

STUDY OF EMISSION CHARACTERISTICS OF A DIESEL ENGINE RUN BY FUEL BLENDS OF DIESEL, JATROPHA BIODIESEL AND CETANE IMPROVER

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

BY

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**DEPARTMENT OF MECHANICAL ENGINEERING
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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 **RAHUL. R (39150104)** and **SABBHARISHI. V (39150112)** who carried out the project entitled **"STUDY OF EMISSION CHARACTERISTICS OF A DIESEL ENGINE RUN BY FUEL BLENDS OF DIESEL, JATROPHA BIODIESEL AND CETANE IMPROVER"** under our supervision from December 2022 to April 2023.

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We **RAHUL .R (39150104)** and **SABBHARISHI .V (39150112)** hereby declare that the Project Report entitled “**STUDY OF EMISSION CHARACTERISTICS OF A DIESEL ENGINE RUN BY FUEL BLENDS OF DIESEL, JATROPHA BIODIESEL AND CETANE IMPROVER**” done by us under the guidance of **Dr. S.P. VENKATESAN** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Mechanical and Production.

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ABSTRACT

Biodiesel produced from oils of vegetable seeds has the potential to be a key alternative energy source for CI engines. The calorific value of vegetable oils is somewhat lower than that of diesel fuel. This is due to the existence of oxygen in vegetable oil molecules. The cetane number of vegetable oils ranges from 35 to 40 based on the composition, but diesel does have a cetane number of roughly 45. Enhancing a cetane number in diesel fuel, either by decreasing the aromatic component of the fuel by hydro treatment or by adding cetane improvers, is a low-cost alternative for reducing diesel engine emissions. This study attempts to provide an insight by comparing the engine emission characteristics and performance for diesel - Jatropha biodiesel blend (BD50) with and without cetane improver.

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LIST OF ABBREVIATION

BTE	-	Brake Thermal Efficiency
CO	-	Carbon Monoxide
CO ₂	-	Carbon Dioxide
DMC	-	Dimethyl Carbonate
HC	-	Hydrocarbon
Nox	-	Oxides of Nitrogen
O ₂	-	Oxygen
PM	-	Particulate Matter
SFC	-	Specific Fuel Consumption
VCR	-	Variable Compression Ratio

CHAPTER 1

INTRODUCTION

The growing number of vehicles has increased the need for fossil fuels (petroleum). Another source of concern for emerging markets is the rise in the cost of petroleum, which would raise their import expense. The world is currently facing a dual problem of fossil fuel exhaustion and environmental destruction.

Fossil fuels have a short lifespan, and their ever-increasing cost has prompted the quest for alternative renewable fuels to provide energy security and environmental protection. Biofuels can give a viable solution to the problem in poor countries. Cottonseed, palm, sunflower, and rapeseed oils, among others, can be used in diesel engines. These lubricants cannot be utilised immediately to extend the life of the engines. The increased volatility and viscosity (more than ten times that of diesel fuel) of these vegetable oils leads to poor fuel atomization and ineffective mixing with air, both of which contribute to incomplete combustion. (Bagby et al. 1987), (Goering et al. 1982), and they can be reduced by a process known as "transesterification." Because the technical qualities of esters are essentially identical to diesel, chemically converting plant oils to bio-diesel by alcoholysis (trans-esterification) was deemed the most appropriate adaptation. (Ma and Hanna et al. 1999), (Meher et al. 2006). Plant oils are trans-esterified to alkyl esters of the fatty acids included in the oil. (Lang X et al. 2001), (Ramadhas et al. 2005). Biodiesel has a greater cetane number than petroleum diesel, has no aromatics, and can include up to 10% by weight of oxygen. When compared to petroleum diesel, the properties of biodiesel lower the emissions of carbon monoxide (CO), hydrocarbon (HC), and particulate matter (PM) in the exhaust gas. (Agarwal A.K. 2007), (Agarwal D et al. 2008). (Pramanik K 2003) studied the utilisation of Jatropha oil mixes with diesel fuel in direct injection diesel engines. It has been stated that 50% of Jatropha oil blends may be used in CI engines in place of diesel fuel. When compared to diesel fuel, Jatropha oil has been shown to have higher specific fuel consumption and lower exhaust gas temperatures.

CHAPTER 2

LITERATURE SURVEY

S. NO	TITLE/YEAR	AUTHOR	RESULT AND CONCLUSION
1	Study on Outcome of Cetane Improver on Emission Characteristics of a Diesel Engine (2018)	A. Devaraj, D. Yuvarajan & I. Vinoth Kanna	Due to the greater oxygen content in the additive, it is further lowered by mixing DMC with Neem biodiesel. Neem biodiesel with dimethyl carbonate added was shown to have lower hydrocarbon emissions than both diesel and Neem biodiesel. NOX discovered more. Adding dimethyl carbonate greatly reduces smoke output.
2	Experimental Investigation of Performance and Emission Characteristics of Blends of Jatropha Oil Methyl Ester and Ethanol in Light Duty Diesel Vehicle (2014)	Mr.S.K.Sinha, Vipul Vibhanshu, Prof. Naveen Kumar	Blends of ethanol and methyl ester of jatropha oil were used in the studies. Because biodiesel has a lower heating value than conventional diesel fuel, JB100 has a higher exhaust temperature than the other mixes, which fall between D100 and JB100.
3	Experimental Investigation of Optimum Blend Ratio	M.I. Arbab, H.H. Masjuki, M. Varman, M.A.	After measuring the performance and emission characteristics of a short-term engine test, the ideal blend of

	of Jatropha, Palm and Coconut Based Biodiesel to Improve Fuel Properties, Engine Performance and Emission Characteristics (2013)	Kalam, S. Imtenan, and H. Sajjad	jatropha-palm-coconut biodiesel was determined to be the best biodiesel to replace diesel. Two or more biodiesels can be blended to improve the qualities of the fuel. In the case of a multi-fuel mix, the qualities of the fuel fluctuate linearly and there is an optimal blend ratio.
4	Experimental investigation on the performance and emission characteristics of a diesel engine fuelled with ethanol, diesel and jatropha based biodiesel blends (2012)	Shyam ent Pandey, Amit Sharma, P. K. Sahoo	Diesel and these fuel mixtures' impacts on engine output and emissions were compared. The test mixes ranged in volume from 5% to 20% ethanol and 15% to 20% biodiesel. The engine was run with varied loads at constant speed of 1500 revs per minute. After the addition of emulsifier (0.7% and 1%), the fuel blends with lower concentrations of ethanol (i.e., 5%-10%) with diesel were discovered to be stable. However, fuel blends with a greater ethanol content (15-20%) are more expensive.
5	Evaluation of Dimethyl Carbonate as Alternative Biofuel. Performance and Smoke Emissions of a Diesel Engine Fueled with Diesel/Dimethyl Carbonate/Straight	Laura Aguado-Deblas, Jesús Hidalgo-Carrillo, Felipa M. Bautista, Carlos Luna, Juan Calero, Alejandro Posadillo, Antonio A.	Application of the blends in a C.I. diesel engine has allowed researchers to study the impact of DMC on the mixtures. The absence of carbon-carbon bonds in DMC and its propensity to break down into CO and CO ₂ make this oxygenated compound an attractive choice as a biofuel to reduce soot particles. DMC

	Vegetable Oil Triple Blends (2021)	Romero, Diego Luna, and Rafael Estévez	successfully reduces the viscosity values of vegetable oils down to the According to the examined parameters, B20CO, which contains 9% DMC and 11% CO, has the best engine efficiency.
6	Performance, emissions, and heat losses of palm and jatropha biodiesel blends in a diesel engine	M.J. Abedin*, H.H. Masjuki, M.A. Kalam, A. Sanjid, S.M. Ashrafur Rahman, I.M. Rizwanul Fattah	The addition of 5%, 10%, and 20% biodiesel (both palm and jatropha) resulted in average BSFC gains of 5.0%, 19.0%, and 26.4%, respectively. In comparison to jatropha blends, the average BSFC was 14.4% lower with palm mixes. The performance of the engine was greatly influenced by the fuel's viscosity, density, and cetane number. When 10% to 20% of palm and jatropha biodiesel is added, the NOx emission decreases by 3.3% and increases by 3.0%.
7	Performance and emissions characteristics of Jatropha oil (preheated and blends) in a direct injection compression ignition engine (2007)	Deepak Agarwal Avinash Kumar Agarwal	The major goal of the current inquiry was to analyse the performance of the engine using novel alternative fuels and to reduce the viscosity of jatropha oil to a level that is comparable to that of standard diesel in order to make it suitable for use in a C.I. engine. In the current study, the viscosity of the oil (Jatropha oil) was decreased by I preheating it and (ii) blending it with diesel. Different physical, chemical, and thermal

			characteristics of diesel and Jatropha oil were studied. It was discovered that heating Jatropha oil to a temperature between 90 and 100 C is sufficient to reduce the viscosity to levels that are comparable to diesel. Jatropha blends' viscosity (up to 30%) was also discovered to be comparable to diesel
8	Investigations on Performance and Emission Characteristics of Diesel Engine with Biodiesel (Jatropha Oil) and Its Blends (2013)	Amar Pandhare and Atul Padalkar	As compared to diesel, the range of biodiesel blends showed a reduction in smoke opacity from 19.4% to 44.4%. This was primarily caused by complete combustion because fuel itself contains more oxygen. As engine loads grow, the smoke becomes more opaque. Even at lower loads, smoke increased as the blend concentration grew and was higher than mineral diesel. This is due to insufficient atomization of Jatropha oil. The difficulty in atomizing and vaporising Jatropha oil blends is caused by their higher viscosity, which has an impact on the air fuel mixing process. Incomplete combustion products like CO and HC are produced in greater amounts by the resulting regionally rich combinations.

9	An Experimental Investigation on the Effect of Cetane Improver with Biodiesel in CI Engine (2014)	P.R. Ayyappan, P.Karthikeyan	It was compared that the engine performance and emission results of blends of trans esterified jatropha oil blend B50 and B50 with EHN were better than those obtained with diesel. The brake thermal efficiency for B50+EHN was higher at full load, albeit slightly less than diesel. The BSFC displays higher value at all loads for all blends when compared to diesel. Diesel fuel has reduced CO, CO ₂ , and HC exhaust emissions from no load to full load. NO _x emissions from diesel and all mix fuels show the rising
10	Experimental investigations on jatropha biodiesel and additive in diesel engine (2009)	Y.V.Hanumantha Rao, Ram Sudheer Voleti, A.V.Sitarama Raju and P.Nageswara Reddy	The methyl ester of Jatropha oil combined with additives was successfully used as the soul fuel in a single cylinder compression ignition engine. The outcomes of the experiment are used to draw the subsequent conclusions. Engine performance is comparable to diesel operation when running on methyl ester of jatropha oil. Methyl ester of Jatropha oil produces a somewhat higher thermal efficiency than diesel. When compared to diesel, the methyl ester of jatropha oil lowers the exhaust gas temperature. With jatropha oil's methyl ester, CO ₂ emissions are minimal. Compared to diesel, the methyl ester of jatropha oil

			has lower CO emission at higher loads. Compared to diesel, NOX emission is marginally increased by jatropha oil's methyl ester.
11	Performance and Emission Characteristics of a Diesel Engine Fuelled with Biodiesel Blends (2016)	Kaushal Kumar, M.P. Sharma	The goal of this study is to identify the best biodiesel blends for diesel engine operation that deliver the maximum power while using the least amount of BSFC and emitting the fewest amounts of CO, HC, and NOx. Based on the review, the following findings are drawn: Because biodiesel blends have a higher oxygen content than diesel does, the combustion process results in an increase in temperature, and NOx emissions primarily affect combustion temperature. As a result, biodiesel blends reduce CO emission by 48.48% and HC emission by 37.5%, but they also increase NOx emission by 11.57%.
12	Experimental Investigation of Performance, Emission and Combustion Characteristics of Compression Ignition Engine using Waste Cooking Oil derived	Ashley Lobo, DK Ramesha, T.Deepak Kumar, L.Bharath	The experimentation showed that when biodiesel and ethanol are combined with diesel, the brake thermal efficiency increases by 2% and 7%, respectively, at 100% load. Because diesel and biodiesel have higher boiling points than ethanol, the BTE has increased. Because ethanol has a lower boiling point, combustion occurs more quickly and completely.

	Biodiesel with Ethanol (2021)		Brake-specific fuel consumption has dropped by 12%, which shows that the engine's performance has improved.
13	Experimental investigation on diesel engine using DMC as a Fuel additive in tamarind seed oil methyl ester (2017)	K.Yamini V.Dhana Raju, P.S.Kishore	The blended fuels have a lower consumption of brake-specific fuel. Compared to diesel fuel, CO emissions decreased by 10% while NOX emissions only slightly decreased. Additionally, there have been small reductions in HC emissions compared to diesel. Due to the increased 34.9% brake thermal efficiency and lower BSFC, the 10% blend of DMC fuel additive performs best. DMC fuel additive lessens the opacity of emissions like CO, CO ₂ , and smoke. The emissions of nitrogen oxides are getting closer. When HC emissions are compared to diesel fuel, they are greater.
14	The impacts on combustion, performance and emissions of biodiesel by using additives in direct injection diesel engine (2016)	M. Vijay Kumar , A. Veeresh Babu, P. Ravi Kumar	Depending on the makeup of diesel and biodiesel, the oxygenated additions will immediately affect characteristics like cetane number, density, viscosity, volatility, flash point, and calorific value. The oxygenated component helps reduce the density and viscosity of the biodiesel fuel while simultaneously increasing the quantity of oxygen in it. The ethanol, DEE, and isobutanol reduce the BSFC.

15	Performance and emission evaluation of a diesel engine fueled with methyl esters of rubber seed oil (2005)	A.S. Ramadhas, C.Muraleedharan S. Jayaraj	The various biodiesel-diesel blends are used as fuel for compression ignition engines. The B10 biodiesel blend greatly raises the braking thermal efficiency of diesel engines by about 3% under conditions of rated load. B10 usage also reduces pollutants and brake-specific fuel consumption. The temperature of the exhaust fumes rose as the blend's biodiesel content did. A rise in biodiesel blends is expected to produce an increase in NO _x emissions because the production of NO _x emissions is a phenomenon that is very temperature sensitive.
16	An experimental comparison of methods to use methanol and Jatropha oil in a compression ignition engine (2003)	M. Senthil Kumar, A. Ramesh, B. Nagalingam	When Jatropha oil's methyl ester is utilised, the braking thermal efficiency is comparable to diesel values. The greatest braking thermal efficiencies for diesel, jatropha oil, and its methyl ester are 27.4%, 29%, and 30.2%, respectively. Jatropha oil emits higher HC emissions than diesel. Diesel has a ppm of 100 at maximum production while jatropha oil has a ppm of 130. But only the methyl ester of jatropha oil contains 110 ppm. When it comes to CO emission, similar trends may also be seen.

17	Blending of jatropha oil with other vegetable oils to improve cold flow properties and oxidative stability of its biodiesel	Dwi Setyaningsih, Erliza Hambali, Sri Yuliani, Djajeng Sumangat	Combining jatropha biodiesel with those from soybean, rapeseed, palm, and coconut led to diverse qualities, ones that were on par with each compound's pure counterparts or even better than pure biodiesel. Jatropha biodiesel had a better pour point and cloud point when it was 50 to 70 percent jatropha-coconut blend. The minimum percentage for jatropha oil in blends was between 40 and 55 percent. With 55% jatropha in blends, lauric ester and jatropha biodiesel had the lowest cloud point and pour point (-3 °C and -18 °C).
18	Experimental Investigation On Performance, Combustion Characteristics Of Diesel Engine By Using Fish Oil (2012)	S.kiran kumar, Prof. K. Apparao, Prof. R. Nagendra Babu	The conclusions deriving from present experimental investigation to evaluate the experimental tests are conducted on 4-stroke, single cylinder, water cooled and direct injection diesel engine by using fish oil blends of F10, F20 and F30, pure diesel at constant speed of 1500 rpm. From the first set of results it can be conclude that the blend F30 has given the better performance in the sense of brake thermal efficiency, specific fuel consumption and emission parameters.
19	Experimental and Simulation Investigation of Effect	Seyed Reza Amini Niaki , Sajad Mahdavi,	Pollutant formation during combustion in compression ignition engines is a complicated phenomena

	of Biodiesel-Diesel Blend on Performance, Combustion, and Emission Characteristics of a Diesel Engine (2017)	and Joseph Mouallem	based on a variety of conditions, the effects of which are difficult to predict. The biodiesel-borne oxygen, high cetane number, and high flash point directly affect the auto ignition of biodiesel fuel. Because of the significantly higher flash point, the fuel mixture auto-ignition time increases as the amount of biodiesel in the blend increases.
20	Combustion Evaluation of Single Cylinder 4 Stroke CI Engine Fueled with Jatropha Biodiesel and Diesel Blend (2019)	Yash kumar A ,Tushar M Patel	At peak loading circumstances, the peak pressure reduced by roughly 1.66 percent and 3.06 percent for JB50 and JB100, respectively. With the base engine running at all loads, diesel has a substantially higher maximum pressure rise rate of 15.61%. At all loads with the base engine, the pressure rate was seen to fall for the JB50 and JB100 by 9.11% and 18.21%, respectively. At peak loading conditions,
21	Performance and Emission Characteristics of Jatropha Biodiesel Blends in a Direct Injection CI Engine (2021)	Khem Raj Bhatta, Rupesh Lal Karna, Ajay Kumar Jha, Surya Prasad Adhikari	When compared to the ASTM standard, the physio-thermal characteristics of biodiesel were found to be within acceptable bounds. JB20 has lower cetane number and calorific value but density and viscosity were higher than that of diesel. When running on blends of biodiesel derived from

			jatropha, the engine runs smoothly, displays no starting issues, and makes no audible knocking noises. For all test fuel under low and high loading conditions, IP was discovered to be very consistent.
22	Investigation on the Behaviour of a DI Diesel Engine Fueled with Jatropa Methyl Ester(JME) and Tyre Pyrolysis Oil (TPO) blends (2013)	Abhishek Sharma and S.Murugan	It is discovered that the ignition delay for JMETPO20 is nearly the same as that of diesel when operating at full load. Diesel has a 38.34o CA combustion time at full load. For JMETPO20, it fell by roughly 0.54o CA. The thermal efficiency of the brakes at full load is about the same for diesel and JMETPO20, coming in at 29.88 and 29.89%, respectively. When compared to diesel at full load, the CO, HC, and smoke emissions for JMETPO20 were reduced by approximately 9.09, 8.6, and 26%,
23	Comparison of Performance and Emissions Characteristics of Mustard oil and Jatropa multi blended Bio-diesel with the Base Streak Diesel (2021)	P. Suresh Kumar, N. Prasanthi Kumari , Amit Kumar Sharma and H. Upender	MJD-1's brake thermal efficiency is closer to that of diesel fuel than the other test fuels. The MJD-5 and MJD-4 test fuels' brake thermal efficiency reduced to a manageable level. With rising biofuel blend percentages, specific fuel consumption rises and is comparable to diesel test fuel. Compared to diesel fuel, the MJD-1, MJD-2, and MJD-3 test fuels had minimal carbon dioxide emissions. The main benefit of multi-blend fuels is this.

24	Investigation on the structural effects of the addition of alcohols having various chain lengths into the vegetable oil-biodiesel-diesel fuel blends: An attempt for improving the performance, combustion, and exhaust emission characteristics of a compression ignition engine (2020)	Murat Kadir Yesilyurta, Mustafa Aydinb, Zeki Yilbasic, Mevlüt Arslana	Due to their lower energy content relative to diesel and biodiesel fuel, quaternary fuel mixes resulted in worse brake thermal efficiency than diesel fuel and B20 blend. B20O10Pt10, a quaternary mix, At an engine load of 750 W, the least brake-specific fuel consumption figures were found to be 322.64 g/kWh for diesel, 343.09 g/kWh for B20, 356.96 g/kWh for B20O10, 417.09 g/kWh for B20O10E10, 408.96 g/kWh for B20O10Pr10, and 365.35 g/kWh for B20O10Pt10.
25	Experimental Investigation on Performance and Emission Characteristics of a Common Rail Direct Injection Engine Using Animal Fat Biodiesel Blends (2017)	V.K.Shahir, C.P.Jawahar P.R.Suresh V.Vinod	Results indicate that animal fat biodiesel is a reliable alternative fuel for compression ignition engines with CRDI technology. Temperatures of the BSFC and exhaust gases were found to be higher for blends containing more than 30% animal fat as compared to diesel fuel. When compared to diesel, it was discovered that the quantity of animal fat biodiesel in the fuel blends increased emission metrics such CO ₂ , NO _x , and HC.
26	Experimental Investigation on Use of Jatropha Oil Ethyl Ester and Diesel	Raghvendra Gautam, Naveen Kumar, Pritam Sharma	In comparison to all other test fuels, JOEE 20 had the highest full load BTE and the lowest brake specific energy consumption. With an

	Blends in Small Capacity Diesel Engine (2013)		increase in the JOEE content in diesel, it was discovered that CO and HC emissions decreased at higher loads. Nevertheless, JOEE 100 showed more CO and HC emissions as compared to the blended test fuels, JOEE10 and JOEE20. In agreement with this, it was discovered that smoke opacity decreased as JOEE content in diesel increased. As biodiesels speed up correct combustion and result in increased in-cylinder NOx production, JOEE 100 showed the greatest full load NOx emission, followed by JOEE20, JOEE10, and D100.
27	The effect of cetane number and oxygen content in the performance and emissions characteristics of a diesel engine using biodiesel blends (2019)	Semakula Maroa; Freddie Inambao	Blend 90/WPPO5/E5 (90% conventional diesel, 5% waste plastic pyrolysis oil, and 5% ethanol by volume) demonstrated brake thermal efficiency results that were extremely similar to those of standard diesel fuel. This was attributable to near density values and the barely discernible changes in the gross calorific values of blends made from waste plastic pyrolysis oil (WPPO). All the combinations and blends examined showed this condition, especially at lower blend ratios.

28	Effect of biodiesel on engine performances and emissions (2011)	Jinlin Xue ^{a,b} , Tony E. Grift, Alan C. Hansena	Since biodiesel is made from natural, renewable materials that are frequently found in one's own backyard, it is a more sustainable source of energy and will thus become more and more important in meeting the energy needs for transportation. As a result, over the past ten years, more research has been done on the emissions and performance of biodiesel engines. Despite the fact that there have always been uneven trends in the performances and emissions of biodiesel engines due to the various tested engines, various operating conditions or driving cycles, various used biodiesel or reference diesel, various measurement methodologies or equipment, etc.,
29	Experimental investigations on performance of mixture of jatropha and castor biodiesels as alternative fuel for diesel engines (2019)	Degaga Petros Areru	Because castor and jatropha oil, which are used to make biodiesel, are totally miscible with one another and with diesel fuel, any ratio of diesel and biodiesel can be used. The viscosity and density of biodiesel made from castor oil are higher than those made from jatropha oil, according to its characteristics. The biodiesel made from Jatropha and castor oil has a lower viscosity and density.

30	Performance and Emission Characteristics of CI Engine Fuelled With Various Ester of Jatropha - An Overview	Jeyaraj R P. Seenikannan	As the percentage of ethanol to biodiesel-ignition improver blend increased, performance metrics like brake thermal efficiency and brake-specific fuel consumption went up. With the addition of ethanol, emission characteristics like CO, unused oxygen, and smoke intensity decreased. As the amount of ethanol in the biodiesel-ignition improver blend increased, so did the CO ₂ and NO _x emissions.
31	Experimental Investigation on Performance, combustion and Emission Characteristics of CI Engine Fuelled with Pumpkin and Maize Biodiesel blends (2021)	N. Magesh T. Pushparaj V. Vinoth kannan	Diesel-only and PM As for maximum load (100%) the BTE was seen to be 28.87% for diesel, and climbed by 30.16%, 29.2%, 30.4%, 30.65%, and 32.22% for B10, B20, B30, B40, and B50, respectively. Biodiesel explains this growing pattern in BTE. The BSFC was found to be 0.297 kg/kW-hr for diesel, 0.286 kg/kW-hr for B10, 0.297 kg/kW-hr for B20, 0.287 kg/kW-hr for B30, 0.286 kg/kW-hr for B40, and 0.274 kg/kW-hr for B50, respectively, at maximum load (100%)
32	Production of biodiesel from Jatropha curcas and performance along with emission characteristics of an	S. Mitra , P. K. Bose & S. Choudhury	However, this work is primarily focused on the performance and emission characteristics of the engine, which are also extremely essential aspects. The effect of the delay time, heat release rates, and

	agricultural diesel engine using biodiesel (2009)		pressure rise are undoubtedly superior selection criteria for biodiesel. The biodiesel's physical and chemical characteristics indicate that because of its greater viscosity and density, it cannot be used directly.
33	Investigation of Engine Emission with Diesel-Palm Biodiesel-Antioxidant Blend (2017)	C.M. Choy, M. Varman, H.H. Masjuki	PPD and DPPD added to biodiesel blends increased kinematic viscosity and density while improving oxidation stability. DPPD antioxidant demonstrated superior emission properties over PPD. DPPD can be taken into consideration to enhance the emission characteristics of biodiesel in the future as the Malaysian Biodiesel Association urges the government to introduce B10 and B20 gradually.
34	Experimental Investigation on Performance and Exhaust Emission Characteristics of Variable Compression Ratio Diesel Engine Fueled with Microalgae Biodiesel Blends (2021)	Bhojraj N. Kale, S. D. Patle, V.R. Khawale, S.V. Lutade and N.P. Mungale	The current investigation showed that all microalgae biodiesel blends had decreased brake thermal efficiency and increased brake-specific fuel consumption. For all microalgae biodiesel blends, an increase in CO ₂ emissions was noted. Additionally, it was observed that when engine load increased, NO _x exhaust output likewise gradually increased.
35	Investigations on Performance and Emission	D. Ramesh and A. Sampathrajan	A biodiesel pilot plant was developed and used for biodiesel production from jatropha oil. Jatropha biodiesel

	Characteristics of Diesel Engine with Jatropha Biodiesel and Its Blend (2008)		was shown to have similar fuel characteristics to diesel. The fuel usage was around 14% greater with jatropha biodiesel alone than with diesel. For B20 to B100 fuels, the percentage increase in particular fuel consumption ranged from 3 to 14. The biodiesel and its blends' braking thermal efficiency
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CHAPTER 3

AIM AND SCOPE

Biodiesel is a clean-burning, sustainable alternative to petroleum diesel that is manufactured in the United States. Using biodiesel as a car fuel improves air quality and the environment while also providing safety benefits. Biofuels assist to lower the carbon footprint of transportation and other businesses by maximising the carbon cycle on our planet. Every gallon of biofuel that replaces a gallon of fossil fuel contributes to lower greenhouse-gas emissions.

CHAPTER 4

MATERIAL AND METHODOLOGY

MATERIAL

Jatropha

Jatropha belongs to the family Euphorbiaceae and has 175 species. It has originated from tropical America and has spread all over the tropics and subtropics of Asia and Africa. Jatropha grows on diverse wasteland without any agricultural impute (irrigation and fertilization) and has 40-60% oil content. Jatropha Curcas is a low-cost biodiesel feedstock with good fuel properties and more oil than other species. It is a non-edible oilseed feedstock. Thus it will have no impact on food prices or the food vs fuel debate. Shown in Fig. 4.1 jatropha oil.



Fig. 4.1: Jatropha oil

Table 4.1: Properties of Jatropha Oil

Properties	Jatropha oil
Density (kgm^{-3})	940
Viscosity(mm^2s^{-1})	24.5
Flash point($^{\circ}\text{C}$)	225
Calorific value (kj/kg)	39,774
Cetane number	45

DIESEL

Diesel fuel also called diesel oil, is any specifically designed for use in a diesel engine, a type of internal combustion engine in which fuel ignition takes place without a spark as a result of compression of the inlet air and then injection of fuel. Therefore, diesel fuel needs good compression ignition characteristics. The most common type of diesel fuel is a specific of petroleum fuel oil, but alternatives that are not derived from petroleum, such as biodiesel diesel are increasingly being developed and adopted. Shown in Fig. 4.2.



Fig. 4.2: Diesel

Table 4.2: Properties of diesel

PROPERTIES	DIESEL
Density (kgm^{-3})	850
Viscosity(mm^2s^{-1})	2.6
Flash point($^{\circ}\text{C}$)	68
Calorific value (kJ/kg)	42
Cetane number	45-55

DIEMETHY CARBONATE

Dimethyl carbonate (DMC) is an organic compound with the formula $\text{OC}(\text{OCH}_3)_2$. It is a colourless, flammable liquid. It is classified as a carbonate ester. This compound has found use as a methylating agent and more recently as a solvent that is exempt from the restrictions placed on most volatile organic compounds (vocs) in the US. Dimethyl carbonate is often considered to be a green reagent. As shown in Fig. 4.3.

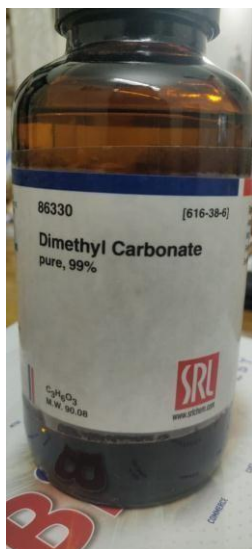
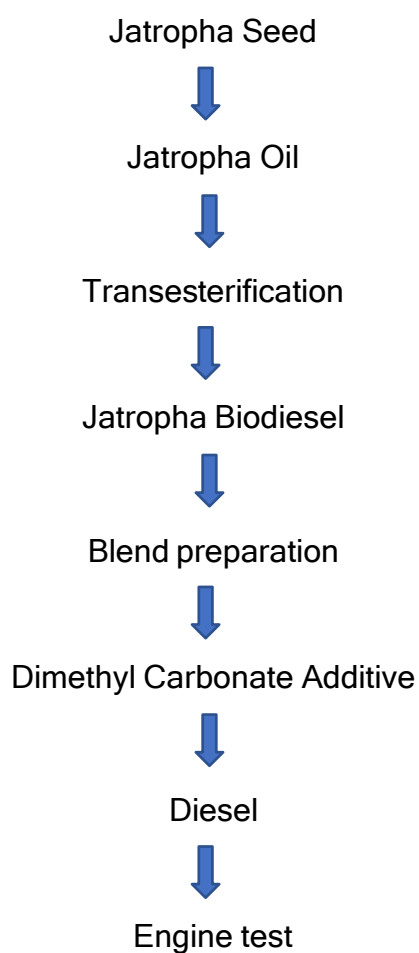


Fig.4.3: Diemethy carbonate

Table 4.3: Properties of DMC

Properties	
Chemical formula	$\text{C}_3\text{H}_6\text{O}_3$
Molar mass	$90.078 \text{ g}\cdot\text{mol}^{-1}$
Appearance	colorless liquid
Density	$1.069\text{-}1.073 \text{ g/mL}$
Melting point	$2 \text{ to } 4 \text{ }^\circ\text{C}$
Boiling point	90 °
Solubility in water	13.9 g/mL

METHODOLOGY



CHAPTER 5

TRANSESTERIFICATION PROCESS

Transesterification process is the convert the raw oil into the bio diesel. Triglycerides (fats) found in oils are utilised as a feedstock to produce useable biodiesel through a chemical process called transesterification. Because it has a slightly less viscosity than petroleum diesel, biodiesel created through the transesterification process can replace it in diesel engines. Biodiesel production is the process of producing biodiesel through the chemical processes of transesterification and esterification. The additional alcohol is deprotonated with a base during the transesterification process to make it a stronger nucleophile. In order to transesterified Castor and Jatropha oil, 5gm of KOH was dissolved in 250 ml of methyl alcohol. The heating oil was then filled with the potassium methoxide solution, which was aggressively agitated. Using a magnetic stirrer, biodiesel may be mixed with gasoline or diesel in any ratio; B5 (5% biodiesel and 95% diesel) and B20 (20% biodiesel and 80% diesel) are the most used ratios. The most common biodiesel/gasoline and diesel mixes are B5 (5% biodiesel and 95% gasoline) and B20 (20% biodiesel and 80% gasoline). The transesterification method can be used to Jatropha oil is converted into its methyl ester. The process of transesterification creates glycerol and fatty acid ester by reacting the fats in jatropha oil with methyl alcohol while using sodium hydroxide (NaOH) as a catalyst.

CHAPTER 6

ENGINE SET-UP

Variable compression ratio (VCR) is a technology to adjust the compression ratio of an internal combustion engine while the engine is in operation. This is done to increase fuel efficiency while under varying loads. Variable compression engines allow the volume above the piston at top dead centre to be changed. Higher loads require lower ratios to increase power, while lower loads need higher ratios to increase efficiency. The compression ratio is the ratio between the volume of the cylinder and combustion chamber in an internal combustion engine at their maximum and minimum values. A fundamental specification for such engines, it is measured two ways: the static compression ratio, calculated based on the relative volumes of the combustion chamber and the cylinder when the piston is at the bottom of its stroke, and the volume of the combustion chamber when the piston is at the top of its stroke. Compression ratio determines the type of fuel, how much boost, and has a significant influence on an engine's power and torque potential.

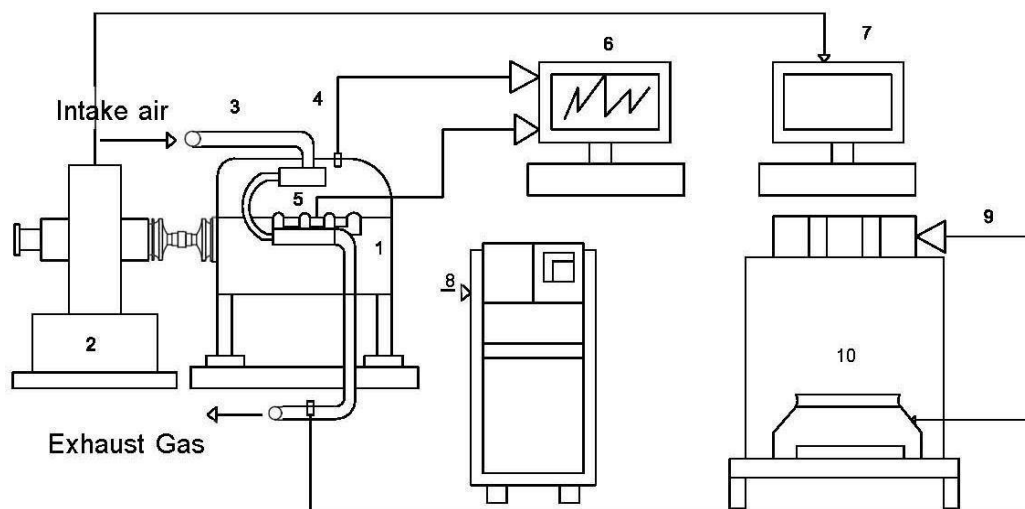


Fig. 6.1: Engine Set-Up

- | | |
|-----------------------------|----------------------------|
| 1. Test Engine | 6. Data Acquisition System |
| 2. Eddy Current Dynamometer | 7. Dynamometer Controller |
| 3. Air Mass Sensor | 8. Bosch Gas Analyser |
| 4. Pressure Sensor | 9. AVL Digas Analyser |
| 5. Accelerometer | 10. Smoke Opacity Meter |

ADVANTAGES OF VARIABLE COMPRESSION RATIO

In diesel engines, variable compression ratio provides control of peak cylinder pressure, improves cold start ability and low load operation, enabling the multi-fuel capability, increase of fuel economy and reduction of emissions. To achieve higher power outputs at the same speed, more fuel must be burned and therefore more air is needed

APPLICATIONS OF VCR ENGINE

The VCR engine is optimized for the full range of driving conditions, such as acceleration, speed, and load. At low power levels, the VCR engine operates at high compression to capture fuel efficiency benefits, while at high power levels, it operates at low compression levels to prevent knock.

CHAPTER 7

BIODIESEL SAMPLE PREPARATION

Jatropha raw oil can be blend and transesterification process converted into jatropha biodiesel .we can take raw jatropha oil and blend it get biodiesel .In that we can take three sample for this experiment that shown in below.

Sample	Diesel	Biodiesel	Additive
1	800 ml	200 ml	5 ml
2	750 ml	250 ml	5 ml
3	700 ml	300 ml	5 ml

CHAPTER 8

RESULT AND DISCUSSION

RESULT

The efficiency of Variable Compression Ratio Engine's performance is yet to be find using jatropha bio diesel with and additive

DISCUSSION

Jatropha oil has been given for Transesterification Process at Centre for Waste Management, Center of Excellence for Energy Research, International Research Centre, Sathyabama Institute of Science and Technology.

CHAPTER 9

CONCLUSION

The objective of this study is to determine the biodiesel. Substances used in diesel engines to produce the at maximum power and consumption, there are SFC, BTE, CO, NO_x, and smoke emissions. *Jatropha crucei* as a sustainable alternative fuel source for biodiesel It is better to put a diesel engine over a big desert place that receive municipal trash. *Jatropha*'s widespread use intends to use the pure oil derived from its seeds to make biodiesel as a substitute non-edible biodiesel oil source.

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