on an industrial scale. Lipids must be extracted from algal biomass, which must first be dewatered using centrifugation or filtration in order to remove the excess water before lipids can be removed. Hydrogenolysis or transesterification of algae-derived lipids can yield kerosene-grade alkane appropriate for use in aviation fuels, or the transesterification method mentioned above..

1.3. BIODIESEL PROPERTIES

The monoalkyl esters of vegetable oils, animal fats, or cooking grease are known as biodiesel. Many commercial fuel producers are interested in using it in compression-ignition engines, which have shown considerable potential. Most of the energy demand is fulfilled by conventional fuels, but they are diminishing at an alarming pace. To understand why biodiesel shares so many features with diesel, researchers turned to the world's finite supply of petroleum-based fuels. A biodiesel's viscosity, cloud point, pour point, flash point, higher heating value (HHV), cetane number, and other characteristics can be used to identify it in general. Before the transesterification process, most of these characteristics have a higher value. After the feedstock is transformed into fatty acid methyl esters, properties such as viscosity, cloud point, and flash point all drop significantly. One such attribute that has the potential to have a significant impact on vehicle emissions is viscosity. Viscosity increases at low temperatures, resulting in poor atomization of fuel particles and erratic fuel burning, which can be controlled by this system. During low temperatures, the viscosity of the fuel can be controlled by adjusting the cloud point. Viscosity at low temperatures is less likely to increase when the cloud

point drops. The higher the flash point, the more energy it takes to burn the fuel, which in turn leads to larger emissions. Since fuel combustion emission concentrations are controlled by characteristics, it is critical to keep an eye on them. This study compared the physical qualities of three distinct biodiesels (soybean, waste cooking oil, and tallow) to Ultra Low Sulfur Diesel. Crushing and pressing can be used to extract vegetable oils, which are found in the seeds of many plants. As of this writing, they have an energy density of 36-39 GJ t⁻¹, which is somewhat lower than that of fossil diesel fuel. Although vegetable oils can be used directly in diesel engines as Raw Straight Vegetable Oils (SVO), due to their high viscosity and other issues such as polymerization, wax sedimentation, coking at fuel injectors, solidification at low temperatures, and other issues, using SVO in burners or engines is difficult. You'll need to make some engine changes if you're going to use SVO as a fuel. If they're mixed with diesel fuel, incomplete combustion, which can lead to carbon buildup in the cylinders, could be a problem. Because of these factors, chemical conversion of vegetable oils into esters, a type of biodiesel, is preferred.

By possessing physical qualities similar to those of fossil diesel, biodiesel avoids some SVO-related issues; yet, important concerns remain, including the presence of methanol and alkali residues in biodiesel. In Mozambique, jatropha and waste cooking oil-based biofuels are important because they help to reduce the country's reliance on imported fossil fuels, contribute to energy diversification and rural development, reduce greenhouse gas emissions, and promote renewable energy sources by reducing the amount of waste cooking oil dumped into sewage, landfills, water, and the soil..

CHAPTER 2

LITERATURE SURVEY

has grown in popularity as a potential biofuel to replace fossil diesel over the last two decades. The non-recyclability of homogeneous alkali catalysts, as well as waste creation from subsequent water washing, were both disadvantages of biodiesel synthesis in the business. Ionic liquids are one of the best alternatives to alkali catalysts because of their non-volatility, superior solubility for various organic and inorganic components, structural tunability, environmental friendliness, and wide liquid temperature range. Despite this, because to their viscosity and recovery issues, their application has been limited. Heterogenization of ionic liquids on solid supports has recently been offered as a solution to these issues. Nanoporous materials, which have a high porosity and specific surface area, have shown promise in providing stable supports for these types of solids. The latest breakthroughs in biodiesel catalyst design employing ionic liquids on nanoporous materials are examined in this study. The major goal was to use these catalysts to optimise reaction conditions. It was also discussed how to use these catalysts to improve the whole production process. The cost of nanoporous materials-supported ionic liquids in biodiesel production is significantly higher than that of traditional catalysts. To solve this obstacle, more cations and anions can be utilised for less money; more ionic liquids can be added; and improving catalyst reusability in future trials can all assist. It was discovered that nitrogen supplementation (with or without 20 g/L peptone) affected *Saccharomyces cerevisiae*'s ability to create bioethanol from waste bread, watermelon, and muskmelon feedstocks. Nitrogen addition led in increased ethanol yield at both temperatures. When compared to fermentation at 250°C, fermentation at 300°C produced more ethanol. The highest ethanol output was 0.502 g ethanol /g fermentable sugar, which was 98.22% of the theoretical maximum, when muskmelon juice was fermented at 300°C with nitrogen addition. The ethanol yields of watermelon and muskmelon changed significantly ($p < 0.05$) between experiments with and without nitrogen addition, while the yields of waste bread hydrolysate were the same at both temperatures. At 250 and 300 degrees Celsius, however, the ethanol yields of all feedstocks with and without nitrogen

treatment were substantially different ($p < 0.05$). Under different conditions, refined and low-grade vegetable oils containing moderate to high free fatty acids (FFAs) and water were treated to one-step homogeneous base catalysis. The reaction was examined utilising a meso-OBR, a continuous process screening device, to quickly screen through situations. This investigation was used to model the conditions. Rapeseed oil was converted to FAME utilising a 0.5 percent catalyst at 500°C for 16 minutes and a 13:1 methanol-to-oil molar ratio. At an 18:1 methanol to oil ratio, 2 wt% catalyst, 500C, and 4.25 minutes for FAME production using low-grade RSO (2.75 wt. percent FFA), up to 90 percent FAME was achieved using low-grade RSO (2.75 wt. percent FFA). The TEAs were computed using a plant capacity of 100,000 te/y and a 20-year plant lifespan. The results of an alkali-catalyzed transesterification stage followed by a pre-treatment step to reduce FFA concentration were compared to those of a normal one-step biodiesel process. Low-quality RSO could be processed in a single step, saving money over the two-step approach that relied on refined oil. Biofuels can help to mitigate the environmental difficulties that come with continued use of fossil fuels. In this study, *Trichiliaaemetica*Vahl (Mafura) seeds from Mozambique can be used as a biodiesel feedstock. Due to the oil's high acidity, esterification with H₂SO₄ as a catalyst was required to convert Mafura oil to fatty acid methyl ester (FAME). The acidity dropped from 27.58 to 0.36. (mg KOH g⁻¹). A variety of additional physical and chemical attributes of FAME were found to be within EN14214 and Brazilian standards' permitted limits. The low induction period (IP) was exceeded by 10.8 hours when 500 ppm of tertbutyl hydroquinone (TBHQ) was added to a test solution. The conversion of the feedstock (90.1 percent weight) was confirmed using a gas chromatograph with a flame ionisation detector (GC-FID). The fatty-acid methyl ester composition of Mafura biodiesel included palmitic acid (39.32 percent weight), linoleic acid (31.09 percent weight), oleic acid (25.77 percent weight), stearic acid (2.29 percent weight), meristic acid (0.78 percent weight), linolenic acid (0.61 percent weight), and lauric acid (0.14 percent wt). The biodiesel manufactured from Mafura oil, according to these studies, met the bulk of the quality requirements imposed by American, Brazilian, and European regulatory organizations. Biodiesel is a sustainable, biodegradable, and non-toxic alternative to traditional fossil fuels. It is often made from non-edible plant oils and leftover cooking oil. Biodiesel creates fewer air pollutants,

greenhouse gases other than nitrous oxide, and is easier to treat than fossil fuels. Biodiesel has a number of advantages, including the fact that it is environmentally benign and may be used as a substitute for normal diesel. This study aimed to address these issues as well, because the scope and need for biodiesel are addressed in addition to other characteristics that influence biodiesel production. The kind and concentration of catalyst, oil to alcohol ratio, and other purification methods have all been explored in order to reduce the number of operations required to manufacture biodiesel from lipid/fat content. Biodiesel Purification by Drying Dry washing, which uses unusual bio adsorbents instead of water, can help to lessen the harmful impacts of contamination. Although commercial adsorbents are obtained from industrial processes, their composition makes them unsuitable for usage as a long-term resource in the biodiesel synthesis process all over the world. Organic wastes such as sawdust, coconut fibre, nutshell, rice husk, and water hyacinth fibre have been proposed as bio adsorbents for the purification of biodiesel from waste cooking oil. The quality parameters of the acid number, water content, and free and total glycerin content were analysed and compared using commercial adsorbents (Magnesol and Amberlite BD10DRY). When compared to unpurified biodiesel, sawdust in the purification process resulted in a 31.3 percent reduction in acid number value, which is promising. Sawdust reduction was actually more effective than Amberlite BD10DRY reduction (that increased the acid number). Using sawdust instead of Amberlite BD10DRY resulted in a 54.8 percent reduction in total free glycerin. Total glycerin levels were similar in commercial adsorbents and sawdust. Sawdust purification yielded water content that was equivalent to Amberlite BD10DRY and superior to Magnesol (399, 417, and 663 mg/kg, respectively). Sawdust can be used as an alternative bio adsorbent with a lower environmental impact for biodiesel purification. biosorbents made from pomelo peel and sugar beets in their natural state. Dry purification of biodiesel samples made from animal fat and vegetable oil was examined using a conventional procedure at loadings of 1%, 3%, and 5% (w/v). The acid value (AV), peroxide value (PV), density and viscosity of the biodiesel, flash point (FP), soap, and free glycerol were among the quality criteria evaluated (FG). When dry washing and water washing approaches were evaluated, the results were found to be similar. FTIR and SEM methods were used to characterise biosorbents. By loading both bio sorbents at 5%, the

soap concentration was reduced to below 36 ppm. After water washing, biodiesel manufactured from vegetable oil included 172.6 ppm of soap, but biodiesel made from lard contained 256 ppm of soap. The FG removal efficiency was directly related to the biosorbent loadings. Purification using 5% pomelos peel and 5% sugar beet yielded the lowest FG values in vegetable oil biodiesel (0.25 ppm) and lard biodiesel (0.23 ppm). The 5 percent pomelo peel outperformed the 3 percent pomelo peel in terms of results. The adsorption capacity of the pomelo peel is explained by its porous structure and functional groups. Over the last ten years (2007–2018), a comprehensive review of biodiesel production literature has pointed to membrane-based sustainable and ecologically friendly manufacturing. Biodiesel manufacturing techniques have progressed in recent years, utilising improved feedstock, better catalysts, more efficient reactor technology, and more effective downstream separation-purification operations. According to a review, despite the relatively simple transesterification process between alcohol and plant oil/animal fats that results in biodiesel, downstream separation and purification of the final product (fatty acid methyl esters) is exceedingly challenging. Productivity can be increased using new generation catalysts, environmentally friendly solvents, and more efficient reactor technology, according to the findings of this review, while downstream purification using custom membranes in appropriate modules offers low-cost and environmentally friendly options. High process intensification can be obtained using membrane-based technology, while the recovery and reuse of catalysts and alcohol are anticipated to boost the process's economy, resulting in a sustainable manufacturing method.

CHAPTER 3

METHODOLOGY

The following steps are involved for the Bio Diesel Production

1. Prepare the 60ml Micro Algae Diesel using Trans esterification Method.
2. 240ml Diesel is added with the Micro Algae Diesel.
3. Blend 1 (B20% + Micro Algae Diesel + 80% Diesel).
4. Blend 2 (B20% + Micro Algae Diesel + 80% Diesel + CaO 50ppm +Al₂O₃ 50ppm mixed and undergo with Ultrasonic Sonication process for 30 min to prepare the nano fuels).
5. Engine Load is applied in this experiment and emission characters are calculated.
6. Hydro carbons, CO, CO₂, O₂,NO_x emission characters are calculated.

CHAPTER4

BIO-DIESEL MATERIAL

The compression of the input air and subsequent injection of diesel fuel, a liquid fuel generally referred to as diesel fuel or diesel oil, causes fuel ignition in diesel engines without the use of a spark. As a result, diesel fuel must have good compression ignition qualities. Biodiesel, biomass to liquid (BTL), and gas to liquid (GTL) diesel are examples of non-petroleum-based fuels that are gaining popularity. In academic circles, the term "petroleum diesel" is increasingly being used to distinguish between the two types of fuel. In numerous countries, diesel fuel is the standard. The European Union's diesel fuel standard, for example, is EN 590. Diesel fuel has a number of nicknames, the most common of which is simply "diesel." In the United Kingdom, diesel fuel for on-the-road use is commonly referred to as DERV, which stands for diesel-powered road vehicles. [2] In Australia, diesel fuel is known as distillate[3] and in Indonesia, it is known as Solar, a trademarked word of Pertamina, the country's national petroleum business. Diesel fuel is also known as distillate in Australia. Sulfur content in ultra-low sulphur fuel has been drastically reduced (ULSD). As of 2016, virtually all petroleum-based diesel fuel in the United Kingdom, continental Europe, and North America is ULSD. The majority of diesel engines were fuelled by low-cost fuel oils prior to the standardising of diesel fuel. These fuel oils are still used in diesel engines in watercraft. Despite its design for diesel engines, diesel fuel can be used in non-diesel engines such as the Akroyd engine, the Stirling engine, or steam boilers.

CHAPTER 5

THE TRANSESTERIFICATION PROCESS

Used cooking oils contain triglycerides, which are large molecules made up of various organic acids and glycerol, an alcohol. Esters, which are a mixture of organic acids and other, less dense alcohols, make up the majority of vegetable oil. The process of turning vegetable oil to ethanol or methanol is known as transesterification. As a result, the triglycerides are converted to free glycerol and methanol or ethanol esters. Transesterification is the separation of fatty acids from the glycerol backbone to produce fatty acid esters (FAE) and free glycerol as a consequence. To create fatty acid esters, a basic or acid catalyst can be used to transesterify triglycerides like animal fat or vegetable oil with lower molecular weight alcohols, resulting in biodiesel. In this procedure, monoglycerides and diglycerides are created as intermediates. The reaction is depicted as a molecular process. Those alkyl esters (methyl esters in the case of methanol) are formed by reacting vegetable oil or animal fat with an alcohol (typically methanol) in the presence of a catalyst to produce the fatty acid combination contained in the parent oil or fat.

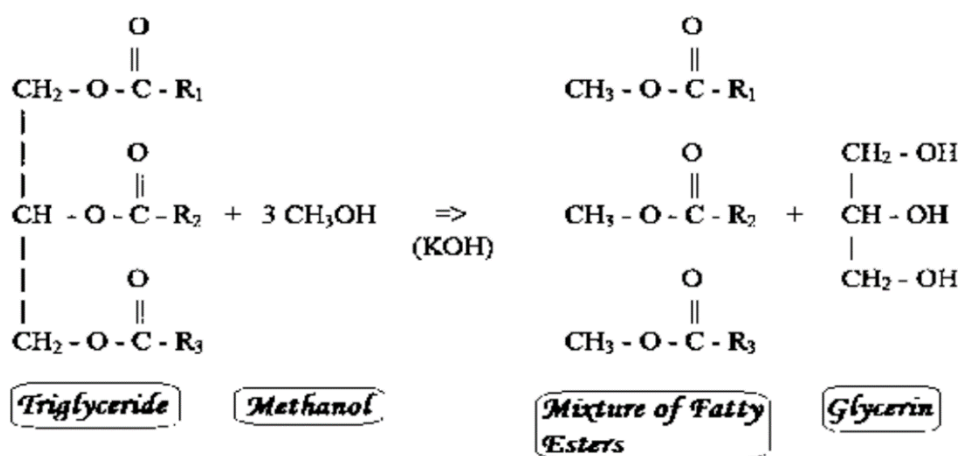


Fig.5.1. Transesterification reaction

In that reaction, the vegetable oil or animal fat is reacted in the presence of a catalyst with an alcohol (usually methanol) to give the corresponding alkyl esters (so, for methanol, the

methyl esters) of the fatty acid mixture that is found in the parent vegetable oil or animal fat.

The transesterification reaction occurs stepwise as shown below :

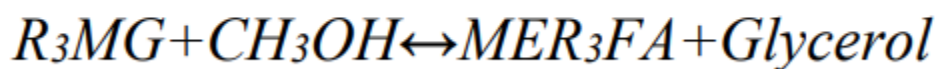
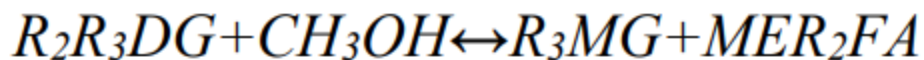
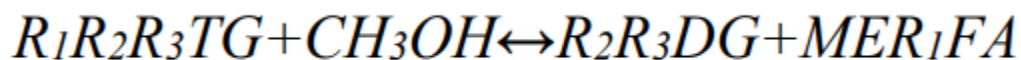


Fig.5.2. Transesterification stepwise reaction

Transesterification reaction stepwise :

where R1, R2, R3 are the alkyl groups of three different fatty acids, e.g., palmitic, oleic or linoleic acids.

TG = Triglyceride

DG = Diglyceride

MG = Monoglyceride

ME = Methyl Ester

FA = Fatty Acid

Transesterification consists of various processes such as alkaline catalyzed, acid-catalyzed esterification, acid-alkaline catalyzed (two stage) and noncatalyzed super critical methanol (Saka), enzyme catalyzed, and heterogeneous catalyst transesterification process.

CHAPTER 6

ULTRASONICATION PROCESS

In order to extract numerous chemicals from plants, microalgae, and seaweeds, sonication is used to apply sound energy to agitate particles in a sample. This method is also known as "ultra-sonication" or "ultra-sonication" because of the frequency at which it is often performed (over 20 kHz). There are several chemical and physical impacts of sonication. Sonochemistry is the study of how sonic waves affect chemical systems, and it's a branch of chemistry. There is no direct interaction between ultrasound and molecular species. Sonochemistry and sonoluminescence cannot be explained by a molecular-level interaction of the acoustic field with chemical species. When sound waves travel through a material in sonochemistry, pressure fluctuations and cavitation growth and collapse occur, converting the audio energy to a form usable by machines.



Fig 6.1: Mixing of Algae With Diesel

Pharmaceutical, cosmetic, food and water industries are among those where it is used. It is also used in ink, paint and coatings, wood treatment, metalworking and many other industries. By disrupting intermolecular connections, sonication can hasten disintegration. NMR tubes, for example, do not have the ability to agitate the material, therefore this technique is very helpful in those situations. Certain chemical reactions can be given a boost with the help of this substance. While the liquid is under a vacuum, sonication can be used to remove dissolved gases from the liquid (degassing). Frozen pump thawing and sparging are alternatives to this technique. Sonication may be sufficient to disrupt or deactivate biological materials in biological applications. In order to rupture cell membranes and release cellular contents, sonication is frequently employed. Sonoporation is the name given to this procedure. Sonication of a dispersion of big multilamellar vesicles can produce small unilamellar vesicles (SUVs) (LMVs). It is also possible to fragment DNA molecules using sonication, which shears long stretches of DNA into smaller fragments. In nanotechnology, sonication is frequently used to disperse nanoparticles in liquids uniformly. It can also be used to disperse micron-sized colloidal particle clumps.



Fig 6.2 :Ultrasonication Bath

Crystallization processes can be started and even controlled with the use of sonication. When precipitation (crystallisation) occurs in an anti-solvent solution, it is employed to facilitate mixing and extract tiny crystals. Ultrasonic cleaning relies on sonication, which loosens particles from surfaces. Nanoparticles can be made by sonication, including liposomes, nanocrystals, and wax emulsions, as well as wastewater purification, degassing, the extraction of seaweed polysaccharides and plant oil, the extraction of anthocyanins and antioxidants, the production of biofuels, crude oil desulphurization, cell disruption, polymer and epoxy processing, adhesive thinning, and many other processes. Ultrasonic baths can be used to clean a variety of goods, including jewellery and eyeglasses, in addition to those used in the laboratory. Even in the food industry, sonication is being used. There are two primary uses for this technology: dispersion to save money on emulsifiers (as in mayonnaise) and filtering speedup (vegetable oil etc.). Sonification has been tested for the artificial ageing of alcoholic beverages such as liqueurs and other spirits.

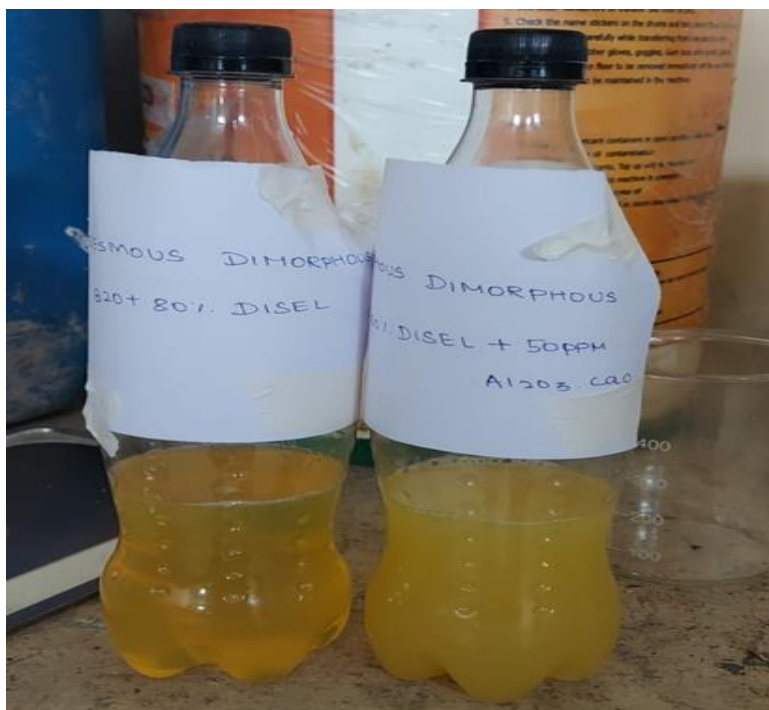


Fig 6.3: Blend Oil

In order to examine the various constituents of soil aggregates (particularly soil organic matter) without submitting them to harsh chemical treatment, ultrasonography is frequently used to break up soil aggregates. It is also possible to remove microfossils from rock using sonication. Several processing methods, including as nano-crystallization, nano-emulsification, DE agglomeration, extraction, and cell disruption, call for high ultrasound amplitudes and intensities. An initial laboratory test can be used to demonstrate feasibility and determine some of the necessary ultrasonic exposure parameters. Flow-through pre-production optimization and continuous production are then carried out on a pilot (bench) size and ultimately on an industrial scale. All local exposure circumstances (ultrasonic amplitude, cavitation intensity, duration spent in the active cavitation zone, etc.) must be kept constant during these scaling-up steps. There will be a predicted "scale-up factor" rise in productivity as long as this condition is met, but the end product quality will stay optimum. In order to process more material per unit of time, ultrasonic processor systems at the lab, bench, and industrial scale contain larger and larger ultrasonic horns, which allow them to generate increasingly larger high-intensity cavitation zones. This leads to an improvement in productivity. "Direct scalability" is the term for this. Increasing the ultrasonic processor's power capacity does not guarantee increased scalability because it might (and commonly does) result in lower ultrasonic amplitudes and cavitation intensities. In order to operate a larger ultrasonic horn, the power rating of the equipment must rise during direct scale-up while maintaining all processing parameters. A problem for process engineers, finding the optimal operating conditions for this equipment necessitates extensive knowledge of the adverse impacts of ultrasonic processors.

CHAPTER 7

ENGINE SPECIFICATIONS

7.1. ENGINE DETAILS

ICEngine set up under test is Research Diesel having power 3.50 kW @ 1500 rpm which is 1 Cylinder, Four stroke , Constant Speed, Water Cooled, Diesel Engine, with Cylinder Bore 87.50(mm), Stroke Length 110.00(mm), Connecting Rod length 234.00(mm), Compression Ratio 0.00, Swept volume 661.45 (cc).



Fig 7.1: Single Cylinder Water Cooled Diesel Engine

7.2. COMBUSTION PARAMETERS

Specific Gas Const (kJ/kgK) : 1.00, Air Density (kg/m³) : 1.17, Adiabatic Index : 1.41, Polytrophic Index : 1.37, Number Of Cycles : 10, Cylinder Pressure Referance : 5, Smoothing 2, TDC Reference :-12.

7.3. PERFORMANCE PARAMETERS

Orifice Diameter (mm) : 20.00, Orifice Coeff. Of Discharge : 0.60, Dynamometer Arm Length (mm) : 185, Fuel Pipe dia (mm) : 12.40, Ambient Temp. (Deg C) : 27, Pulses Per revolution : 360, Fuel Type : Diesel, Fuel Density (Kg/m^3) : 830, Calorific Value Of Fuel (kJ/kg) : 42000".



Fig 7.2: Emission Tester

CHAPTER 8

RESULTS AND DISCUSSION

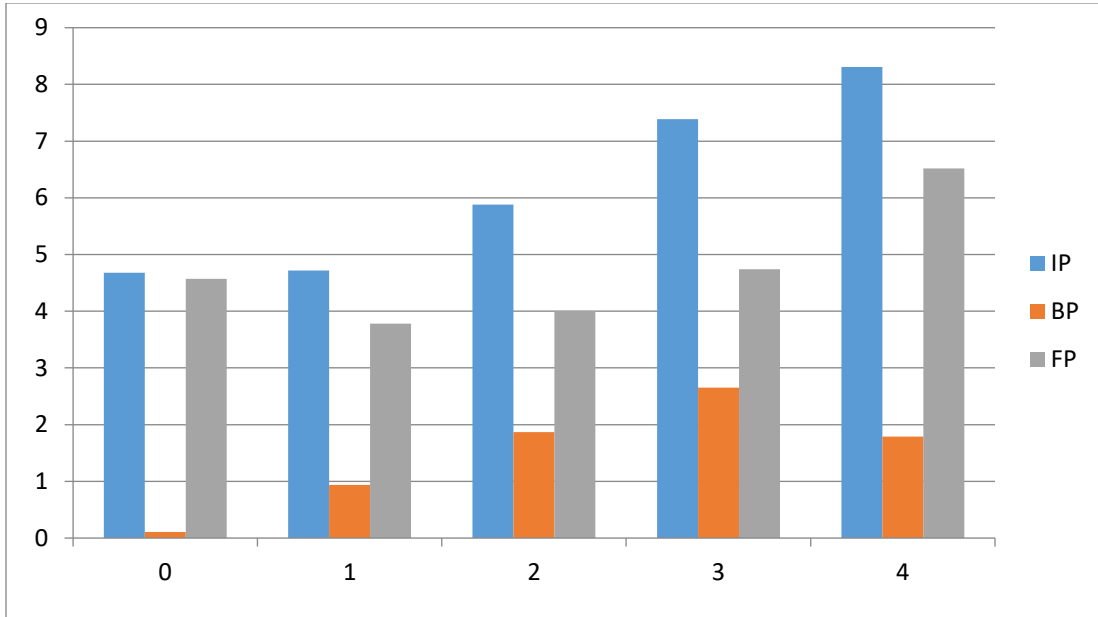


Fig: 8.1 Different Between *Ip,Bp And Fp*

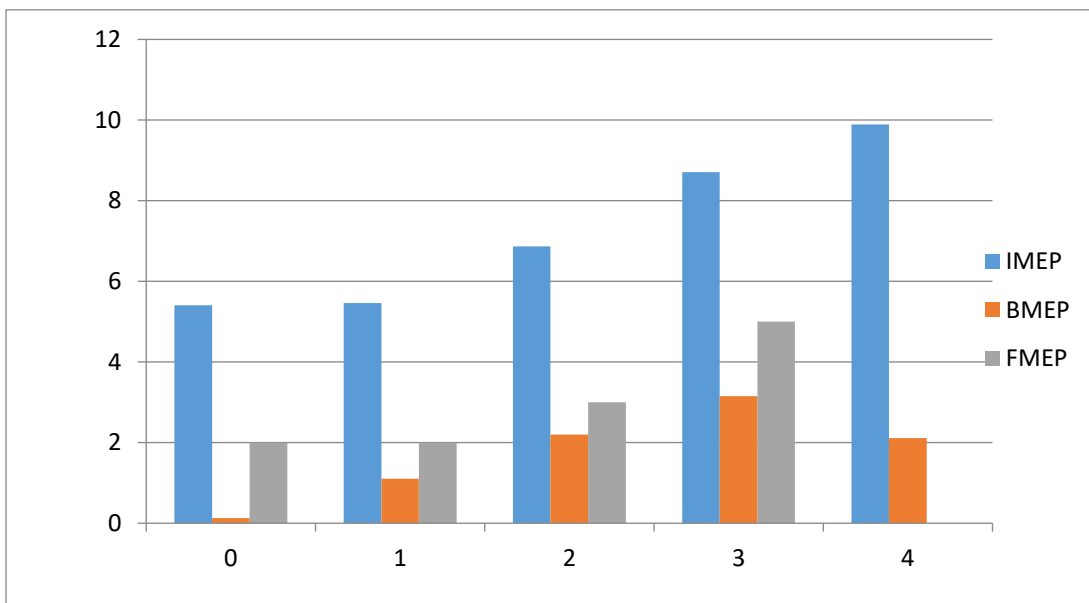


Fig 8.2: Different Between *Imep,Bmep And Fmep*

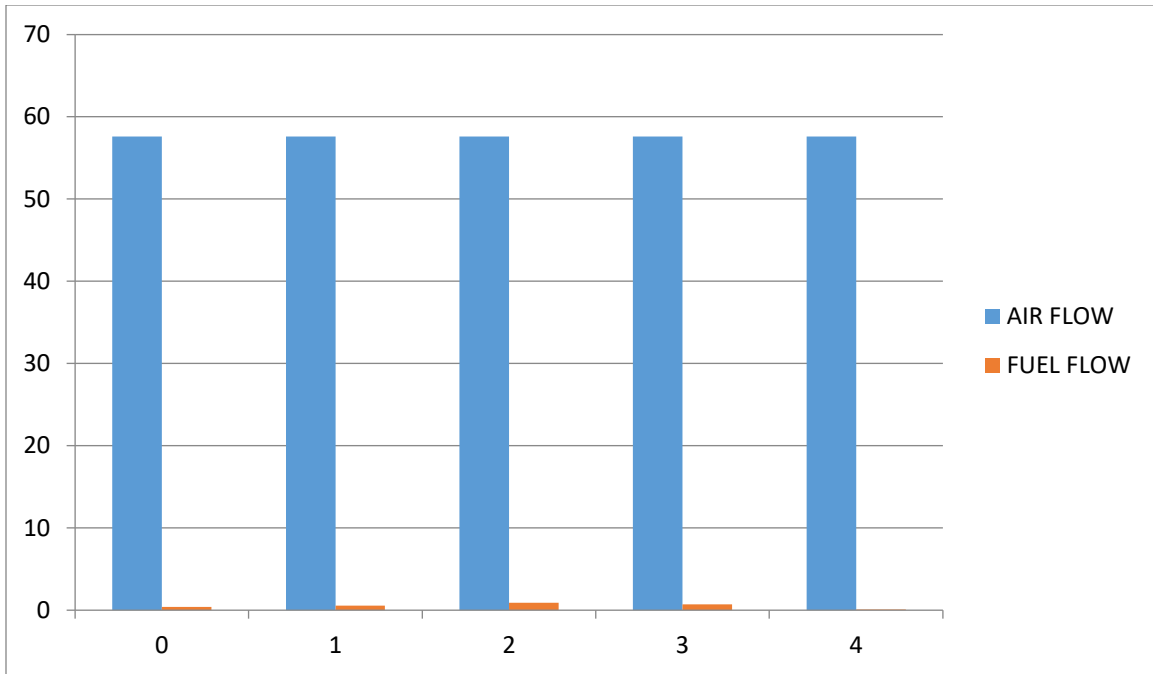


Fig 8.3: Different Between Air And Fuel Flow

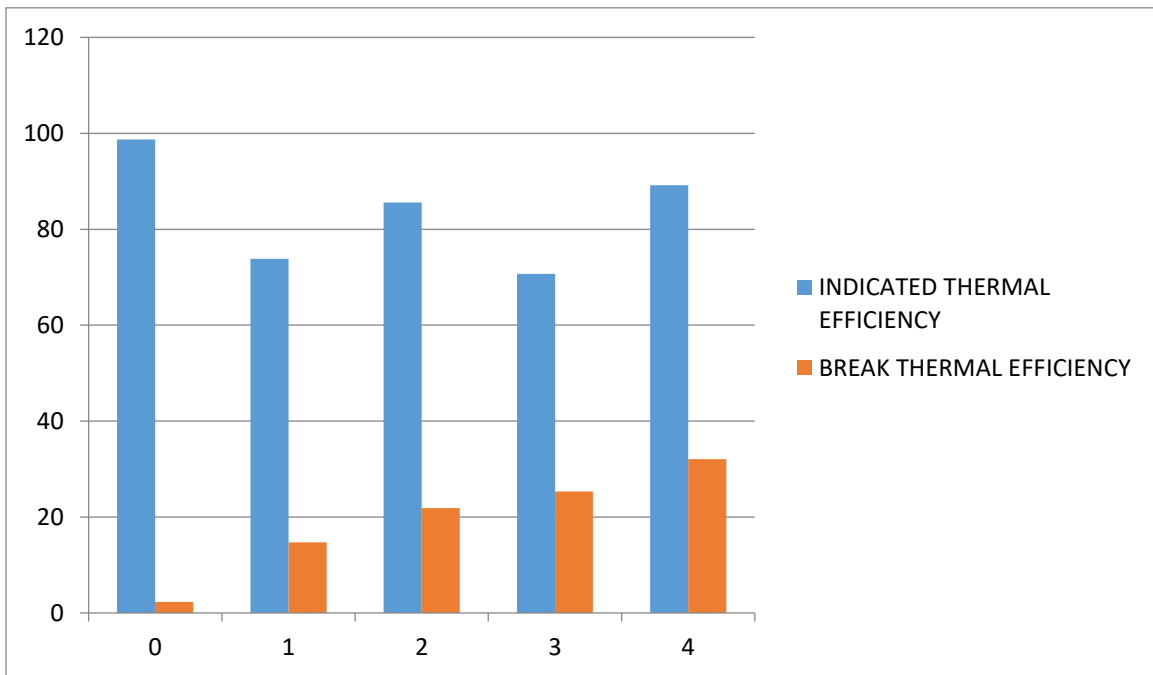


Fig 8.4: Different Between Indicated And Break Theraml Efficiency

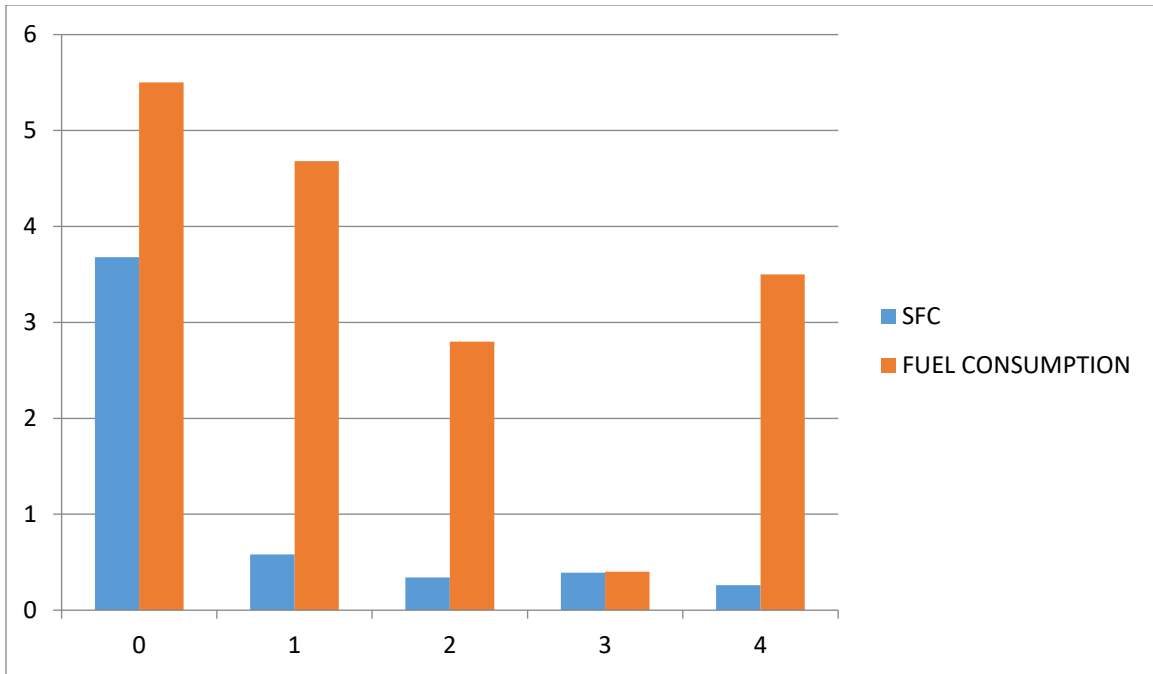


Fig 8.5: Different Between Sfc And Fuel Consumption

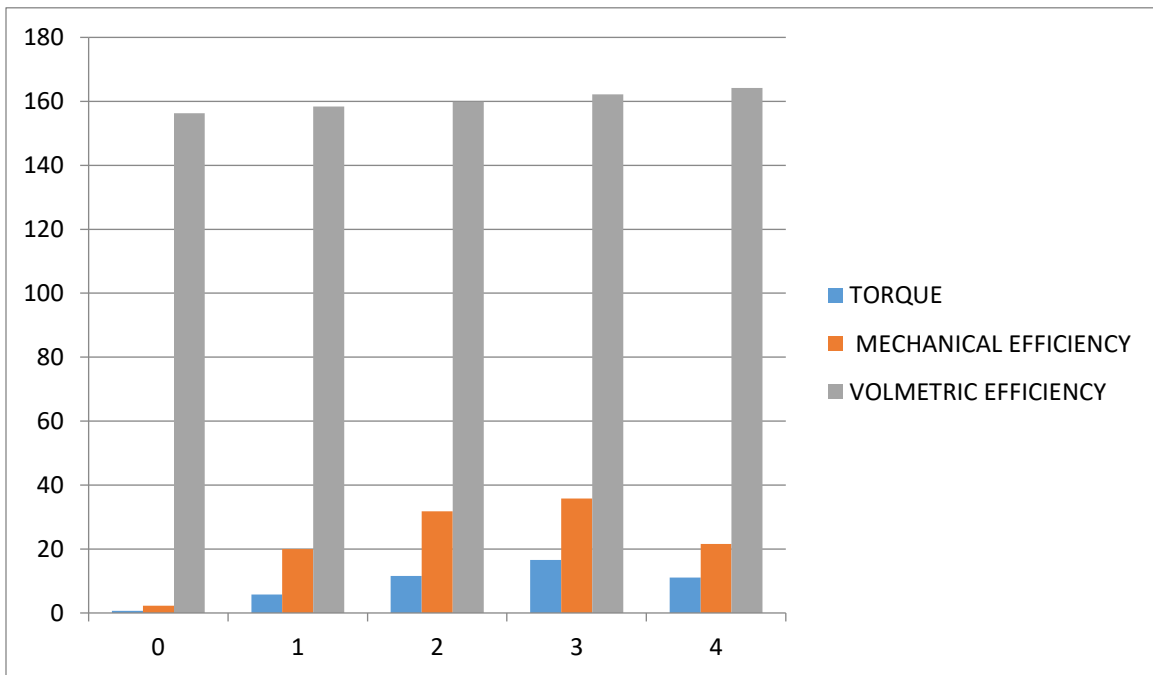


Fig 8.6: Different Between Torque ,Mech And Volumetric Efficiency

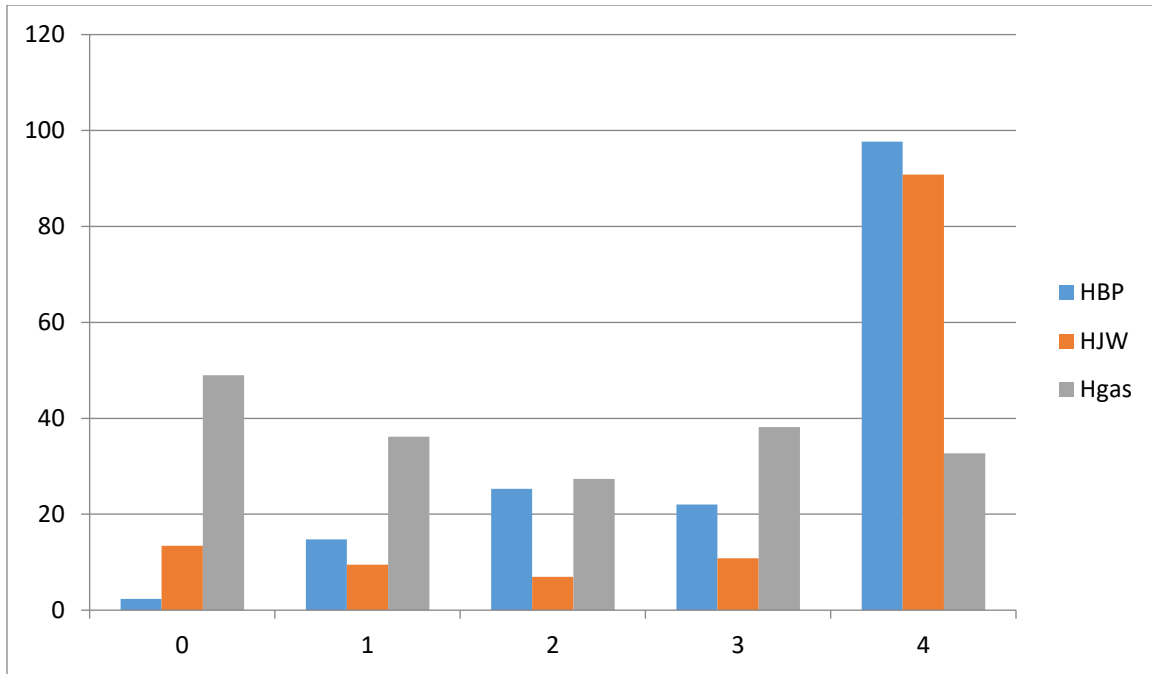


Fig 8.7: Different Between Hbp,Hjw And Hgas

Table 8.1 : Different load applied for speed of engine

Speed (rpm)	Load (kg)	Comp Ratio	T1 (deg C)	T2 (deg C)	T3 (deg C)	T4 (deg C)	T5 (deg C)	T6 (deg C)
1568	0.36	17.50	33.01	38.39	33.02	35.47	155.40	131.01
1554	3.19	17.50	33.02	38.23	33.02	35.14	157.21	128.69
1540	6.39	17.50	33.03	38.82	33.03	35.49	174.26	137.29
1524	9.14	17.50	33.02	39.26	33.02	35.60	186.93	143.87
1541	6.13	17.50	33.05	40.64	33.05	36.61	201.39	158.08
1500	12.13	17.50	33.16	42.24	33.17	37.71	246.25	185.21
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 8.2 : Calculating the flow in an engine

Air (mmWC)	Fuel (cc/min)	WaterFlow Engine (lph)	WaterFlow Cal (lph)
312.89	8.00	100	150
312.88	11.00	100	150
312.87	0.00	100	150
312.88	18.00	100	150
312.88	14.00	100	150
312.90	2.00	100	150
0.00	0.00	0	0

Table 8.3 : Calculating the efficiency value of an engine

Torque (Nm)	BP (kW)	FP (kW)	IP (kW)	BMEP (bar)	IMEP (bar)	BTHE (%)	ITHE (%)	Mech Eff. (%)
0.66	0.11	4.57	4.68	0.13	5.41	2.33	98.271	2.31
5.79	0.94	3.78	4.72	1.10	5.46	14.74	73.84	19.96
11.60	1.87	4.01	5.88	2.20	6.87	21.86	85.6	31.82
16.59	2.65	4.74	7.39	3.15	8.71	25.31	70.68	35.81
11.12	1.79	6.52	8.31	2.11	9.89	32.06	89.17	21.60

Table 8.4: Calculating the flow of an engine load is applied

Air Flow (kg/h)	Fuel Flow (kg/h)	SFC (kg/kWh)	A/F Ratio	HBP (%)	HJW (%)	HGas (%)	HRad (%)
57.61	0.40	3.68	144.59	2.33	13.45	48.96	35.26
57.60	0.55	0.58	105.16	14.74	9.48	36.20	39.58
57.61	0.90	0.34	64.26	25.31	6.94	27.34	40.41
57.61	0.70	0.39	82.62	22.06	10.85	38.19	28.89
57.61	0.10	0.26	78.38	97.69	90.79	32.69	25.5

CHAPTER 9

CONCLUSION

1. Biodiesel has close agreements with diesel characteristics in a compression ignition engine.
2. Biodiesel has positive and negative effects on the emissions.
3. Biodiesel from microalgae strain can be used as alternative diesel fuel for small CI engine without any modifications.
4. The mutagenicity of RME emissions is much lower compared to fossil fuel indicating a reduced health risk from cancer.
5. Biodiesel is a significant sustainable energy resource and is used all over the world.
6. Biodiesel can be used as sn alternative fuel without any modification to the present diesel engine.
7. To do an experiment that satisfies the concerns in india about biodieselbeing a promising alternative fuel.
8. To conduct an further research on biodiesel and new possible feedstock for testing.

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