

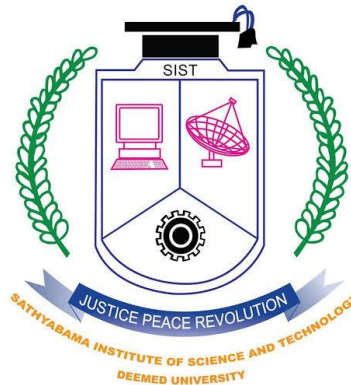
EMISSION REDUCTION IN DIESEL ENGINE BY USING BIODIESEL FUEL WITH CATALYTIC CONVERTER

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 | 12B Status by UGC | Approved by AICTE

JEPPIAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

March - 2021



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BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of **ADESH V (37150006)**, **SHIVAGANESH S (37150178)** who carried out the project entitled **“EMISSION REDUCTION IN DIESEL ENGINE BY USING BIODIESEL FUEL WITH CATALYTIC CONVERTER”** under our supervision from December 2020 to April 2021.

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DECLARATION

We, **ADESH V (37150006)** and **SHIVAGANESH S (37150178)** hereby declare that the Project Report entitled “**EMISSION REDUCTION IN DIESEL ENGINE BY USING BIODIESEL FUEL WITH CATALYTIC CONVERTER**” done by us under the guidance of **Mr. S. SIVASARAVANAN, MBA, M.E., Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

1.

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ABSTRACT

Primary conveyance engines fashionable the world for long period of time momentary is engine motors. Moreover, the decrease in fuel supplies, current environmental concerns, increased fuel prices and have prioritized alternative fuel pursuit. Automobile plays an influential part in gift to the dirtiness. Conventional diesel engines emit gases like CO, NOX and they are produced under this framework combustion of the fuel at Maximum temperature. High release of NOx causes different problem to the organisms in the environment and life. Researchers were very interested in assessing various plant and vegetable oils as diesel substitutes. The present paper discusses efforts to reduce NOx emissions through the development of a catalytic converter for a diesel engine powered by biodiesel and cucumber seed oil.

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LIST OF ABBREVIATIONS

NOx	Nitrogen Oxide
HC	Hydro Carbon
CNG DI	Compressed Natural Gas Direct Injection
ECR	Exhaust gas recirculation
CO	Carbon monoxide
PM	Diesel particulate matter emissions
BSFC	Brake specific fuel consumption
CI	Compression Ignition
WVO	Waste Cooking Oil
KSOME	Kroch seed oil Methyl Ester
KME	Kapok Oil Methyl Ester
ASTM	American Society for Testing and Materials
RPM	Revolutions per minute

TC CNSL	Thermal cracked cashew nut shell liquid
GC MS	Gas chromatography mass spectrum
FTIR	Fourier transformed infrared
DI	Direct injects
CNT	Carbon Nano tubes
CeO ₂	Cerium Oxide
EACS	Electro chemically activated cells
BaO	Barium Oxide
NO ₂	Nitrogen dioxide
MgO	Magnesium oxide
PPM	Parts per million
BTHE	Brake Thermal Efficiency
SFC	Specific Fuel consumption
CO ₂	Carbon dioxide

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CHAPTER 1

INTRODUCTION

1. OVERVIEW OF THE PROJECT

In recent years, there has been a lot of focus on reducing fuel consumption and emissions. Because of the volatility of fossil fuel prices and depletion, there is a growing interest in alternative fuels. Diesel engines are used as a major source in many applications such as transportation, power generation, marine applications, and so on. Because of significant population growth and lifestyle changes over the last century, the use of fossil resources has increased. This causes crises of fossil fuel depletion for diesel engines, necessitating the urgent development of suitable alternative fuels. In this project, we will investigate the use of diesel-wheat germ oil in a four-stroke diesel engine. An attempt will be made to analyse the performance and emission characteristics of a diesel engine using diesel and different blends of germ oil. During the combustion process, internal combustion engines emit harmful emissions. Pollutants emitted by internal combustion engines pollute the atmosphere, causing issues such as global warming, smog, acid rain, respiratory hazards, and so on. Because diesel engine power is directly controlled by the fuel supply, rather than by control of the air/fuel mixture, the physical and chemical conditions that exist inside any such diesel engines under any conditions differ significantly from spark-ignition engines. As a result of these differences, diesel engines produce a different set of pollutants than spark-powered engines, differences that are sometimes qualitative (what pollutants are present, and which are not), but more frequently quantitative (how much of particular pollutants or pollutant classes are present in each). Diesel engines, for example, emit one-twenty-eighth the carbon monoxide that gasoline engines do because even at full load, they burn their fuel in excess air.

Particulate matter, also known as soot, is produced by the incomplete combustion of diesel fuel.

Hundreds of chemical elements are frequently present, including sulphates, ammonium nitrates, elemental carbon, condensed organic compounds, and carcinogenic compounds and heavy metals like arsenic, selenium, cadmium, and zinc in its composition.

Particulate matter varies in size from coarse particulates (less than 10 microns in diameter) to fine particulates (less than 2.5 microns) to ultrafine particulates, despite being only a fraction of the width of a human hair (less than 0.1 microns). Ultrafine particulates, which are small enough to pass through lung cells, account for 80-95 percent of diesel soot pollution. Diesel engines contribute to the problem by emitting nitrogen oxides and sulphur oxides, which in the atmosphere degraded as secondary particulates. Diesel engines, like all fuel-burning equipment, emit nitrogen oxides, which may harm lung tissue, reduce the body's resistance to respiratory infections, and aggravate chronic lung diseases like asthma. They also react with other pollutants in the atmosphere to form ozone, which is a major contributor to smog.

Several air pollutants contribute to environmental acidification. The most important are sulphur dioxide (SO₂), nitrogen oxides (NO_x), and ammonia, which are discussed in this article (NH₃). The impact of SO₂, NO_x, and NH₃ can be seen in the gradual degrading of soils, water, and forests. They also contribute to the formation of fine particles in the air, which can lead to respiratory problems. SO₂ equivalents are commonly used to measure the acidifying potential of SO₂, NO_x, and NH₃.

Nasal and eye irritation, changes in lung function, respiratory changes, headache, fatigue, and nausea are all acute effects of diesel exhaust exposure. Chronic exposure is linked to coughing, sputum production, and decreased lung function.

In addition to symptoms, exposure studies in healthy humans have revealed a number of profound inflammatory changes in the airways, which occur prior to changes in pulmonary function. Such effects are likely to be even more harmful in asthmatics and other subjects with compromised pulmonary function.

The negative health effects of air pollution are causing growing international concern. Pollution is becoming a major public health and political issue as the According to United Nations estimates, cities house 47 percent of the world's population. This urbanisation has resulted in a greater need for transportation and, as a result, an increase in motor vehicle-generated air pollutants. The world's population is growing, and people are migrating from rural to urban areas.

However, a large number of epidemiological studies from around the world have consistently found a link between ambient levels of air particles and a variety of health outcomes, including mortality, Exacerbation of asthma, bronchitis, tract infections, ischemic heart condition, and stroke.

Diesel engines also emit submicron soot particles, which are thought to mediate some of the observed negative effects.

1.1 BIODIESEL

Biodiesel is made up of methyl or ethyl esters obtained by transesterification of animal fat or edible part of plant oils. It can be blended with either gasoline or diesel. In the case of mixtures, the percentage of biodiesel in petrol and diesel should be specified. B100 is a 100% biodiesel. B20 is a biodiesel/petroleum diesel blend that is 20% biodiesel and 80% petroleum diesel. Vegetable oil and waste cooking oil are the two main groups of raw materials used in the production of biodiesel. The most significant waste is used cooking oil, which can be used to

produce biodiesel. However, the current trend is to use pure vegetable oils grown for energetic use.

1.1.1 PRODUCTION

The process of producing biodiesel is known as transesterification. Transesterification is the reaction of oils or fats with a low molecular weight alcohol (typically ethanol or methanol) in the presence of an alkaline catalyst (typically NaOH or KOH) to produce esters and glycerin. Normally, the reaction occurs at atmospheric pressure and a temperature of 65°C. The process employs constant agitation over a period of one to twelve hours. The transesterification process is made up of three reversible and sequential reactions. The transesterification reaction has a stoichiometric ratio of three moles of alcohol to one mole of triglyceride.



To shift the reaction to the formation of methyl esters, more alcohol is added. In the reaction, glycerin is also formed.

1.1.2 BENEFITS

- When compared to other alternative fuels, it is clean and environmentally friendly.
- It can be produced using renewable oilseed crops such as soybeans, rapeseed, cottonseed, and mustard seed, as well as non-edible oilseeds.

- It has no Sulphur in it.
- According to Ames Mutagenicity tests, it reduces cancer risks by 90 percent.
- It can be used alone or in any combination with petroleum diesel fuel.

It could be stored in an unspecified area where petroleum fuel is stocked.

- It is safe to handle and transport because it biodegrades like sugar and is 10 times less toxic than table salt.

1.2 BIOFUELS

Biofuels are made from biomass. Biodiesel was the first biofuel to be created. Bioethanol, biogas, and straight vegetable oils are other first-generation biofuels. Lignocellulosic materials are used to make second generation biofuels. Biofuels can be solid (vegetable waste and a portion of urban and industrial waste), liquid (bio alcohols and biodiesel), or gaseous (biogas and hydrogen). First-generation biofuels are made from cereal crops (such as grain and maize), oil crops (such as rape and palm oil), and sweet substance crops.

1.3 TRANSESTERIFICATION

Backlash in transesterification is frequently catalyzed by the addition of an acid or base. Alcohols that are intoxicating and flammable are primarily used in the transesterification process. In theory, transesterification could occur in addition to the processing of taller or secondary alcohols. The characteristics of biodiesel fuels vary more than those of ethanol fuel due to the wide range of oils and fats that can be used to produce biodiesel. Ethanol is a very specific molecule, whereas

biodiesel is a mixture of molecules that varies slightly depending on the initial oil or fat source used to make the fuel.

1.4 EMISSION FROM DIESEL ENGINE

Diesel engines have been used in heavy duty applications for a long time; however, due to their higher fuel efficiency, they have only recently become very popular in light duty applications. Diesel engines achieve higher fuel efficiency due to high compression ratios and high oxygen concentration in the combustion chamber. These same factors, however, result in high NO_x emissions in diesel engines. NO_x and particulate matter are the primary pollutants produced by diesel engines (PM). The mechanisms of nitrogen oxide and particulate matter formation inside the combustion chamber of diesel engines are contradictory, making simultaneous reduction of both extremely difficult. Researchers have attempted to reduce diesel engine emissions and improve fuel efficiency.

Diesel engines have long been used in heavy duty applications; however, it is only in the last decade that they have gained popularity in light duty applications due to their high fuel efficiency.

Higher fuel efficiency is achieved in diesel engines due to high compression ratios and a relatively higher oxygen concentration in the combustion chamber. These same factors, however, result in higher NO_x emissions from diesel engines. Stringent emission standards have been a major driving force in the development of more environmentally friendly internal combustion engines. NO_x and particulate matter are the primary pollutants produced by diesel engines (PM). The mechanisms of NO_x and particulate matter formation in the combustion chamber of diesel engines are contradictory, making simultaneous reduction of both extremely difficult. Researchers have attempted to reduce diesel engine emissions and improve fuel conversion efficiency.

1.5 MAIN LOCAL AIR POLLUTENTS

1.5.1 Carbon Monoxide: CO is a gas that is produced as a by-product of the incomplete combustion of carbon-containing fuels. The lower the emissions, the more efficient the combustion processes. Road transport is currently the most significant outdoor source of CO.

1.5.2. Nitrogen Oxides: Nitrous oxide (NO_x), Nitrogen oxides (NO_x) are produced by all combustion products in the atmosphere: nitrogen dioxide (NO₂) and nitric oxide (NO) – collectively known as NO_x. Road transport accounts for roughly half of total emissions, more than the electricity supply industry, as well as the industrial and commercial sectors combined. NO_x is also an ozone precursor and thus an indirect greenhouse gas.

1.5.3. Particulates: PM₁₀ Particulate matter with a diameter of less than 10 microns (10 millionths of a metre). They are made up of three types of particles: primary particles emitted by combustion sources (primarily road transport); secondary particles (primarily sulphate and nitrate formed by atmospheric chemical reactions); and coarse particles (suspended soils and 3 dusts, sea salt, biological particles and particles from construction work).

Primary and secondary particles are the most common ultrafine particles (smaller than 2.5 microns).

1.5.4. Sulphur Dioxide: The combustion of sulphur-containing fossil fuels, primarily coal and heavy oils, is the primary source of SO₂. Although road vehicles produce little pollution, the combustion of fuel (particularly diesel) contributes significantly to urban pollution levels.

1.5.5. 1, 3 Butadiene: At normal temperatures and pressures, a gas derived primarily from the combustion of diesel and gasoline engines.

1.5.6. Volatile Organic Compounds: VOCs in the sun react with NO_x to form ozone. As a result, it is classified as an indirect greenhouse gas. As a result, high

concentrations are typically found downwind of the source emissions, most commonly in the summer, in the south, and in rural and suburban areas. (Source: HM Customs and Excise, Using the Tax System to Promote Cleaner Fuels, November 2000.)

1.6 COMPRESSION ENGINE IGNITION

Emissions from a CI engine are strongly influenced by the equivalence ratio (ϕ). Oxides of nitrogen (NO_x), carbon monoxide (CO), unburned hydrocarbons (HC), and particulate matter are all common exhaust emissions from a CI engine (PM). NO_x formation is dependent on atmospheric nitrogen oxidation and is strongly influenced by cylinder charge temperature. Total NO_x emission in a CI engine is higher than in a lean burn spark-ignition (SI) engine because combustion occurs as a diffusion flame at close to 1.0. The stoichiometric air-fuel ratio reaches very high temperatures in this region, accounting for the high level of NO_x. NO_x emissions can be reduced by using CI engines that run on a very lean mixture of fuel and air. In a lean mixture, combustion gases continue to mix with excess air, resulting in lower temperatures and a weakening of the kinetics of NO_x formation. SI engines that operate close to stoichiometrically emit more NO_x than CI engines. Because of the non-homogeneity of the air-fuel mixture, some local spots in the cylinder will be too lean to burn, resulting in misfire and poor combustion at the maximum flame temperature that occurs at stoichiometric air-fuel ratio. 5 Other areas may be too rich, with insufficient oxygen to react with all of the carbons. The conditions of both lean and rich mixture produce high HC emission. CO emission is formed when an engine runs rich, so its formation is unaffected by the intake mixture condition. PM emissions in CI engines are primarily formed in the fuel rich zone, where ϕ is greater than 1.0 within the cylinder during combustion due to incomplete combustion of fuel hydrocarbons and some from lubricating oil.

1.7 PROBLEM STATEMENT AND RESEARCH OBJECTIVES

Compression ignition engine manufacturers and operators are concerned about rising fuel costs and increasingly stringent emission regulations. Lowering fuel costs and emissions can be accomplished by converting the CI unit to dual fuel operation and utilising lower cost natural gas. The cost savings from diesel displacement and emission reductions, on the other hand, must be quantified. Thus, the primary goal of this research is to address the challenges associated with dual fuel engines in order to improve efficiency and control of exhaust emissions. Because dual fuel engines emit more HC and CO than regulations allow, concepts for controlling combustion and emissions should be developed.

1. Does dual-fuel operation save money over diesel operation?

Hypothesis: Over the last five years, natural gas fuel prices have remained significantly lower than diesel fuel prices and have been more consistent. When natural gas is introduced into a diesel engine, it is expected to displace some of the diesel fuel in the CI engine, lowering the fuel cost in a dual fuel engine.

2. Do dual-fuel engines emit less NO_x and PM than diesel engines?

The following is my hypothesis: As the smallest member of the paraffin family, diesel combustion with natural gas in a dual fuel engine is expected to produce less particulate matter. Furthermore, because premixed combustion occurs, the possibility of locally rich mixtures forming is reduced. As a result, under lean conditions, the flame temperature should be lower, lowering NO_x formation in a dual fuel engine.

3. Do dual-fuel engines produce excessive amounts of HC and CO?

The ratio of natural gas to air entering the cylinder is not controlled, according to the hypothesis. It is hypothesised that under these load conditions, the natural gas air mixture in the cylinder is below the flammability limit, and the penetration of the diesel fuel jet does not extend across the cylinder. As a result, regions near the

combustion chamber's edge with natural gas and air mixtures that are below the flammability limit are either unburned (HC emission) or partially burned (CO emission).

The research objectives are as follows, based on the problem statement:

- 1) To compare the emissions and performance of a dual fuel engine to that of a diesel engine.
- 2) To create an emissions control methodology in order to meet applicable regulatory emission levels.
- 3) To investigate in-cylinder combustion by running a CFD simulation with the CONVERGE code and a simplified chemical-kinetic mechanism to save time. The location where the emission occurs will also be investigated.

1.8 NECESSITY OF ALTERNATIVE FUELS

It is clear from the preceding discussions that India is currently confronted with the twin problems of rapidly depleting fossil fuels and environmental degradation. As a result, there is an urgent need to reduce reliance on petroleum-derived fuels for the sake of the economy and the environment. Both issues can be addressed by adapting bio-origin unconventional fuels. These nonpetroleum fuels provide energy security as well as environmental benefits. They have been available in some form or another for over a century. Identifying alternative fuels for use in I.C. engines has been the subject of extensive research around the world. Performance studies have demonstrated the suitability of a wide range of alternative fuels, including hydrogen, alcohols, biogas, producer gas, and various types of edible and non-edible oils. However, in the Indian context, bio-origin fuels such as alcohols, vegetable oils, and biogas can be widely used to address the problems associated with the fuel crisis.

1.9 CUCUMBER SEED OIL

Cucumber (*Cucumis sativus*) is a popular creeping vine plant in the Cucurbitaceae gourd family that produces cucumiform fruits that are eaten as vegetables. Cucumber comes in three varieties: slicing, pickling, and burpless/seedless, each of which has several cultivars. Cucumbers originated in South Asia, but they are now grown on most continents due to the global market's demand for a variety of cucumber varieties. The term "wild cucumber" in North America refers to plants in the genera *Echinocystes* and *Marah*, which are not related.

1.9.1 Countries where it's found

Every year, 80,646,131 tonnes of cucumbers are produced worldwide. China is the world's largest cucumber producer, with a yearly production volume of 61,949,091 tonnes. Russian Federation ranks second with a yearly output of 1,992,968 tonnes. India is ranked 27th with 164,692 people.

1.9.2 History of the Plant

Cucumbers are native to India and are cultivated for over 3000 years. Cucumber pickling is the most popular vegetable in the United States, with 550,000 metric tonnes produced each year. Georgia produced more cucumbers than any other state in the United States in 2012, according to US Department of Agriculture data, with 283.5 million pounds of cucumbers produced. Florida came in second, with 280.8 million pounds of cucumbers produced. The west-central region of Florida, which includes the counties of Hillsborough, Manatee, and Hardee, is the most important producer of cucumbers.

1.9.3 Extraction Process

Steam distillation is used to extract the oil from the leaves of the Cucumber seed plant. The oil is amber yellow in colour and has a fresh, citrus aroma.

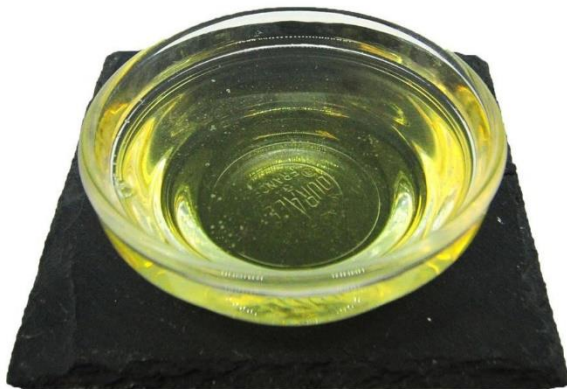


Fig: 1.9: Cucumber seed oil

1.9.3.1 Steam Distillation Process

The steam distillation process was carried out in a custom-sized distillation device that was linked to an electrical steam boiler. The electrical steam boiler used 220 volts, 16 amps of electric current, and was capable of producing 20 bars (max) of steam at 214°C. To separate oil from condensate, the distillation device was outfitted with a custom-sized condenser and a glass decanter. Figure 1 depicts the apparatus's schematic. The volume and diameter of the distillation chamber were 16.5 litres and 256 mm, respectively, and the material was stainless steel with a thickness of 2 mm. The distillation chamber also has a steam distributor mounted 700 mm from the bottom of the chamber and a grating mounted 300 mm from the steam distributor as a place to store ginger rhizome. 500 grammes of pre-treated rhizomes were placed on the grating inside the distillation chamber, and 1.5 bar steam was used as the variable, with flow rates of 0.35, 0.55, 0.76, and 1.16 ml/s. The process conditions were determined by the capacity of the apparatus. The distillation process was continued for 8 hours, with oil measurements taken every hour. This procedure was carried out twice.

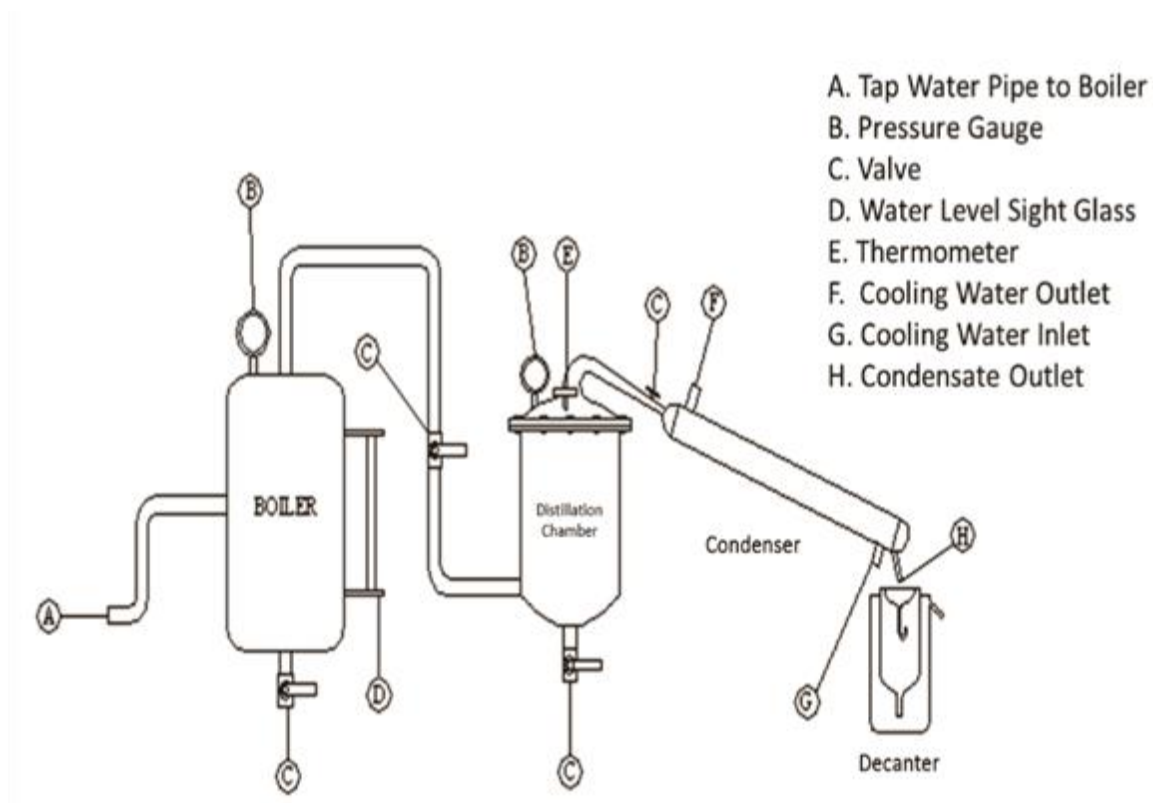


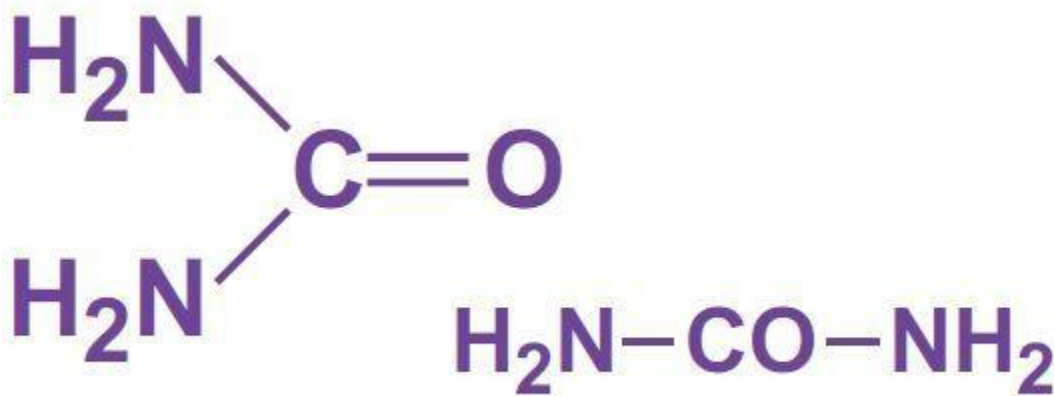
Fig.1.9.3.1: Cucumber seed Steam distillation apparatus

1.9.3.2 Hydro distillation Process

A hydro distillation process was carried out at a standard Clevenger-type apparatus to investigate the maximum oil content in ginger rhizomes. As a boiling flask, a 3000 ml flask was used, and a 1:6 ratio of pre-treated ginger rhizomes: solvent (tap water) was used. The process was carried out for 24 hours and yielded 2.65% of the oil.

1.10 UREA

Urea (carbamide), which can be easily synthesised from ammonia and carbon dioxide, is a critical chemical in the agricultural and polymer industries.



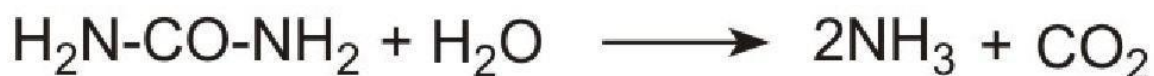
1.10.1 Uses of urea

Urea is the most widely used nitrogen fertiliser in the world, and more urea is produced by mass than any other organic chemical. It is the most concentrated nitrogen fertiliser, containing 46 percent N, and is readily available as free-flowing pills (granules). It is the least expensive nitrogen fertiliser to transport and the least likely to 'cake.' As a result, it is preferred in developing countries. While over 90% of urea produced is used as a fertiliser, it also has other applications, such as the production of melamine, which is used in melamine-methanol resins. Urea can also be used to make important resins (/polymers/ methanol - plastics. resin). Urea is

increasingly being used to reduce air pollution from diesel engines in automobiles, buses, and trucks. Diesel engines operate at high temperatures, and under these conditions, nitrogen and oxygen from the air can react to produce high concentrations of nitric oxide. Allowing it to react with ammonia to form nitrogen is one method of removing this pollutant. However, because ammonia is too volatile and poisonous, it cannot be used directly.

Instead, a urea-water solution is injected into the hot exhaust gases emerging from the engine. Urea decomposes thermally into ammonia and carbon dioxide.

This is the reverse of the method won't to make urea:



Unlike ammonia, urea is non-hazardous and easy to handle. The ammonia and carbon dioxide products, along with the exhaust gases, are immediately passed over a catalyst in the exhaust system. Ammonia converts nitrogen oxides (primarily nitric oxide) formed during combustion processes to nitrogen. The procedure is complicated, but

Overall reaction can be represented thus:



The system, known as Urea SCR (urea-based selective catalytic reduction), can reduce nitrogen oxide pollution to almost zero.



Fig.1.10: Urea is added to the exhaust gasses

Figure 2: A formalised paraphrase In many countries, urea tanks are now standard equipment on most new diesel lorries, buses, and cars. The urea is added to the exhaust gases in the form of a 32 percent aqueous solution known as Blue TEC. A Mercedes bus is being filled with Blue TEC solution (with the blue nozzle to the lower tank) and diesel in his photo (the upper tank). Several catalysts were used. One series is based on transition metal oxides (such as vanadium and tungsten oxides) on a carrier, titanium dioxide. Another series is based on zeolites ([/processes/catalysis-in-industry.html#zeolite](#)), in which some of the cautions have been replaced with metals such as copper.



Fig.1.10.1: A Mercedes-Benz E-Class E300 Blue TEC Hybrid car

Figure 3: A Mercedes-Benz E300 Blue TEC Hybrid. The diesel engine is combined with an electric motor, allowing for purely electric driving even at high speeds, significantly reducing the number of pollutants compared to a pure diesel engine. The use of Blue TEC solution, which converts the oxides in the exhaust to nitro-glycerine, further reduces the amount of nitrogen oxides emitted.

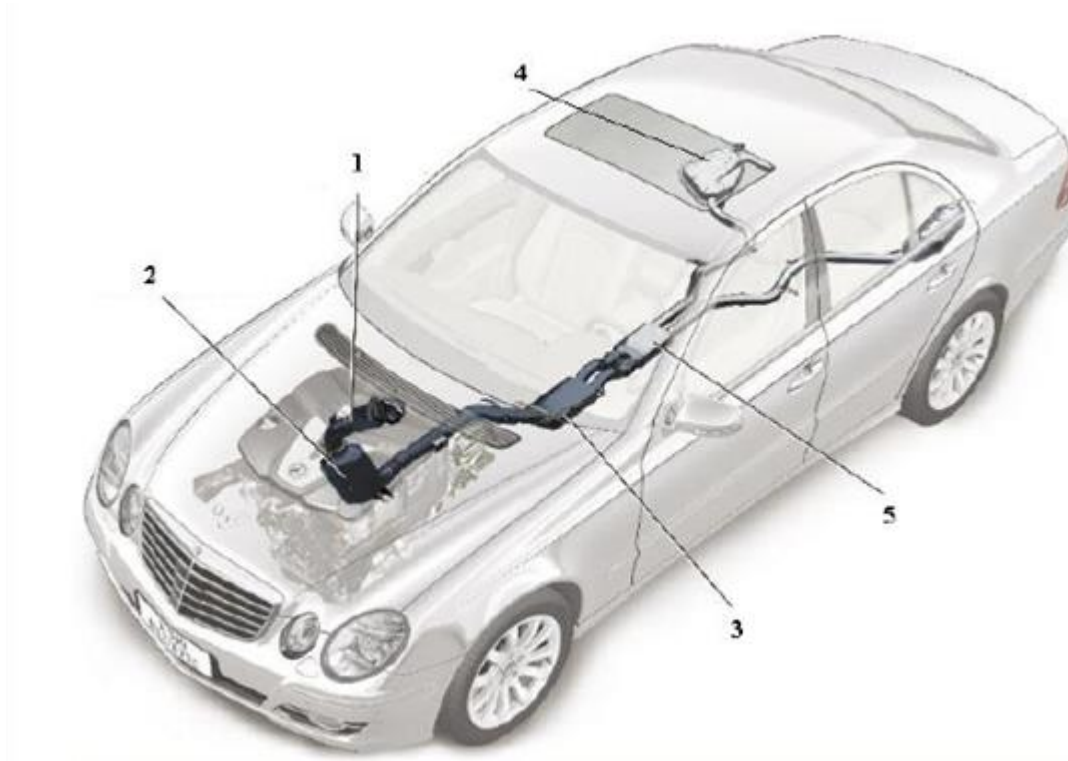


Fig.1.10.2: Design of the exhaust system of the Car

Figure 4: A line diagram of the car shown above illustrating five key elements in the exhaust system design.

1. The oxidation catalyst is used to remove unwanted hydrocarbons and convert them to carbon dioxide and water. Typically, the catalyst is made of platinum or palladium.

2. It is referred to as a NO_x catalytic convertor because it contains aluminium oxide on the surface of which platinum and barium oxide are present. It captures nitrogen oxides. When the solid is saturated with the oxides, unburned hydrocarbons pass through, converting a large portion of the mixture to nitrogen, carbon dioxide, and water vapour.

3. A particulate-trapping filter (small pieces of carbon and other solids).

4 A tank containing urea solution.

5. The SCR-catalytic convertor, which contains another catalyst, such as a vanadium (or tungsten) oxide on titanium dioxide, which allows the exhaust gases, which still contain some nitrogen oxides, to react with ammonia formed from the urea solution, producing exhaust gases with only traces of the oxides.

1.10.2 Annual production of urea

Table.1.1: Annual production of urea in various countries

World	164 million tonnes
China	62 million tonnes
India	23 million tonnes
Middle East	20 million tonnes
Rest of Asia	18 million tonnes
FSU	12 million tonnes
North America	9.5 million tonnes
Europe	9.5 million tonnes

It is expected that the worldwide annual production will increase to over 200 million tonnes by 2018

Manufacture of urea

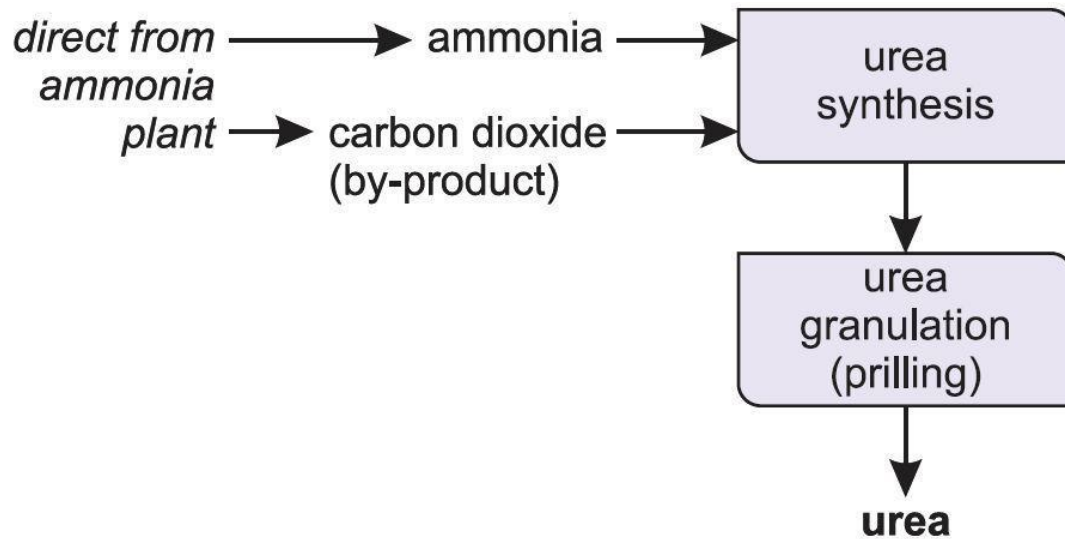


Fig.1.6: Flow chart of manufacturing of urea

At 450 K and 200 atm pressure, ammonia and carbon dioxide are heated together. The first product is ammonium carbamate, which quickly decomposes to form urea:

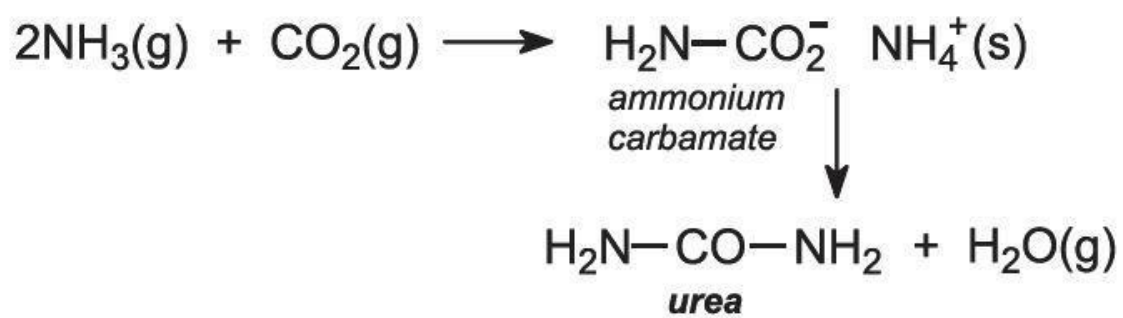


Fig.1.7: Granular form of Urea

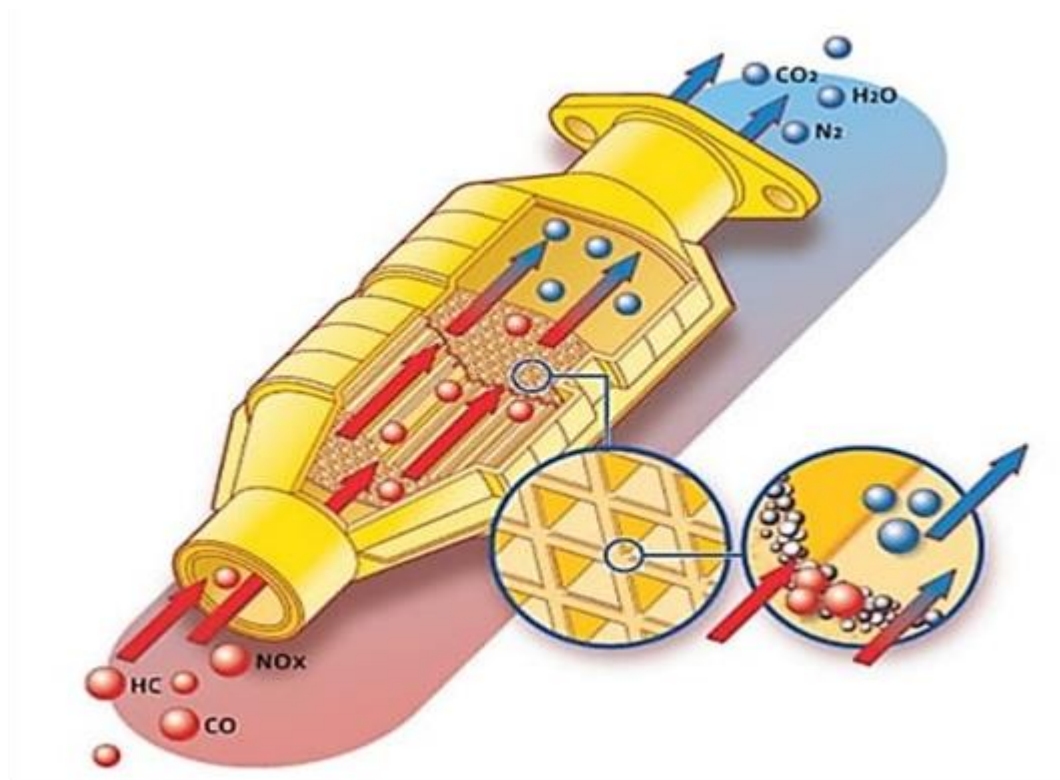
Figure 6 These urea spheres are known as prills. The prills are created by spraying molten urea down a tower that is filled with air. They are slightly smaller than urea granules and are especially useful when applying fertiliser by hand.

1.11 CATALYTIC CONVERTER

A converter is an exhaust emission control device that catalyzes a redox reaction to convert toxic gases and pollutants in exhaust gas from an indoor combustion engine into less-toxic pollutants (an oxidation and a discount reaction). Catalytic converters are typically utilized in combustion engines that run on gasoline or diesel oil, including lean-burn engines and kerosene heaters and stoves. Catalytic converters were first widely used in the automobile market in the United States.

Most gasoline-powered vehicles beginning with the 1975 model year must be equipped with catalytic converters to comply with the U.S. Environmental Protection Agency's stricter regulation of exhaust emissions. Formalized paraphrase. Formal paraphrase These "two-way" converters combine oxygen with carbon monoxide (CO) and unburned hydrocarbons (HC) to produce CO₂ and water (H₂O). This is due to the fact that three-way converters require either rich or stoichiometric combustion to effectively reduce NO_x.

Catalytic converters are most commonly used in automobile exhaust systems, but they are also found in electrical generators, forklifts, mining equipment, trucks, buses, locomotives, and motorcycles. They are also used to control emissions on some wood stoves. This is typically in response to government regulation, either direct environmental regulation or health and safety regulations.



CHAPTER - 2

LITERATURE SURVEY

Remiszewska.E et al, the author proposed a novel micro analytical system based on absorption photometry for urea determination in small volume biological samples is described. The developed micro system with built-in micro reactor with urea immobilised on its surface was fabricated using low temperature co-fired ceramics (LTCC) technology. For detection of the ammonium ions – product of urea hydrolysis, the modified Berthelot's reaction was applied and conditions of this reaction were optimised in a way to be suitable for analysis in micro systems and for particular application,

Rafal Sala et al, this work tried to identify the influence of dosing vaporized urea solution in a selective catalytic reduction (SCR) system. In the SCR method, optimising the urea evaporation and mixing properties can significantly improve the NO_x conversion efficiency in the catalyst. It can also exert a positive effect on the uniformity of NH₃ concentration distribution across the catalyst face. The concept of an electrically evaporated urea-dosing system was investigated and it was found that urea pre-heating prior to introduction into the exhaust gas is favourable for enhancing NO_x removal under steady-state and transient engine operation.

Kasim Mohammed Hello et al, the author proposed a new treatment has been demonstrated for urea to synthesis solid-state form of urea sulfate onto silica extracted from rice husk ash via 3-(chloropropyl)triethoxysilane. The 3-(chloropropyl)triethoxysilane was immobilized onto silica at room temperature to

functionalize the silica with chloride end groups. The chloride groups were reacted with urea by a nucleophilic substitution reaction. The resulting silica with urea (which had amine end groups) was sulphated with diluted sulfuric acid to produce a novel solid state form catalyst designated.

Jiranart Jeenchay et al, the purposes of this work are to design conceptual processes of ammonia/urea plants and to do economic analysis and feasibility study. This paper consists of two main parts; simulation of ammonia/urea plants and techno economic analysis. First, the simulation software PRO/II is used to simulate the base-case process. From the base-case studies the principal route of urea production is originally from carbon dioxide and ammonia, which are produced from nitrogen and hydrogen. All conditions and input parameters are obtained from petrochemical industry in Thailand. Finally, techno economic analysis is a key of feasibility study to estimate investment cost and the profitability of project.

Qian Wang et al, they attempt, the catalytic converter for SCR have been researched from these respects of carrier, coating and package. A catalyst has been designed based on these characteristics of carrier, coating, package. The reasons for the crystallization of urea in pipe are analysed, in order to eliminate the crystallization, the layout of exhaust pipe is optimized; and the best nozzle installation location is confirmed. To prove the performance of catalyst and the result of optimization of exhaust pipe layout, verification experiments are conducted. These results of experiment can meet European IV emission regulations.

Howard L et al, Urea-selective catalytic reduction (SCR) has been a leading contender for removal of nitrogen oxides (deNOx) from diesel engine emissions. Despite its advantages, the SCR technology faces some critical detrimental effects on its catalytic performance such as catalyst surface passivation (caused by deposit formation) and consequent stoichiometric imbalance of the urea consumption. Deposit formation deactivates catalytic performance by not only consuming part of the ammonia produced during urea decomposition but also degrading the structural and thermal properties of the catalyst surface. We have characterized the urea thermolysis with and without the urea-SCR catalyst using both spectroscopic (DRIFTS and Raman) and thermal techniques (thermal gravimetric analysis (TGA) and differential scanning calorimetry (DSC)) to identify the deposit components and their corresponding thermal properties

Muhammad khristamto et al, A study on the effects of urea injection timing and wall temperatures to predict NOx reduction efficiency is simulated using a commercial code of STAR-CCM+. In this study, the experimental and simulations work to obtain constant and stable conditions in the SCR system were conducted. Because the constant condition can optimize the uniformity of urea distribution in the system. This data explains if the distribution of gas reaction in simulation was unstable below 20s of time.

Karthickeyan Viswanathan et al, From the present experimental investigation, the urea based selective reduction technique along with catalytic converter was considered as the prominent technique for the reduction of engine exhaust emissions in diesel engine. B25 biodiesel sample showed lower CO, HC, NOx, and smoke emissions with SCR and CC setup than conventional engine (without SCR

and CC). Thus, SCR and CC technique along with B25 biodiesel sample was considered as the promising parameter for emission reduction in diesel engine.

Ghosh.S et al, Injection of aqueous solutions of urea in the tail pipe of a diesel engine fuelled with Pongamia pinata methyl ester (PPME) for the reduction of oxides of nitrogen (NO_x) was carried out in a four stroke, single cylinder, water cooled, constant speed diesel engine. Four observations were made for various concentration of urea solution 0%, 10%, 20%, and 30% by weight with different flow rates of urea solution as reductant by fitting Marine Ferromanganese nodule as SCR catalyst which improves the chemical reactions. 64% NO_x reduction achieved with the urea flow rate 0.60 lit/hr, 30% concentration of urea solution and marine ferromanganese nodule as SCR.

Julia M.C et al,. Chitosan is an adequate material for the preparation of potentiometric urea biosensors based on coupling of enzymatic membranes with all-solid state PVC membrane ammonium electrodes with nonactin as sensor. The characteristics of response of these urea biosensors depend on the procedure used for enzyme immobilization. The biosensors with urea immobilized on chitosan membranes by adsorption followed by cross linking with dilute aqueous glutaraldehyde solutions, showed the best characteristics of response, including the longest lifetime (more than 2 months).

Husnawan M, et al in this paper they have concluded that by using vegetable oil-based additive combined with metal-based additive. Test was conducted using biodiesel from palm blended with diesel, the results shown that fuel burns better and excess air reduces the CO content.

Pradip Kumar B, et al in this paper they have explained how to overcome the problems associated with biodiesel i.e., A fuel additive generally improves the combustion efficiency and reduces the pollution. Important advantage of nanoparticles is its size because there is no chance for fuel injector and filter clogging as in case of micron sized particles.

Ganesh D, et al In this they have concluded that reduction in CO emission was observed with cobalt oxide and magnalium nano fuel additive. Cobalt oxide showing 50% reduction at 75% load, because cobalt oxide acts as an oxygen buffer and donates surface lattice oxygen.

S. Thiyagarajan, et al From this paper they have concluded that the use of high and low viscosity biofuels in CI engines can adversely affect engine performance due to poor mixture formation and longer ignition delay. However, FIF could alleviate the challenges associated high and low viscosity biofuels. The difficulty associated with high viscosity is addressed through fuel ionisation which improves fuel atomisation and air-fuel mixing while the ignition delay is reduced with low viscosity biofuels due to shorter physical delay which in turn reduces NO emission.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

Automobile vehicle engine exhaust after treatment design has become vital because exhaust emissions standards are ever increasing. Converter may be a main apparatus for eliminating the pollutants in engine exhaust. The challenge is the problems that emission control designers especially demanding different standards in exhaust gas conditions.

3.2 SCOPE OF WORK

To achieve the emission levels well below the standard regulations a specially designed catalytic converter. Experimental investigations to be carried out with specially designed catalytic converter using urea in a granular form with metal oxide (Barium oxide) deposited as catalysts and diesel mixed with Cucumber seed oil to reduce the emission characteristics like NO_x, HC, CO and CO₂ as well as increase the performance characteristics in DI Diesel Engine

CHAPTER 4

METHODOLOGY AND EXPERIMENTAL WORK

4.1 METHODOLOGY

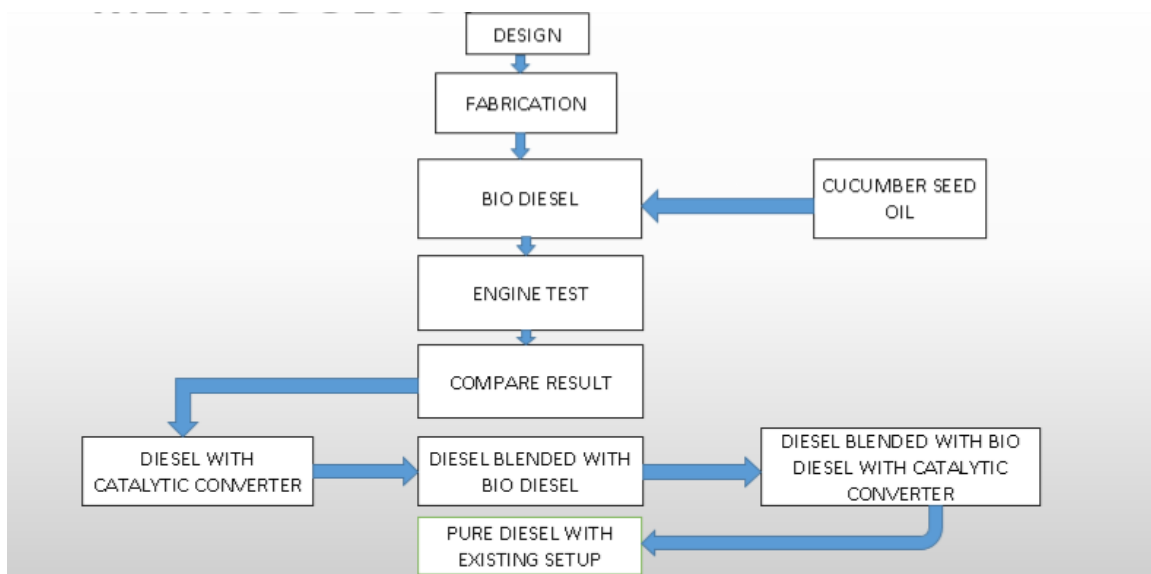


Fig.4.1: Methodology

4.2. CUCUMBER SEED-BIOFUEL PREPARATION

Cucumber seed oil was esterified using the transesterification method. The base catalysed transesterification process is the reaction of a triglyceride (Fat/oil) with an alcohol to form ester and glycerol in the presence of a base catalyst, which in most of the cases is either sodium hydroxide (NaOH) or Potassium Hydroxide (KOH). This process brings the fuel properties closer to that of diesel and reduces its viscosity. The oil properties were checked after the oil was esterified and the free fatty acid value is 0.846%

Table: 4.1 Properties of Cucumber seed oil

S.No	parameters	Results
1	Free fatty acid	0.846%
2	Density	0.925 g/cc
3	Kinematic Viscosity @ 40°C	0.798 cSt
4	Flash point by PMMC Method	80°C
5	Fire point by PMCC Method	91°C
6	Moisture Content	0.011%
7	Calorific valuer	7884.806 cal/g

4.2.1 Transesterification process

The transesterification process was followed by magnetic stir ration which may be a common technique won't to mix liquids. A magnetic mixer could also be a laboratory device that employs a rotating magnetic flux to cause a stir bar (also called "flea") immersed in a liquid to spin very quickly at a speed of 1200 rpm at 40 deg cel, thus stirring it. The rotating field which is created by a rotating magnet placed beneath the vessel with the liquid. Totally five samples namely B10, B20, B30, B40, and B50 were prepared. B10 contains a mixture of 90% of diesel, 10% of Cucumber seed biodiesel and cerium oxide nano additive 30 ppm. B20 contains a mixture of 80% of diesel, 20% of Cucumber seed biodiesel and 30 ppm of cerium oxide nano additive. B30 contains a mixture of 70% of diesel, 30% Cucumber seed biodiesel and 30 ppm of cerium oxide. B40 contains a mixture of 60% of diesel, 40% Cucumber seed biodiesel and 30 ppm of cerium oxide. Finally, B50 contains a mixture of 50% of diesel, 50% Cucumber seed biodiesel and 30 ppm of cerium oxide All five samples allowed to mix in the magnetic stirring machine for 30 minutes each. After 20 minutes all the five samples were ready to test in the engine.

Table: 4.2 Transesterification Report of Cucumber seed biodiesel

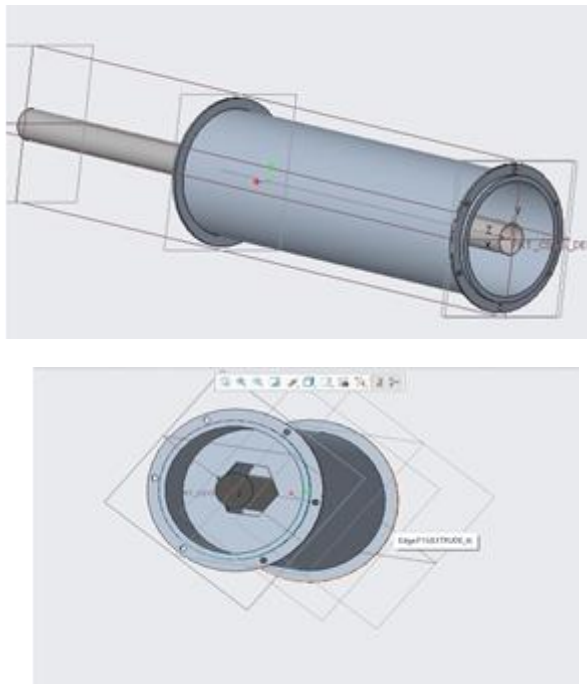
S. No	parameters	Results
1	Free fatty acid	0.1912%
2	Catalyst (NaOH) quantity	5 grams
3	Oil to methanol molar ratio	1.6
4	Temperature	60°C
5	Reaction Time	90 minutes
6	Yield	94.6%

4.3 FABRICATION OF CATALYTIC CONVERTER

Catalytic converter had been specially designed for the emission reduction and used barium oxide as catalyst along with Ceramic oxide. The materials used in the fabrication of catalytic converter are as follows

The sheet metal is cut as per the dimension (3.5 inch- diameter, 30 meters-length) and rolled. Two circular shape disks with drilled hole at centre and outer of the circumference of the disk 1 inch gap for each hole. Half inch circular pipe drilled throughout the circumference of the length. Three circular filters are welded and fitted at the inner side of

the body. One end is fixed permanently and another side is removable type using bolts and nuts. We used the rust coating for inner and outer surfaces to avoid rusting. Full silencer is coated with metallic paint. Arc welding and gas welding were used for fabrication works. Finally, urea mixed with metal oxide is filled inside the silencer and ready for testing as shown in figure.



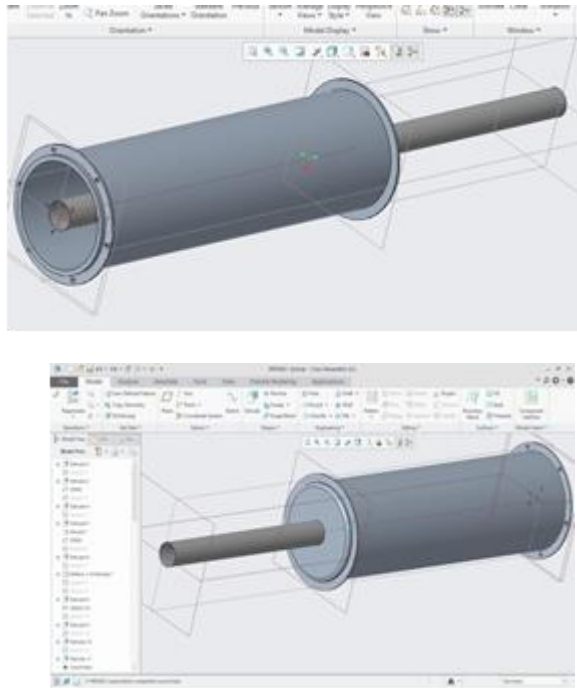


Fig.4.2: Catalytic converter design





Fig.4.3: Catalytic converter fabrication

4.4 EXPERIMENTAL SETUP

A solitary chamber has 4-stroke, direct infusion Kirloskar TV1 diesel with a most extreme appraised yield of 5.20 kW at 1500 rpm was used to get the arrangement of test information required. The motor highlights a pressure proportion of 17.5. The motor highlights 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 technique



Fig 4.4: Engine set up

4.4.1 Engine details

IC Engine discovered under test is Research Diesel having power 3.50 kW @ 1500 rpm which is 1 Cylinder, four strokes, Constant Speed, Water Cooled, diesel , with Cylinder Bore 87.50(mm), Stroke Length 110.00(mm) pole length 234.00(mm), Compression Ratio 18.00, Swept volume 661.45 (cc).

4.4.2 Combustion Parameters

Specific Gas Constant (kJ/kg K) = 1.00, Air Density (kg/m³) = 1.17, Adiabatic Index: 1.41, Polytrophic Index: 1.15, Number of Cycles: 10, Cylinder Pressure Reference: 6, Smoothing 2, TDC Reference: 0

Table: 4.3 Engine Specifications

Product	Product VCR Engine test setup 1 cylinder, 4 stroke, Diesel with EGR
Engine	Engine Make Kirloskar, Type 1 cyl., 4 stroke Diesel, water cooled, power 3.5kW at
	1500rpm, stroke 110mm, bore 87.5mm. 661cc, CR17.5
	Engine CR 12 to 18. With electric start arrangement, battery and charger
Dynamometer	Type eddy current, water cooled,
Propeller shaft	With universal joints
Air box	Air box M S fabricated with orifice meter and manometer
Fuel tank	Capacity 15 lit with glass fuel metering column
Calorimeter	Type Pipe in pipe
EGR	Water cooled, SS, Range 0-15%
Piezo sensor	Range 5000 PSI, with low noise cable

Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Data acquisition device	NI USB-6210, 16-bit, 250kS/s.
Piezo powering unit	Model AX-409.
Temperature sensor	Temperature sensor Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	RTD PT100, Range 0–100oC,3 No's; Thermocouple, Range 0-1200oC, 2 No's
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gage, range 0-50 Kg
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC

Table: 4.4 Performance Parameters

Orifice Diameter (mm)	20.00
Orifice Coefficient. Of Discharge	0.60
Dynamometer Arm Length (mm)	185

Fuel	12.40
Pipe dia (mm)	
Ambient Temp. (deg C)	27
Pulses Per revolution	360

4.4.3 specification of gas analyser

4.4.4. Measuring ranges:

Oxygen (O₂) 0 - 25,00 % vol

Carbon monoxide (CO) 0 – 15,00 %

Carbon dioxide (CO₂) 0 – 20,0 %

Carbon hydride (HC) 0 - 20000 ppm n-hexane

Nitrogen monoxide (NO) 0 - 2000 ppm

Excess Air calculated according to Brettschneider

Temperature -40 ... +650°C

Rounds per minute 400 ... 10000 U/min

4.4.5. Precision:

Oxygen (O₂) $\pm 0,1$ % or $\pm 3\%$

Carbon monoxide (CO) $\pm 0,06$ % or $\pm 5\%$ of measured value

Carbon dioxide (CO₂) ± 0.5 % or $\pm 5\%$ of measured value

Carbon hydride (HC) ± 12 ppm or $\pm 5\%$ of measured value

Nitrogen monoxide (NO) ± 5 ppm or $\pm 5\%$ of measured value

Temperature $\pm 1\%$ ($T < 150^\circ\text{C}$) + 2% ($T < 250^\circ\text{C}$) $\pm 3\%$ ($T > 250^\circ\text{C}$)

rounds per minute $\pm 1\%$

4.4.6. Resolution:

Oxygen (O₂) 0,01 %

Carbon monoxide (CO) 0,01 %

Carbon dioxide (CO₂) 0,1 %

Carbon hydride (HC) 1 ppm

Nitrogen monoxide (NO) 1 ppm

Carbon hydride (HC) 1 ppm

Nitrogen monoxide (NO) 1 ppm

Temperature 0,1°C

Rounds per minute 1U/min (< 6000) or 10U/min (> 6000)

4.5. AVL GAS ANALYSER

AVL gas analyser for estimation of CO HC CO₂ O₂ and lambda.

Contamination testing machines. Our clients are workshops, vehicle designing schools iits nits rta all motor producer. It is compact sort

and used to gauge convergence of SO₂, NO, CO, CO₂ and O₂ from stack or kettle 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, figuring ignition proficiency, lambda, and so on.



Fig 4.5: Gas Analyser

A Gas analyser measures follow gases by deciding the absorption of an emitted infrared light source through a certain air sample. Follow gases found in the Earth's air get energized under specific wavelengths found in the infrared reach. The idea driving the innovation can be perceived as testing the amount of the light is consumed by the air. Various particles noticeable all around ingest various frequencies of light. Air with bunches of a specific gas will assimilate to a greater

degree a specific recurrence, permitting the sensor to report a high centralization of the relating particle. Infrared gas analysers as a rule have two chambers, one is a reference chamber while the other chamber is an estimation chamber. Infrared light is radiated from some sort of source toward one side of the chamber, goes through a progression of chambers that contains given amounts of the different gases.

4.6 MAGNETIC STIRRER

A magnetic stirrer or magnetic mixer is a research center gadget that utilizes a turning magnetic field to cause a stir bar (additionally called "bug") drenched in a fluid to turn rapidly, accordingly mixing it. The turning field might be made either by a rotating magnet or a bunch of fixed electromagnets, set underneath the vessel with the fluid

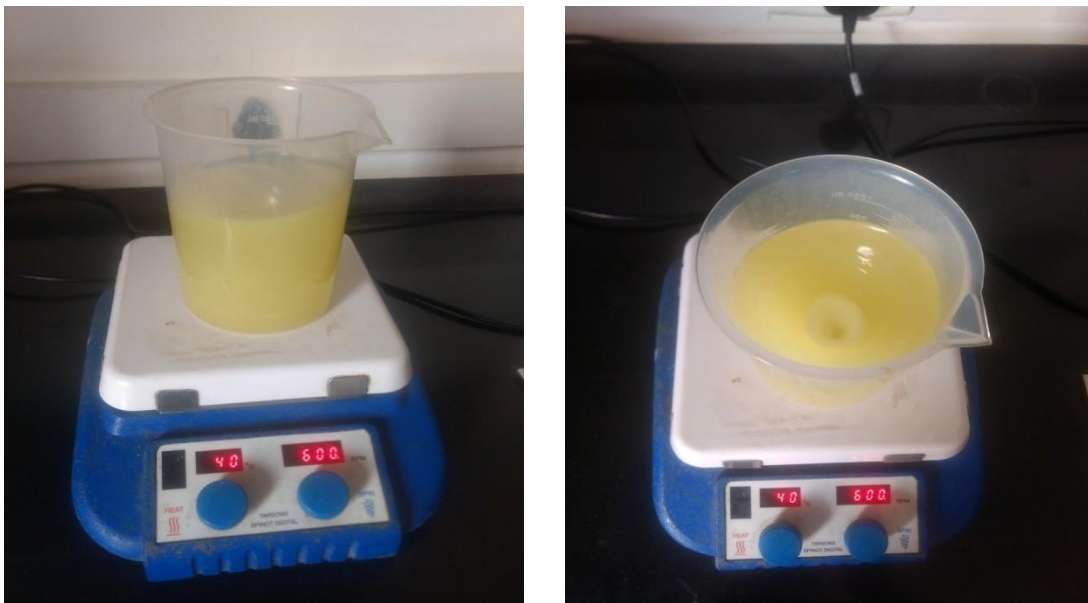


Fig 4.6: Magnetic Stirrer

magnetic stirrers are frequently utilized in chemistry and biology, where they can be utilized inside airtight shut vessels or frameworks, without the requirement for complicated rotary seals. They are liked over gear-driven motorize stirrers because they are calmer, more proficient, and have no moving outside parts to break or wear out (other than the basic bar magnet itself). Attractive mix bars function admirably in glass vessels ordinarily utilized for substance responses, as glass doesn't apparently influence a magnetic field. The restricted size of the bar implies that attractive stirrers must be utilized for generally little trials, of 4 liters or less. Mix bars additionally experience issues in managing with viscous liquids or thick suspensions. For bigger volumes or more thick fluids, some kind of mechanical blending is ordinarily required.

4.7 EXPERIMENTAL TEST

A single cylinder has 4-stroke, direct infusion Kirloskar TV1 diesel motor with a most extreme evaluated yield of 5.20 kW at 1500 rpm was used to get the arrangement of trial information required. The motor has a pressure proportion of 17.5. The motor has a cleared volume of 661.45 (cc), bore width 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 interaction.

BLEND

Sample Number	Description
B10	10% Biodiesel + 90% Diesel
B20	15% Biodiesel + 85% Diesel
B30	20% Biodiesel + 80% Diesel
B40	25% Biodiesel + 75% Diesel
B50	30% Biodiesel + 70% Diesel

4.7.1 SFC

Table: 4.6 SFC

BP (KW)	BP (LOAD)	S1	S2	S3	S4	S5	D 100
0	0%	6.45	5.96	5.39	5.02	4.77	2.48
0.87	25%	0.55	0.56	0.56	0.54	0.51	0.52
1.74	50%	0.38	0.37	0.33	0.31	0.27	0.38
2.76	75%	0.3	0.32	0.31	0.32	0.30	0.29
3.5	100%	0.1	0.16	0.28	0.34	0.34	0.2

4.7.2 BTHE

Table: 4.7 BTHE

BP (KW)	BP (LOAD)	S1	S2	S3	S4	S5	D 100
0	0%	1.33	1.44	1.59	1.63	1.67	2.45
0.87	25%	15.46	15.42	15.27	15.25	15.20	16.49
1.74	50%	22.64	22.93	25.65	25.87	26.89	22.75
2.76	75%	28.87	27.21	27.37	28.60	28.76	31.71
3.5	100%	30.17	32.73	31.16	31.76	32.65	32.59

4.7.3 NOx

NOx

BP (KW)	BP (LOAD)	S1	S2	S3	S4	S5	D 100
0	0%	88	92	108	120	131	200
0.87	25%	105	126	204	210	225	376
1.74	50%	201	232	277	291	312	615
2.76	75%	325	357	469	481	501	868
3.5	100%	455	460	490	510	530	1022

4.7.4 O₂

O₂

BP (KW)	BP (LOAD)	S1	S2	S3	S4	S5	D 100
0	0%	18.8	18.8	18.85	18.9	19	17.05
0.87	25%	18.29	18.66	18.30	18.51	18.45	15.9
1.74	50%	18.27	18.72	19.11	19.35	19.51	14.74
2.76	75%	18.04	17.61	17.32	17.15	16.99	13.72
3.5	100%	17.19	17.46	17.11	16.88	16.75	13.55

4.7.5 CO₂

CO₂

BP (KW)	BP (LOAD)	S1	S2	S3	S4	S5	D 100
0	0%	1.24	1.19	1.08	1.02	1.00	2.35
0.87	25%	1.41	1.19	1.48	1.63	1.78	3.08
1.74	50%	1.5	1.58	1.89	1.97	2.17	3.9
2.76	75%	1.82	1.82	2.06	2.24	2.45	4.59
3.5	100%	2.14	2.03	2.24	2.82	2.85	4.71

4.7.6 HC

HC

BP (KW)	BP (LOAD)	S1	S2	S3	S4	S5	D 100
0	0%	2	3	5	7	9	32
0.87	25%	4	5	6	7	8	38
1.74	50%	7	8	9	11	14	41
2.76	75%	8	9	11	14	17	46
3.5	100%	10	12	15	16	18	47

4.7.7 CO

CO

BP (KW)	BP (LOAD)	S1	S2	S3	S4	S5	D 100
0	0%	0.037	0.039	0.042	0.045	0.052	0.054
0.87	25%	0.035	0.037	0.038	0.041	0.043	0.052
1.74	50%	0.032	0.033	0.034	0.035	0.036	0.05
2.76	75%	0.031	0.032	0.033	0.034	0.036	0.049
3.5	100%	0.029	0.03	0.031	0.035	0.039	0.047

CHAPTER – 5

RESULT AND DISCUSSION

5.1 RESULTS

The biodiesel prepared in the five samples were one by one poured into a container which is attached to the venturimeter in the front. The venturimeter shows the amount of fuel exactly sent to the engine. The exhaust is attached to a smoke meter in order to obtain the amount of pollutants released. The results obtained from each of the blend are compared in a graphical format below.

5.1.1 Load Vs Brake Thermal Efficiency (BTHE)

The figure shows the performance of the brake thermal efficiency for different loads with blended fuel at different ratios of diesel, Cucumber seed oil with catalytic converter. Brake thermal efficiency will increase with increase in load, from graph we can observe there is an increase. The BTHE of all the samples have been increased and it is near to diesel. The maximum increase in BTHE can be seen in sample 1 and sample 5

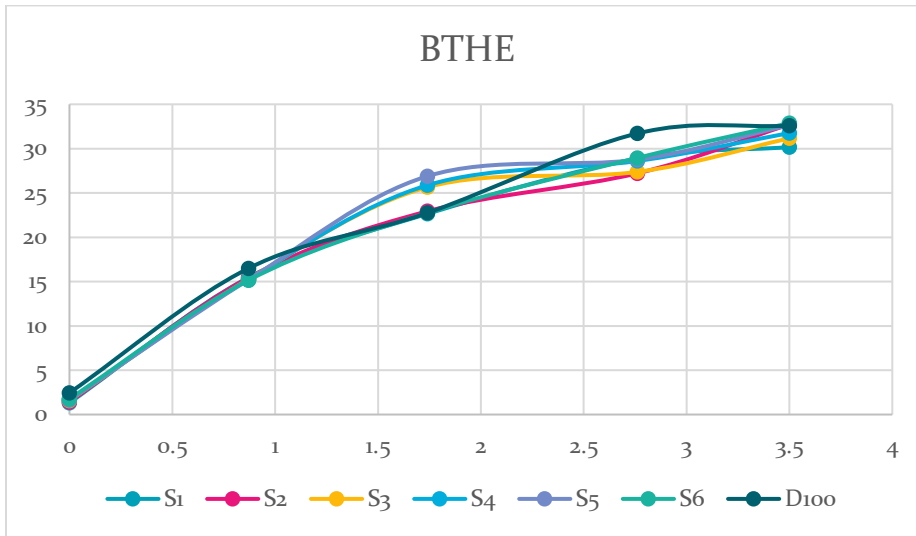


Fig: 5.1 Load Vs BTHE

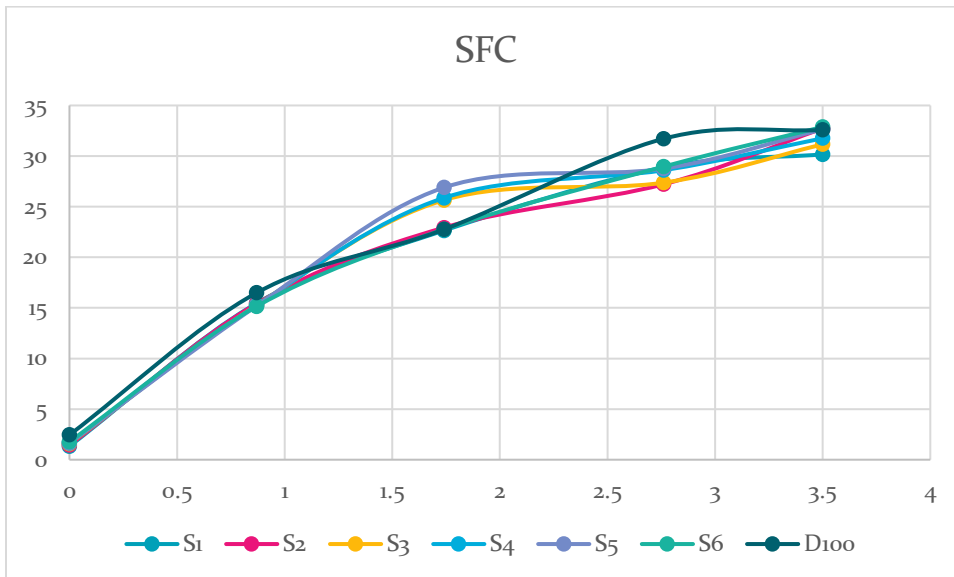


Fig: 5.2 Load Vs SFC

5.1.2 Load Vs Specific Fuel Consumption (SFC)

The above figure shows the performance of the specific fuel consumption for different loads with blended fuel at different ratios of diesel and Cucumber seed oil with catalytic converter. The Specific fuel consumption will decrease with increase in load, from graph we can observe there is a decrease in SFC. All the sample values are nearer to diesel.

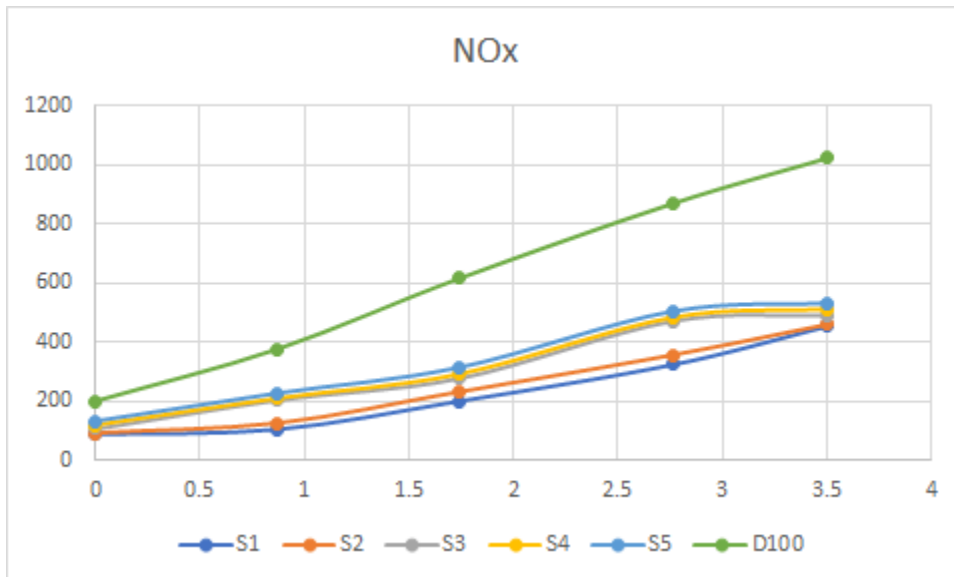


Fig: 5.3 Load Vs NOx

5.1.3 Load Vs NOx

NOx is an important particulate that has to be reduced ,above graph shows the variation of NO at different loads When compared to diesel all the samples emits very less amount of NOx The maximum reduction of NOx is at sample 1.

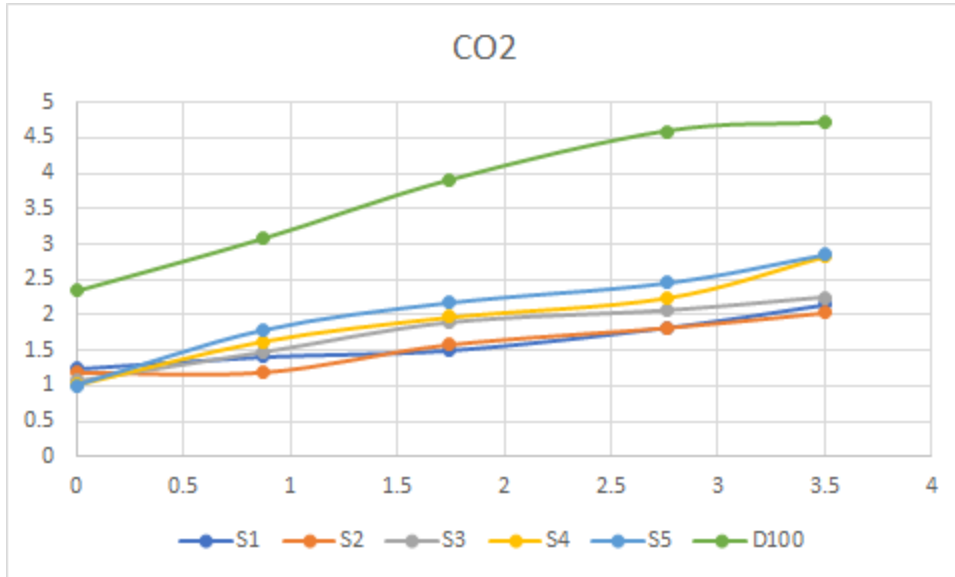


Fig: 5.4 Load Vs CO₂

5.1.4 Load Vs CO₂

By increasing the load CO₂ emission also increases and it is a cause of global warming and its presence is good. The emission of CO₂ less in all samples the maximum reduction of CO₂ can be seen in sample 5

5.1.5 Load Vs O₂

By increasing the load O₂ emission decreases and its presence is good. The emission of O₂ more in all samples the maximum increase of O₂ can be seen in sample 5

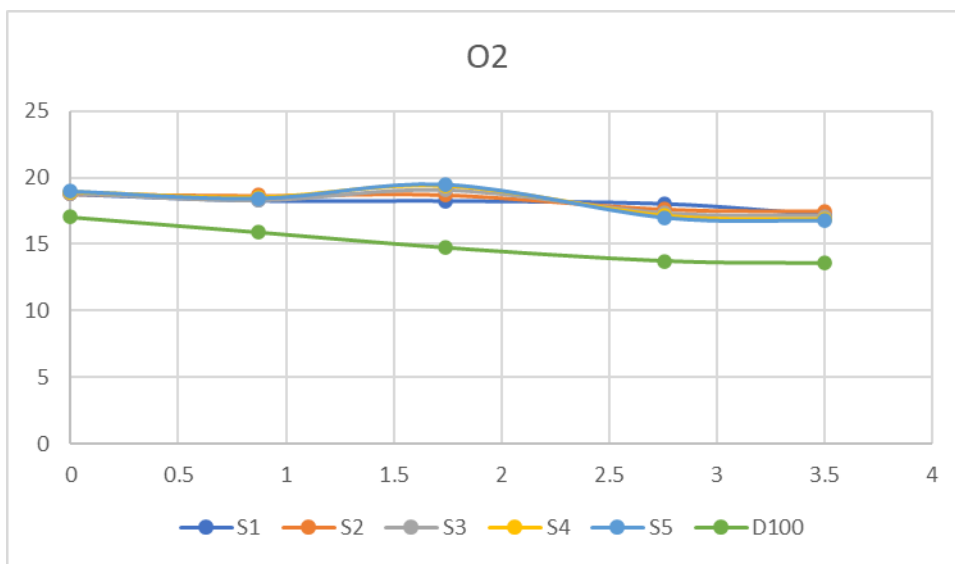
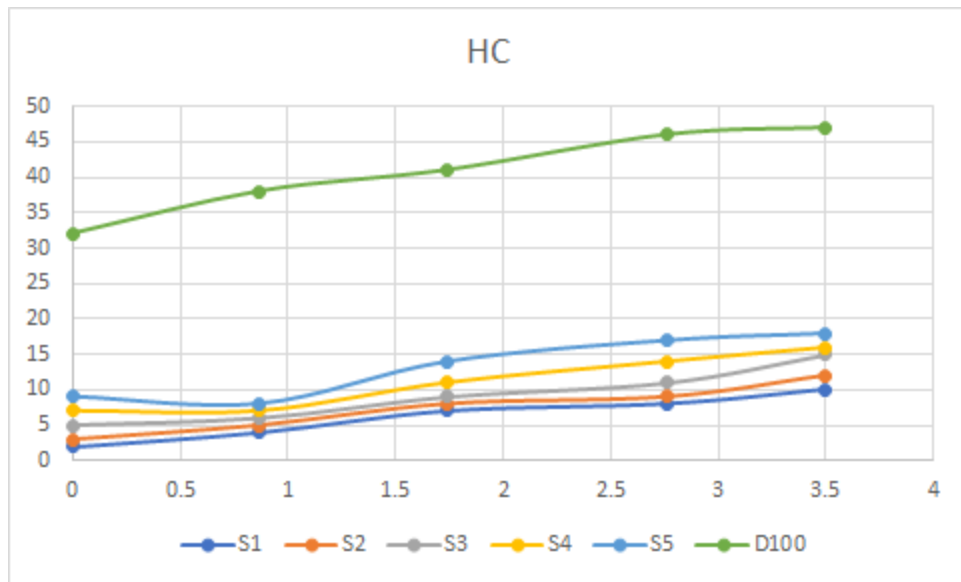


Fig: 5.5 Load Vs O₂



5.1.5 Load Vs Hydro carbon (HC)

The above graph shows that the amount of HC emitted during testing. Hydrocarbons result from the incomplete combustion of fuels. The HC emission increases with increase of engine load. From the results we can conclude that all the samples except sample 1 emits more amount of HC emission is less in sample 4 when compared with diesel.

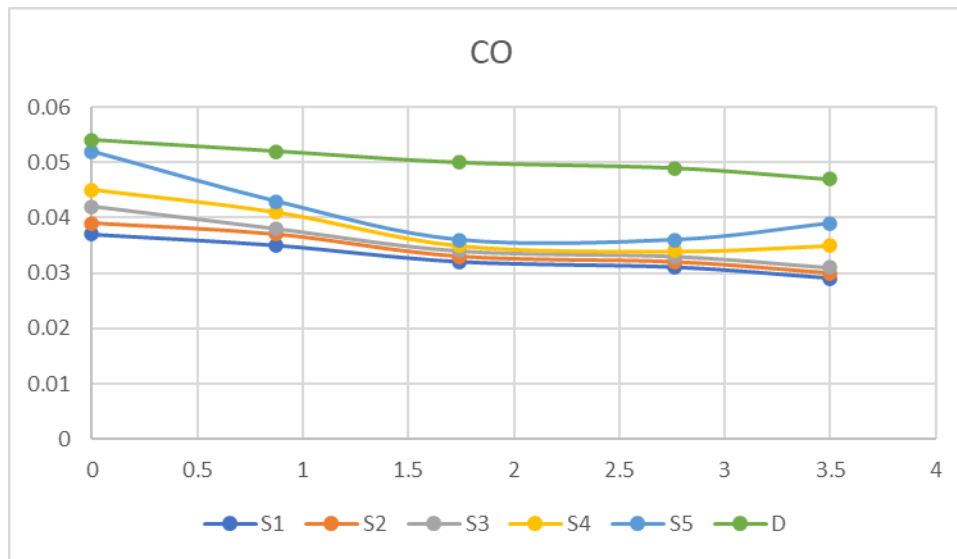


Fig: 5.6 Load Vs CO

5.1.6 Load Vs Carbon monoxide (CO)

Carbon burns in absence of insufficient oxygen, Carbon monoxide is formed. It is toxic and harmful to the environment. From the values obtained we can observe that all the samples producing less CO than diesel. Minimum amount of CO is released from sample 1.

CHAPTER – 6

CONCLUSION

6.1 SUMMARY AND CONCLUSION

The experimental investigation of performance and the emission characteristics of wheat germ oil and its blends have been performed in DI diesel engine and has been completed; the following conclusions have been drawn.

- Brake thermal efficiency is increased with increasing load for diesel-biodiesel blends with addition of urea based catalytic converter, in sample 15% BTHE increase compare with pure diesel at full load condition, remaining sample nearer to almost diesel value
- Specific fuel consumption is less with diesel-biodiesel blends with catalytic converter when compared to diesel and there is a little variation with increase in load
- The NO_x emissions with all the biodiesel blends shows less amount of NO_x release when compared with diesel and the minimum amount of NO_x emission is at sample 1 that is 550 ppm (90%diesel+10%biofuel+Catalytic converter)
- The CO₂ emissions are lower for all the diesel-biodiesel blends and the maximum reduction of CO₂ emission is for sample 1

- HC emission is less with sample 1 (90%diesel+10%biofuel+Catalytic converter) when compared to diesel
- CO emission is higher at lower load and then decrease at maximum load at sample 1(90%diesel+10%biofuel+catalytic converter) but all other sample higher when compare to pure diesel
- Finally, it was found that B10 sample, Cucumber seed oil with Barium oxide deposited catalytic converter has shown the better result means of emission as well as performance compare to pure diesel. Sample 1 (B10 + D90 + with Barium oxide deposited catalytic converter) could be taken into consideration as an alternate solution when compare with existing model.

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