

Impact of Cyclohexyl Nitride on VCR diesel engine Performance using Biodiesel

Submitted in partial fulfilment of the requirements for the award

Bachelor of Engineering degree in

Mechanical Engineering

By

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**DEPARTMENT OF MECHANICAL ENGINEERING SCHOOL OF MECHANICAL
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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(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 Edumudi Gowtham (Reg. No. 39150039) and Madepalli Avinash (Reg. No. 39150076) who carried out the project entitled **"Impact of cyclohexyl nitride on VCR diesel engine performance using biodiesel"** under our supervision from December 2022 to April 2023.

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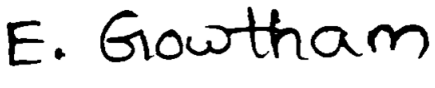
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DECLARATION

We Edumudi Gowtham(Reg. No.39150039) and Madepalli Avinash (Reg. no: 39150076) hereby declare that the Project Report entitled **“Impact of cyclohexyl nitride on VCR diesel engine performance using biodiesel”** done by us under the guidance of **S. Lakshmi Sankar M.E., (Ph.D.)** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

1) 

2) 

DATE:26.04.2023
PLACE: CHENNAI

SIGNATURE OF THE CANDIDATES

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ABSTRACT

Biofuels help in reducing the dependence on crude oil and fostering a cleaner environment. It also generates additional income and employment for rural areas. This will not only help meet India's rural energy needs but also fulfill the rising demands for transportation. The use of carbon fuels will reduce carbon emissions and meet the energy requirements of the 21st century.

Biodiesel is an alternative fuel with growing usage in the transportation sector. In this research work, palm oil and ground nut oil has been used for a diesel engine. The biodiesel blends were B5, B10, B15, and B20. Compared to other blends, B20 fuels showed better performance and reduced exhaust emissions such as smoke, carbon monoxide, and unburned hydrocarbons. The B20 blended fuels higher NO_x emissions than other fuel blends. This paper provides a comparative baseline to compare biodiesels regarding fuel properties, engine performance, and emission characteristics. biofuel are environment friendly fuels and their utilization would address global concerns about containment of carbon emissions. biofuel are derived from renewable bio- mass resources and, therefore, provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the energy needs of India's vast rural population.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO BIO FUEL

Crude oil used to make petroleum products were use to fuel aircraft, four wheeler, and trucks; to heat homes; and make products such as plastics and medicines . Although petroleum products make life easier, finding, producing, and moving crude oil may have negative effects on the environment. Technological advances in exploration, production, and transportation of oil and enforcement of safety and environmental laws and regulations help to avoid and reduce these effects. Petroleum literally means 'rock oil'. It exists in the upper strata of the Earth's crust, and is mainly a complex mixture of hydrocarbons. Today, petroleum has transformed the world we live in. It provides the bulk of our energy and fuel requirements. Now the day's oil counties are demands for the oils price populations increase demands of oils is increased. The petroleum products are affects the environment and increase global warming. The world all countries now to moving for alternative sources that makes are renewable or non- renewable sources. Moe countries are concentrating biofuels the biofuels are taken for waste fruit ,vegetables wastes and vegetables seeds .biofuels are taken for widely available and

cheapest materials are testing for alternative fuels. Now days India cured oils price higher than other countries so we are moving alternative sources. Petroleum products are affects the environments and its emitting the gases of HC,CO,CO₂,Nox the gases are affects environment and increase global warming.

The bio fuels are eco-friendly for all countries fuels are made for Vegetables waste and fruit seeds oils. History records that Rudolph Diesel, the inventor of the engine that bears his name, used vegetable oils as a fuel in his engines as early as 1900. For many years, the ready availability of inexpensive petroleum middle distillate fuels provided little incentive for experimenting with alternative, renewable fuels for diesel engines. The OPEC oil embargo of the '70's, fuel shortages and rapidly escalating fuel prices caused a resurgence of interest in finding alternative fuels.

However, the success of oil conservation measures and the very real possibility.

Bio fuel for diesel engines (i.e., biodiesel) is a promising alternative fuel for diesel engines that can be used upon the exhaustion of petroleum-derived fuels.

Biofuel includes methyl esters and can be derived from raw oil. They are derived from different bio-sources such as vegetable oils, used lubricating oils, or algae. Many types of biofuels can be obtained from raw bio-sources, including Jatropha oil, cottonseed oil, palm oil, used lubricant oils, used vehicle tires, coconut oil, soybean oil, rapeseed oil, microalgae, waste animal fat, Crambe oil, rubber seed oil, castor oil, and waste cooking oil. Waste biomass has also been used to produce bio ethanol or bio methane. Bio fuels must exhibit certain normal physical and chemical properties.

As a matter of fact, the way the bio fuel is produced from the raw materials

by transesterification, the mixing temperature and time, and the amount of catalyst or the type of additives that may be added to the produced bio fuel would affect the physical and chemical properties of the bio fuel produced. One important characteristic is the flow behavior with respect to the fuel viscosity at different shear rates (i.e., the relative velocity of the oil film between the moving parts). This characteristic affects the spray behavior when the fuel is injected into the combustion chamber at high pressures and temperatures.

Further, bio fuel is similar to diesel fuel with respect to the dependence of its viscosity on the operating temperature. Several previous studies have aimed to determine the rheological properties of bio fuel derived from vegetable oils. Rheological properties have been studied for different bio fuels produced from waste cooking oil, castor oil, and rubber seed oil. They have been compared to their raw oils and have also been blended with pure diesel fuel and studied at different temperatures and shear rates.

1.2 ALMOND OIL

Determination of Acid Value :

The acid value was determined using the following equations:

$$\text{Acid value} = 56.1 \times V \times N / M$$

Where

V=Volume of the KOH solution used

N= Normality of KOH
m= Mass of oil sample

Esterification procedure

Methodology

The goal of this study is to create a method for turning non-edible neem oil into biodiesel. Alkaline esterification and acid esterification are the two phases that make up the process.

(a) Acid Esterification: The first step uses an acid catalyst to lower the FFA value of crude neem oil to roughly 2%.

(b) Alkaline Esterification: Using an alkaline catalyst, the first-step product is transesterified into mono-esters of fatty acids after the impurities have been removed. The process' influencing factors, such as the amount of catalyst used, the temperature of the reaction, and its length, are examined.

CHAPTER – 2

2.1 LITERATUR REVIEW

Biodiesel from renewable resources is one of the most attractive alternative fuels currently being developed because of its low emissions and its desirable chemical characteristics, such as being non-toxic, biodegradable, and carbon neutral. Additionally, biodiesel fuel can be used in any conventional diesel engine (Yaakob et al.,2013) [1]. Currently, fossil fuel usage accounts for 80% of total energy consumed globally (Suleman et al., 2015) [2]. However, research has shown that blending of vegetable oils with petrol diesel reduces the adverse effect of fossil fuel usage (Igbokwe et al., 2015; Khan et al., 2016) [3].

This study's primary goal was to improve the transesterification process for producing biodiesel in order to produce the fuel with the best viscosity, cetane number, flash point, fire point, and calorific value (S.Sivaprakasam,2007) [4]. Transesterification is taking place if the Free Fatty Acid value is less than or equal to 2. If not, we must use the esterification procedure to lower the amount of free fatty acids (mg KOH/g) to a number less than or equal to 2. However, the transesterification is reliant on the weight basis of KOH and the molar ratio of alcohol that we employ as the catalyst. Acids and bases are frequently utilised as catalysts (Arachchige et al., 2021) [5].

The purpose of the transesterification process is to lower the viscosity of the oil (Demirbas, 2008) [6]. There is a need for more research on other feedstocks like almond seed oil since it has been shown that almond oil is more suitable for biodiesel production due to the less

time and cost required, than most vegetable oils which require substantial amount of antioxidants. (Kumar & Sharma, 2015)[7]. Biodiesel was found to be advantageous for reducing premixed combustion duration and improving in-cylinder temperature and brake thermal efficiency. The crossover between premixed and diffusion combustion durations was made less obvious by using biodiesel as fuel (Xin Wang)[8].

Biodiesel has a greater cetane number, better ignition performance, and higher combustion efficiency as compared to pure diesel. The use of biodiesel fuels and development studies on it are continuing diligently due to its similar physical and chemical features to those of diesel (Simsek et al.,2021) [9]. Research indicated that using ethanol-diesel blends had a negative impact since their decreased calorific content led to higher fuel usage (Channappagoudra et al., 2020) [10]. A higher calorific value of fuel means it releases higher heat and consequently improves engine performance during combustion (Mahmudul et al.,) [11]. Cetane number is a measure of a fuel's autoignition quality characteristic (Faizal, C. K. M. 2013)[12].

The brake thermal efficiency decreases with shorter ignition delay of biodiesel and heat loss of diesel engine (Vijay Kumar et al., 2018) [13]. Biodiesel has some disadvantages that include lower heat of combustion and in some cases higher cloud point (Ramírez-Verduzco et al., 2011) [14]. Additionally, it should be noted that using methanol mixes causes CO and HC emissions to rise while NO_x and smoke emissions fall (Farouk,H.2017) [15].The combination of B20 and CNG (B20-DDF) performed best when compared to other fuel types since it generated the most torque at low speeds (1000 RPM) and had a wider range of emission reductions (a 20% reduction at high speeds) (2500 RPM)(R.Mohsin,2014) [16].

Biodiesel is also compatible with the existing fuel largely distribution infrastructure (Knothe & Steidley,2005) [17]. With the use of water injection, NO_x emissions from diesel and biodiesel-powered engines can be cut by up to 50%. Nevertheless, it slightly raised CO and BSFC and decreased BTE by lowering the premixed combustion temperature(S.M.Palash,2013) [18].

CHAPTER – 3

3 AIM AND SCOPE OF WORK

3.1 AIM

The aim of conducting this experimental study is to find the performance for the diesel engine using Almond oil mixture of diesel.

3.2 SCOPE OF THE WORK

The bio fuel is testing for various blending ratios and performance test of single cylinder diesel engine. The test can be conducting with diesel and Almond oil blends .the oil blends are making of B10,B20,B25,B30 and B40.The fuels are used to reduce diesel requirement. Vegetables oils are easily available in world that can use for transportation and vehicle. Decreasing of fossil fuels, increasing energy demands, together with the growing of greenhouse gas emissions effects of combustion have lead to the importance of studying biodiesel. Ordinary diesel fuels are available only in certain regions of the world. All countries are moving for easily available oils for biofuel energy. Biodiesel is made by combining alcohol (usually methanol) with vegetable oil, animal fat, or recycled cooking greases. It can be used as an additive to reduce vehicle emissions (typically 20%) or in its pure form as a renewable alternative fuel for diesel engines. As global energy requirements change and grow, it is crucial that all aspects of the bio energy production process are streamlined and improved, from the design of more efficient bio refineries to research into bio hydrogen as an energy carrier. Current energy infrastructures need to be adapted and changed to fulfil the promises of biomass for power generation.

CHAPTER – 4

4METHODOLOGY

4.1 METHODOLOGY IS PRESENTED BELOW

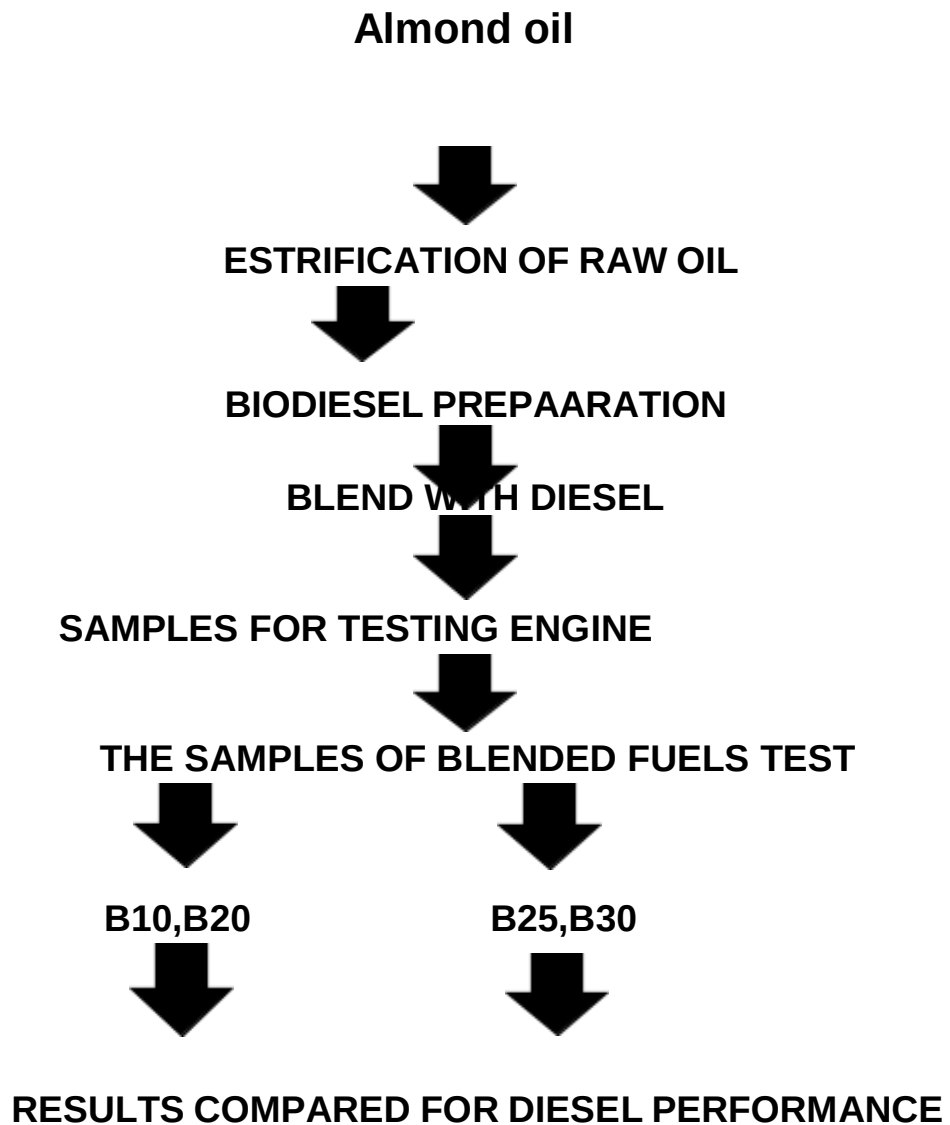


Fig 4.1 Methodlogy

CHAPTER – 5

5 . EXPERIMENTAL SETUP AND EQUIPMENTS

5.1 EXPERIMENTAL SET UP

A single-cylinder has 4-stroke, direct injection Kirloskar TV1 diesel engine with a maximum rated output of 5.20 kW at 1500 rpm was utilized to obtain the set of experimental data required. The engine has a compression ratio of 17.5. The engine has a swept volume of 661.45 (cc), bore diameter of the engine is 87.50 mm and stroke length of 110.00 mm. Injection pressure is 210 bar maintained constantly throughout the process.



Fig 5.1 Engine setup

5.2 VCR ENGINE TEST SETUP-PERFORMANCE TEST RIG

The setup consists of single cylinder, four stroke, VCR (**Variable Compression Ratio**) Electric start Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement.

The setup enables study of VCR engine performance with EGR for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. Lab view based Engine Performance Analysis software package “Engine soft” is provided for on line performance evaluation. A computerized Diesel injection pressure measurement is optionally provided

5.3 FEATURES

- CR changing without stopping the engine
- No alteration in Combustion chamber geometry
- Water cooled EGR
- Electric start with battery and charger
- Arrangement for blend test

- PÈ-PV plots, performance plots and tabulated results
- Data logging, editing, printing and export, Configurable graphs • IP, IMEP, FP indication, combustion analysis

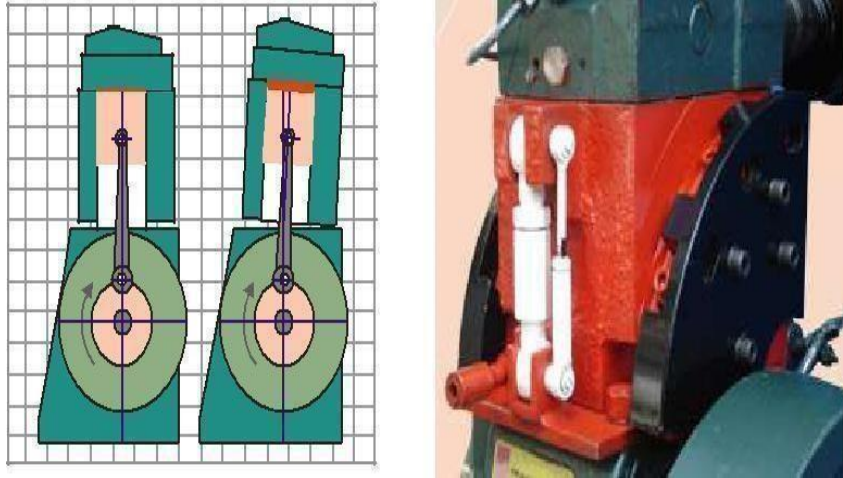


Fig : 5.2 VCR Engine

5.4 Range of Experiments

- Study of VCR engine performance (Computerized mode)
- Study of emissions with EGR variation
- Study of combustion with different fuel blends
- Study of pressure volume plot and indicated power

5.5 Utilities Required

Electric supply

230 +/- 10 VAC, 50 Hz, 1 phase

Water supply

Continuous, clean and soft water supply @ 1000 LPH, at 10 m. head. Provide tap with 1" BSP size connection

Computer

IBM compatible with standard configuration

Software

Engine Soft is Lab view based software package developed by Apex Innovations Pvt. Ltd. for engine performance monitoring system. Engine Soft can serve most of the engine testing application needs including monitoring, reporting, data entry, data logging. The software evaluates power, efficiencies, fuel consumption and heat release. It is configurable as per engine set up. Various graphs are obtained at different operating condition. While on line testing of the engine in RUN mode necessary signals are scanned, stored and presented in graph. Stored data file is accessed to view the data graphical and tabular formats. The results and graphs can be printed. The data in excel format can be used for further analysis.

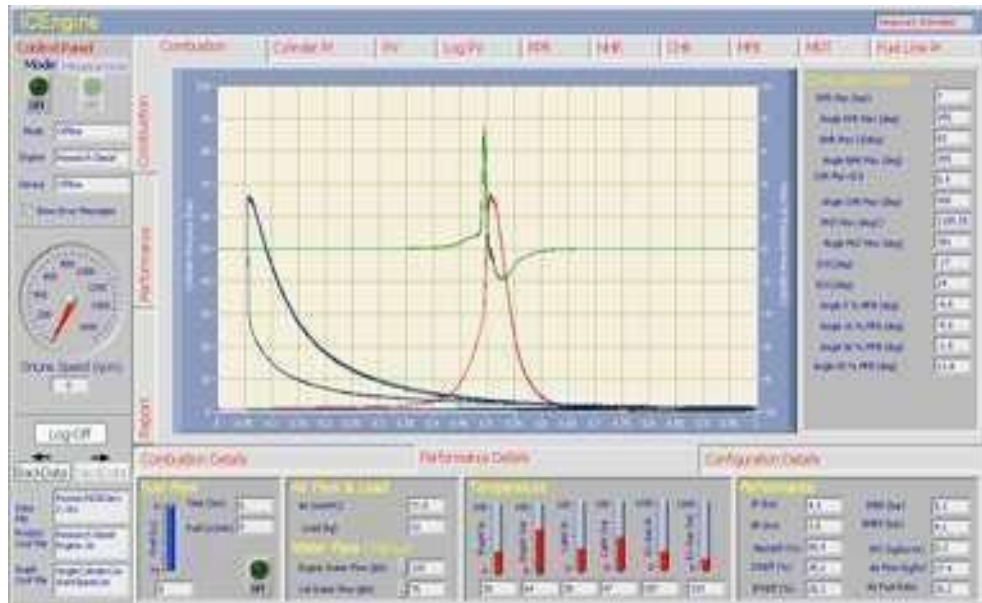


Fig 5.3 : Performance analysis

5.6 Specifications of Engine

Table 5.6.1 Specification of Engine

Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel with EGR (Comp.)
Product code	234
Engine	Make Kirloskar, Type 1 cyl., 4 stroke Diesel, water cooled, power 3.5kW at1500rpm, stroke 110mm, bore 87.5mm. 661cc, CR17.5, Modified to VCR 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	M S fabricated with orifice meter and manometer
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250 mm WC
Software	“Engine Soft” Engine performance analysis software
Rotameter	Engine cooling 40-400 LPH; Calorimeter 25250 LPH
Pump	Type Mono block
Overall dimensions	W 2000 x D 2500 x H 1500 mm
Optional	Computerized Diesel injection pressure measurement with injection variation 0-25 deg BTDC
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.
Piezo powering unit	Model AX-409.
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	RTD PT100, Range 0–100° C, 3 Nos; Thermocouple, Range 0-1200 ° C , 2 Nos

GAS ANALYZER: DIGAS 444



Fig 5.4 Avl Digas 444 Image

SMOKEMETER 437 STD/ SMOKEMETER 437 ° C

Table 5.2 Smoke meter Specifications

Type	AVL 437 Smoke meter Make
Make	AVL India Private Limited
Measuring range	0 to 100 HSU (Hatridge Smoke units)
Smoke Temperature	2500 C (Maximum at entrance)
Ambient temperature	0 to 50°C
Humidity	90% at 50 (Non conditioning
Power Supply	205 A, 11.5 -36V DC
Principle	Light absorption principle

°C



Fig 5.5 Smoke Meter

5.7 GAS ANALYZER

To take the readings from Gas analyzer to ADCS Software kindly follow these steps.

Kindly fill the details (Engine No. Model, Engine Type, Engine Speed) in respective text boxes given on the form.

Click on “Connect button” to connect the PC with equipment and wait for 2-3 minutes. if the readings are not coming it show the message in red color “ CO HC power not communicating.” kindly check the following:

- Be sure that gas analyzer settings in “MAHA Euro” mode
- Check the COM port settings with PC and the software.
- RS232 Cable is working properly and connected with equipment.
- Readings are coming with equipment and display on panel.

After 6 seconds readings are automatically save in database and status bar strip moving according to readings save in database.

After taking the readings click on “Disconnect button” it disconnect the communication with equipment and show the message “Data Saved in Database”.

Report: Click on report button to take the report of the test.

Print: Click on print button to take the printout of screen as bitmap image.

Export to MS Excel Sheet: To export data in excel sheet click on “EXPORT TO

EXCEL” button. When pressing export button a excel file is generated in a path “C:\AVLFolder\”. The file name of excel file is same as Test Date and VIN no (Tuesday, January 06, 2009_23).

Close button: click on close button to exit from current active window or screen.

BLUE POWER FOR A BLUE PLANET (Ver 1.3.0)



Fig 5.6 Emission Analysis

SMOKEMETER 437 STD/ SMOKEMETER 437 C

To take the readings from Smoke meter to ADCS Software kindly follow these steps.

Kindly fill the details (Engine No. Model, Engine Type, Engine Speed) in

respective text boxes given on the form if you didn't check "Vehicle details " check box in Master data entry form all the textboxes related to (Engine No. Model, Engine Type, and Engine Speed) become disabled.

Click on "Connect button "to connect the PC with equipment and wait for 5- 10 seconds. if the readings are not coming it show the message in red color ""Unable to Communicate with Equipment."" kindly check the following:

- Be sure that Smoke meter model name display on screen is same as your smoke meter model if not kindly change the model in "Master Data Entry Form".
- Check the COM port settings with PC and the software in "Master Data Entry "form.

RS232 Cable for smoke meter is working properly and connected with equipment.

Readings are coming with equipment and display on remote of smoke meter.

According to "Time interval settings in selection box, readings are automatically saves in database.

After taking the readings click on "Disconnect button" it disconnect the communication and show the message "Disconnected"

Report: Click on report button to take the report of the test.

Print: Click on print button to take the printout of screen as bitmap image.

Export to MS Excel Sheet: To export data in excel sheet click on “EXPORT TO EXCEL” button. When pressing export button a excel file is generated at path “C:\AVL Folder\”. The file name of excel file is same as Test Date and VIN no (Tuesday, January 06, 2009_26).

Close button : click on close button to exit from current active window or screen, it takes time to close, so wait for 10-15 seconds for form window to close.

5.8 SAMPLE PREPARATION



Fig 5.7 Bio diesel Sample

5.8.1 SAMPLES OF ALMOND OIL Sample

1:90% Diesel & 10%Biofuel

Sample 2:80% Diesel & 20%Biofuel

Sample 3:75% Diesel & 25%Biofuel

Sample 4:70% Diesel & 30%Biofuel

5.9 EXPERIMENTAL WORK

The biodiesel blends was prepared and samples are ready for testing. The samples of biodiesel are connecting with venturi meter to diesel pump and testing the fuel to engine. The testing was conducting and readings are taken for one by one samples.

The emission testing was conducting 437C smoke meter and readings are taken from the meter. The engine was conduct on various load tests and readings are taken.

CHAPTER - 6

RESULTS AND DISCUSSIONS

6.1 RESULTS

The Almond oil biodiesel prepared in the five samples and they were one by one poured into a container which is attached to the venturi meter in the front of engine pump. The venturi meter shows the amount of fuel exactly sent to the engine.

The exhaust is attached with 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.

6.2 RESULTS ARE EVALUATED WITH GRAPH

- Brake Thermal Efficiency
- Specific Fuel Consumption

6.2.1 Brake Thermal Efficiency (BTHE)

Current on-road diesel engines have approximately 42% brake thermal efficiency at full load, with 28% of fuel energy wasted in exhaust gas (including 4% going to pumping loss), 28% of fuel energy dissipating to cooling media as heat rejections to the ambient (including 4% going to mechanical friction and parasitic accessory power), and 2% going

to miscellaneous heat losses. There are strong interactions between heat rejections and exhaust gas energy, mainly depending on EGR rate and pumping loss.

When EGR rate increases, heat rejections become higher and exhaust energy becomes less. Pumping loss is related to EGR rate and air–fuel ratio (or essentially EGR circuit flow restriction, turbine area, and turbocharger efficiency). Such an energy distribution change affects the strategy of waste heat recovery. A roadmap for achieving 50–55% engine thermal efficiency can be planned by allocating improvement targets for each part of the energy distribution or each engine subsystem

6.2.2 Specific Fuel Consumption (SFC)

Specific fuel consumption (SFC) is a parameter that reflects the efficiency of a combustion engine which burns fuel and produces rotational power (at the shaft or crankshaft). In automotive applications, BSFC is used to evaluate the efficiency of the internal combustion engines (ICE). The keyword “brake” is related to the use of a dynamometer (electrical brake) to measure the engine parameters (fuel mass flow rate, torque, etc.).

An internal combustion engine requires fuel and air to produce energy. The amount of fuel used is usually measured on a dynamometer, as a mass flow rate, in kilograms per second [kg/s]. This parameter cannot be used to evaluate the efficiency of the engine because it is not obvious how much power we can extract from the fuel.

Therefore by dividing the fuel mass flow rate [kg/s] to the engine output power [W], we obtain the brake specific fuel consumption [kg/J]:

CHAPTER - 7

CONCLUSIONS

The Experimental analysis is study for alternative fuels feasibility. The source is using to develop the jojoba and grape seed oil for future bio fuel. The biodiesel is analyzed the performance and characteristics of NO_x , CO, HC, CO_2 , O_2 , BTH and SFC. Test has been conducted and the values are Tabled and chart has been drawn the values are come positive for the test results.

The results indicated the biodiesel is increased the brake thermal efficiency. Biodiesel sample are reduced the harmful gas effects in exhaust.

Ground nut and palm oil blends is equally blended. The blend sample S1 (almond oil 10% + diesel 90%). All samples are made for the blends for B20,

B25, B30 and B40. The bio diesel is near to come the diesel values for the testing. It used for the alternative fuel for the transportation purpose.

Test results are come for NO_x , CO, CO_2 , HC has increased the O_2 has been decreased. All other parameter has shown the significant improvement for the diesel.

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