International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 09, September 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

REVIEW ON PERFORMANCE AND ANALYSIS OF C.I. ENGINES BY USING DIFFERENT BIODIESEL (ALTERNATE FUEL)

Rupesh H. Singh[1], Suprabhat A.Mohod[2]

[1]*Department of Mechanical Engineering, Lokmanya Tilak College of Engineering, Koparkhairane, Navi Mumbai (India)*

[2]*Asst. Professor Department of Mechanical Engineering, Lokmanya Tilak College of Engineering, Koparkhairane, Navi Mumbai (India)*

ABSTRACT

Technology is ever-evolving. Since the 90s, there has been much advancement in every field especially in the field of industrialization. The sophistication and the level of machinery have enlarged. Production rate and supply demand has gone up very high. To fulfill everyone's need and demand, industries and various other production and manufacturing companies have to work at a higher speed. For this purpose industries are forced to use heavy machineries which can be used for many applications, right from machines which can work at tremendous loads, to work so precise that the veracity of this degree of the machining process would have been unheard of 20years ago and a web of transportation system to satisfy the production and supply needs of their customers.To engage with the level and the rate of modernization, the basic requirement for every individual is an automobile. The primary controller or brain that is behind machinery or any automobile is a mechanical device known as Engine. Heavy and agile engines are being used to run heavy machines for the purpose of faster production rates. Efficient and better engines are being used in automobile for rhythmic and sophisticated performance. Just like we humans require food in order to harvest energy to accomplish our daily objects and goals, engines too require fuel supply so it can work efficaciously. Since the rate of use of engine has increased, it has indirectly increased the rate of consumption of fossil fuel. Fossil fuels being a non-renewable source of energy, this has elevated the rates of the fuels and day by day there is a sharp depletion in the reserves of the fossil fuels. To overcome this problem there is a requirement for an alternative form of fuel that is derived from renewable sources of energy which will transact the same work when used in engines and may even perform exceptionally. This paper epitomizes the use of different biodiesel in C.I. engines and their performances have been reviewed. The main purpose is not only to provide an equivalent for diesel or any such type of fuel but it has to be considered that it also abate the rate of harmful emission and other particulate matter that is flung out from the exhaust manifold of the engines. These biodiesels are derived from the vegetable or from the seed oils. Many researches have already been conducted to supersede diesel by vegetable and seed oil. Unfortunately the results were not in favor. Since vegetable and seed oils have high viscosity and low volatility, these restrict the direct use of the vegetable and seed oils in the engines. However, in further and higher studies it was found that these oils can be an alternative to diesel, provided that they are initially transesterified and later blended with

diesel which brings a deviation in the original properties of the oil and gets it in the range of diesel. Blending is a process in which the seed or the vegetable oil is mixed in proportion with diesel for the effective performance of the new fuel.

Keywords*: *Alternative, Bio-diesel, Blending, Depletion, Performance, Transesterified

I. INTRODUCTION

The elemental component vital to run any sort of machinery or a system is a mechanical device known as engine. Engines are those devices which converts one form of energy to "useful" mechanical energy which is further passed down to the machineries for their applications. Engines can mainly be classified as

- External combustion engines.
- Internal combustion engines.

In the initial stages of industrial revolution external combustion engines were used in industries, steam engines etc. to run the machineries and locomotives. They can be defined as heat engines in which an internal working fluid is combusted with the help of an external source. This causes the fluid to expand which then act on the mechanical linkages to perform useful work. The main sources of combustion were fossil fuels such as coal and wood having higher calorific values. The apparatus that were used in external combustion engines were enormous and therefore many researches and investigations were done to formulate a new type of engine which was compact and work with same or better efficiency than external combustion engines and finally internal combustion engine was built in.

Internal combustion engines can be defined as heat engines where combustion of fuel occurs in the combustion chamber in the presence of an oxidizer mainly air. As a result the temperature and pressure of the gases increases tremendously and they further expand which causes the movement of engine parts such as piston or turbine blades to generate useful mechanical energy. The main origin of fuels used in internal combustion engines are again fossil fuels such as diesel, petrol etc. Due to amplification in applications of engines, the fossil fuels are used in preponderance day by day. This has led to the shortfall of fossil fuels in the reservoirs. If proper care or any initiative is not taken it will soon extinguish from its origin.

II. FOSSIL FUELS

The paramount sources to run any sort of engines are fossil fuels. Fossil fuels can be defined as fuel which can be composed by naturally occurring processes such as anaerobic (absence of free oxygen) decomposition of buried dead organisms. The buried dead animals and plants below the surface of earth are exposed to high temperature and pressure underground which causes chemical variation in the primary sources resulting in the formation of fossil fuels. The overall processes that are involved in the production of fossil fuels are carried out over hundreds of millions of years. The amount of carbon content is immensely high which makes it the best source of combustion fuel. The major constituents of fossil fuels are petroleum, natural gas, and coal. Fossil fuels have got a number of applications where useful energy can be created by the combustion of fuels.

2.1 Advantages/Applications of Fossil Fuels

- They have high calorific value and therefore small amount of fossil fuel can create tremendous amount of energy.
- Coal has a number of applications in power plants and also reduces the production cost.
- Transportation of fossil fuels is not a big issue.
- Petroleum is the main source of fuel for all types of engines.
- Fossil fuels are easy to extract from there reservoirs.

Petroleum consists of untreated crude oil and petroleum products. The crude oil is treated and is distilled at huge refinery plants to extract fuels like diesel and gasoline. These fuels are highly used in internal combustion engines. Diesel fuel is widely used in industries to run heavy machineries. Diesel fuel is also used in power generator for the production of electricity. It has got countless applications in every field.Although fossil fuels are being manufactured continuously by natural processes, they are still considered as non-renewable sources of energy because the rate of production is way lesser than the rate of consumption. The fuels from the known reserves are consumed at higher rate than the new ones are being formed. There is a need to maintain the balance between the production and consumption rate.

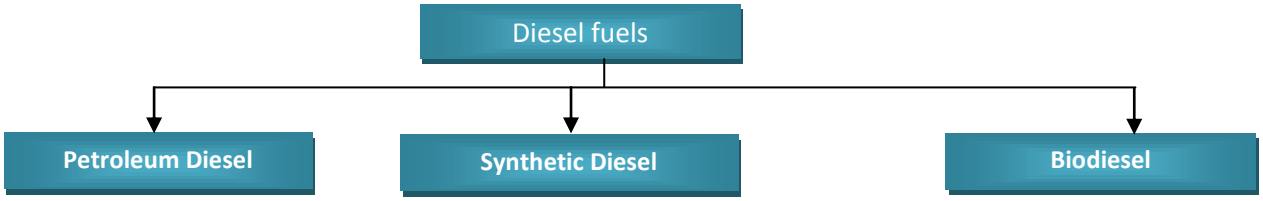
III. DIESEL

Diesel fuel can be defined as chain of hydrocarbons which is obtained after the refinery and distillation process of crude oil. It can be used in diesel engines or power generators or any such type of machinery in order to produce useful work.

Following are the properties of diesel oil:-

1.	Cetane no.	40-55
2.	Octane no.	15-25
3.	Pour point	12°C
4.	Flash point	>52°C
5.	Cloud point	18°C
6.	Kinematic Viscosity (40°C)	2.6 mm^2/s
7.	Density (15°C)	853.8 Kg/m^3
8.	Calorific value	42500 kJ/kg
9.	Self-Ignition point	256°C
10.	Sulphur (% weight)	1.0-1.5
11.	Carbon residue (% weight max.)	0.01

3.1 Types of Diesel Fuels



Petroleum diesel (petro diesel) also named as fossil diesel is obtained from the refinery plants where the crude oil is treated and fractional distillation is carried out to procure petro diesel. This is the most common type of diesel oil which is used in industries and automobiles. Synthetic diesel can be obtained from substances having high carbon composition in them such as biogas, coal, biomass and other such substances. The raw material used for the production is synthesized into gas which is further treated or distilled to produce diesel oil. The main advantage using synthesis diesel is that it reduces the amount of emission from the exhaust and other such and particulate matter. The sulphur content in synthetic diesel is almost negligible.

IV. BIODIESEL

Biodiesels can be delineated as an alternate source of fuels having long alkyl esters chain processed by transesterification and can be considered as renewable source of energy. They are elicited from vegetable/seed oils and also animal's fat. They can be used in all types of diesel engines. It can be used as a whole or sometimes it is blended with diesel. Biodiesels are normally not used in its original state, they are usually blended. Biodiesels have high viscosity and low volatility which makes it difficult to use biodiesel at many places or it may not be able to serve fluently. Blending is a process of amalgamating biodiesel fuels with diesel fuel in weight by weight ratio or volume by volume ratio in so that the attributes of the biodiesel fuels can relate to the diesel fuel and thus it can be used efficaciously.

4.1 Advantages of Biodiesel

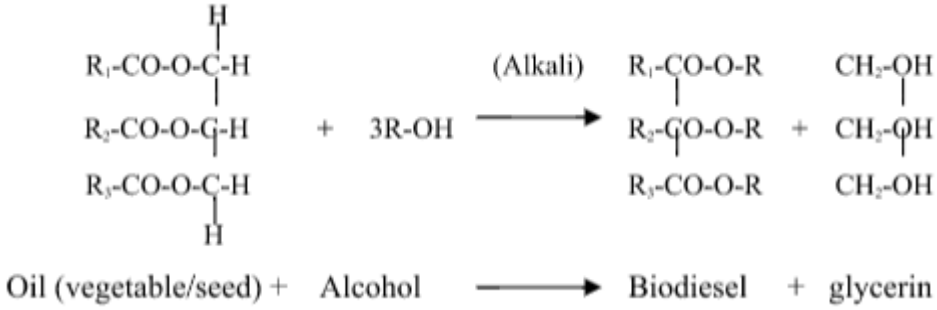
- Biodiesel are gleaned from vegetable or seed oil or from animal's fat. They are abundantly available in nature and thus can be considered as renewable sources of energy unlike petroleum products.
- They have imperceptible amount of sulphur in it and hence this reduces the harmful emission from the engines and machinery.
- It can be used as an alternative to diesel in engines and machinery.
- Countries having their won biodiesel reserves are free from exporting oil from the other countries.
- The emissions caused after burning bio diesel are free from all types of toxic gases and substances and have least impact on human health.

Biodiesel fuels are manufactured by the transesterification process of vegetable or seed oil. Common batch production, ultrasonic production process etc. are practiced in order to carry out transesterification process.

The commonly used feed stocks are Soy oil, palm oil, cottonseed oil, jatropha seed oil, mustard oil, peanut oil, coconut oil etc. can be used for the production.The transesterified vegetable or seed oil results into the formation of long chain fatty acids of mono alkyl esters. Here the oil of vegetable or seed is made to react with the alcohol

usually methanol since it is very economical and is available abundantly in the presence of a catalyzer. The final products of the transesterification process are biodiesel and glycerin.

4.2 Chemical Reaction of Tranesterification Process



Following are the properties of the vegetable/seed oils and methyl esters.							
Sr. No.	**Properties**	**Cotton seed oil**	**Soy seed methyl ester**	**Mustard oil**	**Peanut methyl ester**	**Palm oil**	**Jatropha oil**
1	Calorific value (kJ/kg)	40358	38800	39510-42650	39200	41300	39600-41580
2	Density (Kg/m^3)	909	860-900 (15°C)	921.43	946.79	867 (15°C)	926 (15°C)
3	Flash point (°C)	234	199	187	190	165	180
4	Kinematic viscosity (mm^2/s)	37.9 (37.8°C)	4.7 (40°C)	4.62 (45°C)	7 (40°C)	4.53 (40°C)	55 (40°C)
5	Specific weight	0.929 (15°C)	0.924-0.928 (15°C)	0.907-0.910 (30°C)	0.815-0.918 (15°C)	0.921-0.924 (15.5°C)	0.91-0.92 (15/40°C)
6	Ignition point (°C)	342-357	342	207	342-363	341	340
7	Sulphur content	3.5 (mg/kg)	10 (mg/kg)	2.7 (mg/kg)	0.0087-0.5696 (% by wt.)	6 (mg/kg)	0.13 (% by wt.)
8	Cloud point (°C)	-1 to 3	-6	4	15	14	6

The use of biodiesel in industries and automobiles should be aggrandized as it is derived from renewable sources of energy. Biodiesel are economical than petrochemical products and also abundantly available. The burning of biodiesels has infinitesimal impact of environment as well as human body. They are easily available and can be easily processed. The main purpose behind using biodiesel as a substitute is to maintain a balance between the nonrenewable sources and the renewable sources of energy.

V. REVIEW OF SOME RESEARCHERS

5.1 Palash M. Mendhe et al [1]:- The researchers have investigated the application of biodiesel as an alternative to diesel fuel for its service in diesel engines. They have studied the properties of cotton seed oil as a source of biodiesel. Cotton seed oil is extracted from the seeds of various cotton plants. Cotton seed oil as a whole is highly viscous and low volatile and therefore the application of cottonseed oil as a complete unit in diesel engines becomes difficult. To overcome this problem, they are blended with diesel oil in volume by volume ratio. Vegetable/seed oils can be easily blended with diesel oil in any proportion. The researches have blended the diesel oil with cottonseed oil in 20%, 40%, 60%, and 80% by volume. Biodiesel was prepared by transesterification process under the presence of potassium hydroxide (KOH) as a catalyzer. The source of alcohol for the transesterification of cottonseed oil was methanol. The catalyzed transesterification process was carried out in a water bath shaker. The resulting mixture obtained after the tranaesterification process was tested in a diesel engine at the speed of 1500 rpm (rated).After the performance of blended biodiesel in the engine, they have found out the brake thermal efficiency, exhaust gas temperature, volumetric efficiency, carbon monoxide, hydrocarbon, nitric oxide emission rates from the engine.

5.1.1 Material Specification

- Blended cottonseed oil with diesel (20%, 40%, 60%, and 80% by volume).
- Single cylinder 4 stroke engine with variable compression ratio.
- Eddy current dynamometer.

5.1.2 Experimental Setup

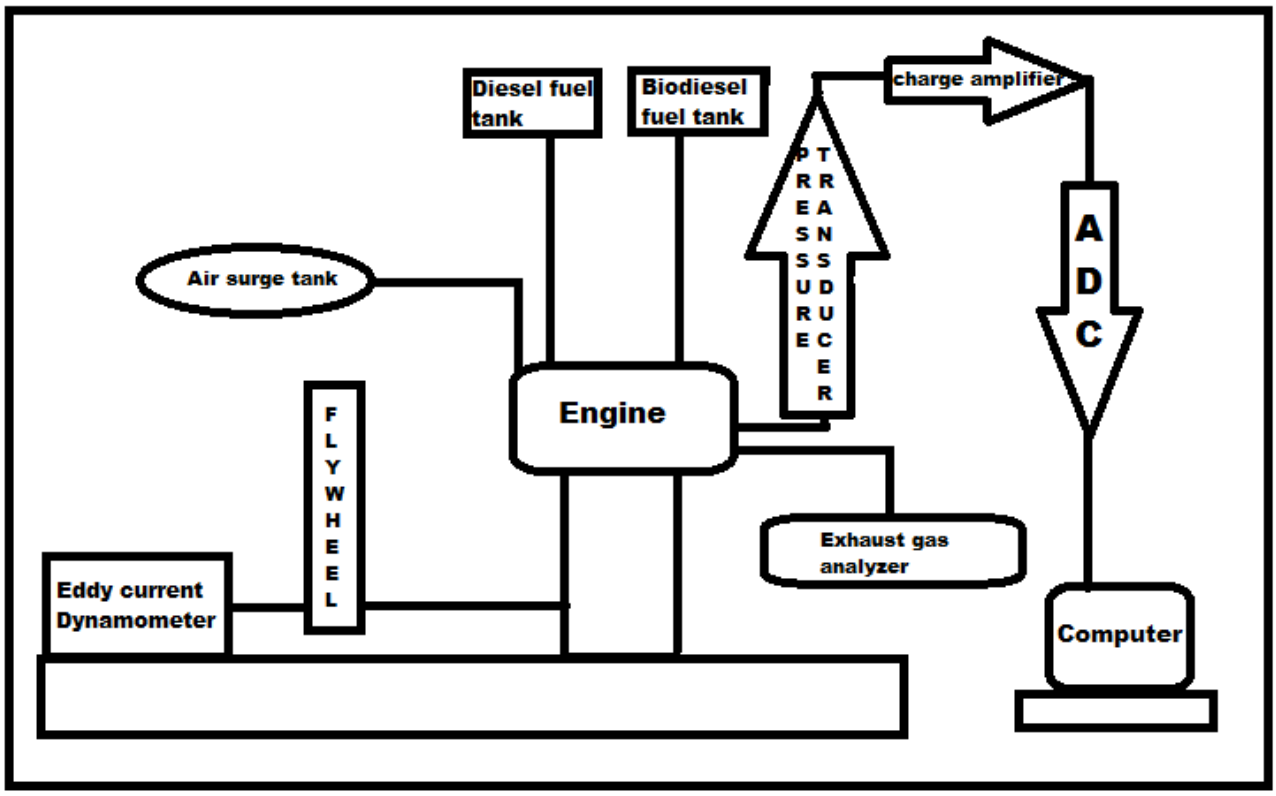


Figure 1.1

ADC*: - Analog to digital convertor.*

Specifications:

Table 1.2

1.	Engine	Single cylinder 4 stroke
2.	Stroke length	110 mm
3.	Displacement volume	661 cm3
4.	Bore diameter	87.5 mm
5.	Compression ratio	17.5:1
6.	Rated power	3.5 kw
7.	Injection mode	Direct
8.	Cooling system	Water
9.	Dynamometer	Eddy current dynamometer

5.1.3 Experimental Procedure

The experimental setup is shown in Fig 1.1. The engine used for the experiment is a 4 stroke single cylinder engine. The engine specifications are given in TABLE 1.2. The compression ratio of the engine can be varied without any physical change in the combustion chamber of the engine. Fuels tanks provisions are provided for the fuel supply of the individual fuels i.e. diesel fuel and blended cotton seed fuel in order to measure sole performance. Special instruments are used in order to measure crank angle and pressure measurements. The engine is cranked and fuel is provided through the fuel reservoirs. For the purpose of loading the engine, eddy current dynamometer is used. The signals generated from the engine are incorporated using highly advanced electronic devices and is fed to the computer for the measurement purpose. Emission from the exhaust manifold is directed to exhaust gas analyzer for the analysis of gases like carbon monoxide, nitric oxide and various hydrocarbons.

5.1.4 Result and Conclusion

After the examination following results were obtained:-

Sr. No.	Properties	Cottonseed oil	Diesel	Blended cottonseed oil
1	Brake thermal efficiency	Poor due to high viscosity.	More than cottonseed oil	Increases as amount of diesel in the blend increases as the viscosity decreases.
2	Exhaust gas temperature	Highest due to slow combustion of cotton seed oil because of high viscosity and low volatility.	Least due to uniform combustion of fuel	Escalates as the blend increases due to presence of oxygen atoms.
3	Nitric oxide(NO) emission	Lowest 703 ppm	Maximum due to good fuel mixing rate	The emission rates decreases as the cotton seed blend increases. 756 ppm (20% cotton seed 80% diesel)

4	Hydrocarbon(HC) emission	Due to high viscosity the droplets formation are larger resulting in intermittent distribution with air resulting in higher emission rate (75ppm)	50 ppm	Decreases as the blending rate of diesel increases. 55ppm (80 % diesel blend)
5	Carbon monoxide (CO) emission	Highest due to improper mixing.	Lowest	Decreases with increase in diesel blend.

- After studying at the above results it is clear that the performance of diesel is better than the cotton seed oil as well as the blended cotton seed oil.
- The blend with 80% diesel performs better than the rest of the blends when used in diesel engines.
- Blending of diesel with cotton seed oil decreases the carbon monoxide and hydrocarbons emission rates.

So we can finally conclude that 20 % or 40 % blend of cottonseed oil with diesel oil can be used as an alternate in diesel engines without varying their designs.

5.2 T. Mirunalini et al [2]:- This paper presents the research work on Jatropha oil as a source of biodiesel as an alternate to diesel fuel for its application in diesel engines. Jatropha oil can be obtained from Jatropha curcas plant. In this paper the property of jatropha oil are studied and is used in diesel engine and the results are investigated. Jatropha oil being highly viscous and low volatile makes it difficult for its direct application in the engine. The direct use of Jatropha oil in diesel engine may result into poor vaporization and atomization of the fuel during the injection process and may even harm the engine parts. To overthrow this, Jatropha oil is blended with diesel oil. Blending will result into the lowering of viscosity and it also increases the cetane number of the fuel. The researchers have created a blended mixture by amalgamating diesel oil with different proportions of clean jatropha oil. They have used the blended biodiesel fuel to run a 4 stroke single cylinder engine and at the end the performance and emission of the engine is reviewed. In order to load the engine electric dynamometer is used. They have initially carried out this experiment by using pure diesel oil and later blended mixture is used and comparisons are done.

5.2.1 Material Specification

- 4 stroke single cylinder diesel engine (rated power 4.41kw @ 1500rpm).
- Blended Jatropha oil with diesel.
- Electric dynamometer.

5.2.2 Result and Conclusion

- Brake Thermal efficiency of 10 % blended Jatropha oil at 200 bar fuel injection pressure was almost equal to that of diesel fuel.
- As the Jatropha oil blend in the diesel increases, the exhaust gas temperature also increases as jatropha oil and diesel blend self-ignites at a higher temperature which results into longer ignition delay.
- The hydrocarbon emission rate was higher for all blend of Jatropha oil than diesel oil.

- Carbon monoxide emission was observed minimum for 10% blend of Jatropha oil at 200 bar fuel injection pressure.
- Maximum reduction of NO gas was observed (32.53%) when 40% jatropha oil was blended.

So it can be concluded that 10% blend of jatropha oil with diesel oil can be used in the spot of pure diesel oil as it resembles similar characteristics as that of diesel oil.

5.3 Chralampos Arapatsakos et al [3]:- In this paper the researchers have examined the properties of soy oil and its utilization in various diesel engines. Soy oil can be used as a source of biodiesel and also a replacement to the use of diesel fuels. Due to increase in demand of diesel fuel, the diesel reserves are getting depleted and a solution to this expanding problem must be found out. The direct use of soy oil in the diesel engines may cause disservice to the engine parts. This problem of soy oil can be defeated by blending the soy oil with diesel oil in any proportion and biodiesel can be obtained. The researchers have obtained various blended mixture of soy oil with diesel fuel i.e. blending diesel with 5%(S5), 10%(S10), 20%(S20), 30%(S30), 40%(S40), and 50%(S50) oil pure soy oil. They have used the obtained mixture in a single cylinder 4 stroke diesel engine. The blended fuels are tested at various speed of the engine. The speed of the engine is set using a device known as Tachometer. At the end the performance of the engine and the fuel is reviewed.

5.3.1 Material Specifications

- Single cylinder four stroke diesel engine (1000 rpm, 1500 rpm, and 2000 rpm)
- Blended soy seed oil (S5, S10, S20, S30, S40, and S50).
- Smoke module exhaust gas analyzer MOD 9010/M.
- HORIBA analyzer MEXA-324 GE (to measure HC emission).
- Single GAS analyzer SGA92-NO (to measure NO emission).

5.3.2 Result and Conclusion

- As the soy oil volume is increased in the blend there is a downfall in emission rate of CO gases except in some cases (S5, S30, and S40 @ 1000 rpm).
- There is a reduction in hydrocarbons emission when blended biodiesel is used in the diesel engine.
- There is also a downfall of emission of nitric oxide gases when blended biodiesels are used.
- Smoke level of the engine increases as different blended soy oils are used as a source of fuel.

Overall it can be concluded that various blends of soy oil biodiesel can be used as an alternative to diesel fuel.

5.4 Zannatul Moiet Hasib el at [4]:- In this paper the use of Mustard oil as a source of fuel for diesel engines and power generators have been studied. According to the researchers mustard oil can be used as an alternative to diesel fuel in various diesel engines and power generators in various sectors. Mustard oil can be easily retrieved by pressing or crumbling the mustard seed. Direct use of clean mustard oil causes durability and may cause improper action of the engines. Being highly viscous they may block the tip of the fuel injectors when used for a longer time and due to low volatility incomplete combustion of the fuel air mixture will take place leading to the formation of impurities that may get deposited on the various parts of the engine. To conquer this problem of mustard oil they are blended with diesel fuel in any composition and transesterification process is carried out to obtain a biodiesel which will service more fluently. The transesterification process of mustard oil was carried by treating the clean oil with methanol in presence of Sodium hydroxide (NaOH) as a

catalyzer. Different blends of biodiesel with diesel oil were used in a single cylinder 4 stroke engine and the performance of blended biodiesel was studied.

5.4.1 Material Specification

- Single cylinder 4 stroke engine (2600rpm).
- Blends of mustard oil.
- K-type thermocouple to measure exhausts gas temperature.

5.4.2 Result and Conclusion

- All biodiesel blends except B30 had higher exhaust gas temperature than diesel
- Specific fuel consumption of biodiesel blends was always higher than diesel

So it can be concluded that biodiesel can be produced from mustard oil and it is possible to use mustard oil biodiesel as a source of fuel to run diesel engines.

5.5 Mohd Hafizil M. Yasin el at [5]:- This paper exemplifies the purpose of palm methyl ester as a source of fuel and also an alternative to depleting diesel fuel in order to run diesel engines in various fields. The presence of sulphur content in palm methyl ester is negligible and hence it can be concluded that burning of palm methyl ester is safer to environment and human health over diesel. The researchers have used palm methyl ester as a source of fuel to run a 4 stroke 4 cylinder inline engine and the performance of palm methyl ester is analyzed and is compared to the diesel fuel.

5.5.1 Material Specification

- Mitsubishi 4D68 diesel engine (4 stroke 4 cylinder in line).
- Palm methyl ester.
- Eddy current dynamometer.
- Fuel flow meter brand AIC 1204 (to measure the fuel flow)

5.5.2 Result and Conclusion:

- The specific fuel consumption of palm methyl ester was more than diesel oil due to lower energy content of palm methyl ester.
- The peak cylinder pressure of engine was more in the case of the palm methyl ester due to more oxygen content in palm methyl ester which tends to increase the heat release rate.

Finally it can be concluded that palm methyl ester can be used as a source of fuel to run various diesel engines. The biodiesel can work more efficaciously if blended with diesel oil.

5.6 Bjorn S. Santos el at [6]:- In this paper the researchers have followed an experimental procedure to use peanut oil methyl ester as a replacement for diesel oil in various diesel engines. Peanut oil or groundnut oil can easily be extracted from peanut seeds. Peanut oil when transesterified using Sodium hydroxide as a catalyzer results in the ester formation of the peanut oil. The properties of the obtained mixture such as viscosity are closer to diesel or other petrochemical fuels.

The researchers have blended diesel oil with 5 %(B5), 20 %(B20), and 50 %(B50) of peanut methyl ester and 100% peanut methyl ester is also used to run two separate diesel engines and in order to provide load dynamometer is used. At the end the performance of the fuel is reviewed.

5.6.1 Material Specifications

- Yanmar 3009D (14.2kW @ 3000rpm, 3 cylinders).
- JD 4045DF150 (60kW @ 2700rpm, 4 cylinders).
- Blended Peanut methyl ester.
- Water cooled eddy current absorption dynamometer (braking power- 22.4kW @ 6000rpm)

5.6.2 Result and Conclusion

- The peak torque values of both the engines were greater when blended peanut methyl ester was used.
- The NO_x emissions from the engine were found to increase as the peanut methyl ester in the blend is increased.
- The CO_2 emission was in small engine than in larger engine when pure peanut methyl ester was used.
- The amount of CO emission was lesser and tends to decrease as the peanut methyl ester in the blend increased.
- The emission rate of SO_2 remained lower (below 10 ppm) than the emission while using pure diesel fuel.

So after investigating the results it can be concluded that 5% to 10 % of peanut methyl ester blend in diesel fuel can be used to run diesel engines.

5.7 Md A. Hossain el at (7):-According to the researchers point of view coconut oil can be used as a source of biodiesel to replace the diesel oil as a source of fuel in various diesel engines. Coconut oil can be elicited from the harvested coconut's flesh. The direct use of the coconut oil as a source of fuel in diesel engines may result into choking or blocking of the fuel injectors. Coconut oil is blended or transesterified to obtain biodiesel so that the viscosity of the oil reduces and volatility increases which may result into proper injection of fuel and proper atomization and vaporization during ignition process. Coconut oil can be transesterified by mixing it with methanol under the presence of sodium hydroxide (NaOH) as a catalyzer. The researchers have obtained a blended mixture of diesel fuel with 80 %(B80), 60 %(B60) and 40 %(B40) of biodiesel from coconut oil and a pure form of biodiesel (B100) are used as a source of fuel to run a mono cylinder 4 stroke diesel engine and the performance is reviewed.

5.7.1 Material Specifications

- ZS1110 diesel engine (mono cylinder 4 stroke, nominal power- 3HP @ 2600 rpm)
- Different blends of coconut oil biodiesel.

5.7.2 Result and Conclusion

- The specific fuel consumption rate is higher for blends of coconut oil biodiesel than the diesel fuel.
- The thermal efficiencies of the blends are lower than diesel due to lower heating value of biodiesel fuels.

So after the analysis it can be concluded that biodiesel can be used as a source of alternative fuel in countries where the fossil fuel reserves are getting depleted at a faster rate. Especially coconut oil has a better lubricating property than other biodiesel fuels.

VI. CONCLUSION

After reviewing all the research papers it can be concluded that, there is a need for a detailed research into this sector. The biodiesels are performing well when used as a source of fuel and in some cases the emission rate of

few gases are lower than the conventional diesel fuel and it can be further improved. Some biodiesels like coconut oil have better lubrication property than other biodiesels, so it can be blended with other biodiesel to improve their lubrication property. Biodiesel can be a best alternate as a source of fuel in countries having depleting fossil fuel reserves.

REFERENCES

[1] Palash M. Mendhe, Mirza Munawwar BaigandChetan D. Madane: "Cottonseed Oil Used As an Alternative Fuel for the Performance Characteristics of Ci Engine by Blending With Diesel". INTERNATIONAL JOURNAL FOR RESEARCH IN EMERGING SCIENCE AND TECHNOLOGY E-ISSN: 2349-7610

[2]T. Mirunalini, R.Anand and N.V.Mahalakshmi: "JATROPHA OIL AS A RENEWABLE FUEL IN A DI DIESEL ENGINE".Proceedings of the 3rd BSME-ASME International Conference on Thermal Engineering 20-22 December, 2006, Dhaka, Bangladesh

[3] CHARALAMPOS ARAPATSAKOS, DIMITRIOS CRISTOFORIDIS, ANASTASIOS KARKANIS, KONSTANTINOS MITROULAS:"Soy oil as fuel in a four stroke engine".WSEAS TRANSACTIONS onENVIRONMENT and DEVELOPMENT ISSN: 1790-5079

[4] ZannatulMoietHasib, JomirHossain, SaikatBiswas, Asif Islam: "Bio-Diesel from Mustard Oil: A Renewable Alternative Fuel for Small Diesel Engines" Modern Mechanical Engineering, 2011, 1, 77-83

[5] MohdHafizil M. Yasin1, R. Mamat1, K.V. Sharma2 and Ahmad Fitri Yusop1: "INFLUENCE OF PALM METHYL ESTER (PME) AS AN ALTERNATIVE FUEL IN MULTICYLINDER DIESEL ENGINE".Journal of Mechanical Engineering and Sciences (JMES) ISSN (Print): 2289-4659; e-ISSN: 2231-8380; Volume 3, pp. 331-339, December 2012

[6] Bjorn S. Santos*, Sergio C. Capareda, Jewel A. Capunitan: "Engine Performance and Exhaust Emissions of Peanut Oil Biodiesel".Journal ofSustainable Bioenergy Systems, 2013, 3, 272-286

[7] Md A. Hossain, Shabab M. Chowdhury, YaminRekhu, Khandakar S. Faraz, MonzurUl Islam: "Biodiesel from Coconut Oil: A Renewable Alternative Fuel for Diesel Engine" World Academy of Science, Engineering and Technology Vol:6 2012-08-27

[8] Deepak Ashri and Dr. Raj Kumar: "Effective Process Parameters of Mustard Oil Biodiesel - A Review and Analysis". International Journal on Emerging Technologies 5(1): 99-106(2014)

[9] D. Rachel Evangelene Tulip and K.V. Radha: "Production of biodiesel from mustard oil its performance and emission characterization on internal combustion engine". Advanced Engineering and Applied Sciences: An International Journal Universal Research Publications. All rights reserved ISSN 2320–3927

[10] B. B. He, J. H. Van Gerpen, J. C. Thompson: "SULFUR CONTENT IN SELECTED OILS AND FATS AND THEIR CORRESPONDING METHYL ESTERS". 2009 American Society of Agricultural and Biological Engineers ISSN 0883-8542

[11] Mushtaq Ahmad*, Sofia Rashid, Mir Ajab Khan, Muhammad Zafar, Shazia Sultana and SobiaGulzar: "Optimization of base catalyzed transesterification of peanut oil biodiesel" African Journal of Biotechnology Vol. 8 (3), pp. 441-446, 4 February, 2009

[12] ANIL KUMAR DUBEY, R.M. SARVIYA and A. REHMAN: "Characterization of Processed Jatropha Oil for use as Engine Fuel" Current World Environment, Vol. 6(1), 101-107 (2011)