Biodiesel - An Alternative Fuels in Internal Combustion Engine

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Abstract— The rapid growth in industrial development and motorization, the world has extraordinarily raised the demand of the petroleum products. The reservoirs of such a petroleum based fuels are limited in the world. In recent time, the world is facing problems with energy crises due to depletion of conventional energy sources and increase environmental problems. Also, they are exhaustible and cost is rapidly increasing day to day. Hence, it is quit necessary to focus on an alternative fuels which are neither exhaustible nor harmful to environment and can be derived from the material available in the country. Recently biofuels is being considered as one of the most promising alternative fuels in internal combustion engine. Because it have low evaporation losses as well as it is safer for transportation and storage. From the past research's it concludes that with the use of bio-fuels as a fuel in engines, there is remarkable reduction in harmful emissions as well as one will get the same engine efficiency. Recently consumption of biodiesel as well as their blends with diesel is increases, as it decreases the dependence on imported petroleum; providing a market for the excess production of vegetable oils and animal fats, using renewable and biodegradable fuels, reducing global warming; and reducing substantially the exhaust emissions of carbon monoxide, unburned hydrocarbons, and particulate emissions from diesel engines. However, there are major drawbacks in the use of biofuel blends as NOx tends to be higher. The fuel additives become obligatory tools not only to decrease these disadvantages but also to produce specified products. Additives improve ignition and combustion efficiency, stabilize fuel mixtures, protect the motor from abrasion and wax deposition, and reduce pollutant emissions, among other features.

Key words: Diesel Engine, Palm Biodiesel, Blends, Performance, Emission, Additives

I. INTRODUCTION

The world is facing problems with energy crises due to depletion of conventional energy sources and increase environmental problems. This situation has led to the search for an alternative energy resources, which should be not only in exhaustible but also less harmful to environment. For developing countries, fuels of bio origin such alcohol, vegetable oils, bio-mass, bio-gas, synthetic fuels etc. are becoming most popular. Such fuels can be used directly, while others need some modification before they are used as fuel. And also by the application of the bio-fuels the harmful emission from engine such as CO, SO2, soot, hydro carbon, etc. can be controlled. Increasing air pollution is the most important problems of developed countries today. Exhaust emission from motor vehicle have a main role in this pollution. It is not enough to change the design of engine of vehicle to cope with the legal regulation, so it is quit necessary to focus on alternative fuels. These alternative fuels can be produced from renewable energy sources such as sugar-cane, cassava, jetropha, karanja, soybean oil, sunflower oil, cotton seed oil, ground nut oil, sesame oil, palm kernels oil, castor oil. Furthermore bio-fuels have some advantages' over petroleum fuels, such as the reduction CO and hydro carbon emissions and well antiknock performance, which allow the use of higher compression ratio of engines. And also self -ignition temperature and fleshing point of bio-fuel are higher than those of petroleum fuels. Due to low evaporation losses it safer for transportation and storage. Many researchers have been conclude that with the use of bio-fuels as a fuel in engines a reduction in harmful emissions as well as a comparable engine Performance with petroleum fuels can be possible. [1]

Fuels are of great importance because they can be burned to produce significant amounts of energy. Many aspects of everyday life rely on fuels, in particular the transport of goods and people. Main energy resources come from fossil fuels such as petrol oil, coal and natural gas. Fossil fuel contributes 80% of the world's energy needs. Most industries use diesel machines for the production process. In the transportation sector, private vehicles, buses, trucks, and ships also consume significant amounts of diesel and gasoline. This situation leads to a strong dependence of everyday life on fossil fuels. However, the growth of the population is not covered by domestic crude oil production [5-6].Fossil oils are fuels which come from ancient animals and microorganisms. Fossil fuel formation requires millions of years. Thus, fossil oils belong to non-renewable energy sources. An increase of the oil price often leads to economic recessions, as well as global and international conflicts.[4]

In addition the emission produced by the combustion of fossil fuels also contributes to the air pollution and global warming [1-4]. Most countries also experience more and more international pressure on global warming issues. Hence, renewable and clean alternative fuels have received increasing attention for current and future utilization. [6]. Biodiesel as one promising alternative to fossil fuel for diesel engines has become increasingly important due to environmental consequences of petroleum-fuelled diesel engines and the decreasing petroleum resources. Biodiesel can be produced by chemically combining any natural oil or fat with an alcohol such as methanol or ethanol. Methanol has been the most commonly used alcohol in the commercial production of biodiesel. Lots of researches on biodiesel have shown that the fuel made by vegetable oil can be used properly on diesel engines [3]. In fact the energy density of biodiesel is quite close to regular diesel. Biodiesel can be produced by soybean and methanol via trans esterification in the presence of acid catalysts. Similarities between the combustion properties Table 1 of biodiesel and petroleum-derived diesel have made the

former one of the most promising renewable and sustainable fuels for the automobile [4].

Biodiesel is a derivative of vegetable oils. Biodiesel is made from vegetable oils and animal fats through a chemical process named transesterification. Biodiesel can be blended in any ratio with petroleum diesel fuel. Its higher cetane number improves the combustion even when blended in the petroleum diesel. It can also be used as an additive to achieve the following objectives:

1) To reduce the overall sulphur content of blend,
2) To compensate for lubricity loss due to sulphur removal from the diesel fuel,
3) To enhance the cetane number of diesel fuel.[5]

Type of Vegetable Oil	CN	HV (kJ/kg)	Viscosity (mm^2/s) Temp	Cloud Point (^oC)	Pour Point (^oC)	Flash Point (^oC)	Density (kg/m^3)
Castor oil	N A	39500	297 (38 ^{o}C)	N A	-31.7	260	961
Coconut oil	N A	N A	N A	N A	N A	N A	924.27
Cottonseed Oil	41.8	39468	33.5 (38^{o}C)	1.7	-15.0	234	925.87
Linseed Oil	34.6	39307	27.2 (38^{o}C)	1.7	-15.0	241	929.07
Olive Oil	N A	N A	N A	N A	N A	N A	918
Palm Oil	42	N A	N A	N A	N A	N A	910.1
Peanut Oil	41.8	39782	39.6 (38^{o}C)	12.8	-6.7	271	914
Rapeseed Oil	37.6	39709	37.0 (38^{o}C)	-3.9	-31.7	246	920
Sesame Oil	40.2	39349	35.5 (38^{o}C)	-3.9	-9.4	260	922
Soybean Oil	37.9	39623	32.6 (38^{o}C)	-3.9	-12.2	254	997.5
Sunflower Oil	37.1	39575	37.1 (38^{o}C)	7.2	-15.0	274	920
Tallow Oil		40054	51.15 (40^{o}C)	N A	N A	201	820
Jatropha Oil	51	39700	51 (30^{o}C)	16	N A	242	932
Pongamia Oil	51	46000	55.1 (30^{o}C)	23	N A	110	884
Diesel	47	45343	2.7 (38^{o}C)	-15.0	-33.0	52	870.20

Table 1: Comparisons of Properties of Vegetable Oils and their Esters with Diesel Fuel [2]

II. BIODIESEL AND ITS BLEND FOR CI ENGINES

The search for sustainable and environment approachable fuels are going to increase with increase in the human population and increased awareness about climate change. Greenhouse emissions from the biofuels can be recycled and hence favourable for atmospheric environment than fossil fuels. [5]

The mahua methyl esters and its blends with diesel were used as fuel. Various proportions of mahua methyl ester fuel blends (25% and 50%) were used for conducting the performance tests at varying load conditions. Some modifications and additions to the conventional esterification process are required. Esters of waste oils and fats oils give a performance similar to rape methyl ester in vehicles. Problems of high melting point can be overcome by mixing with mineral diesel. [7]

Most of the researchers reported that adding ethanol into biodiesel-diesel blend in diesel engines significantly reduce HC, PM, NOx and smoke emissions but slightly increase fuel consumption. The study concluded that biodiesel-diesel-ethanol blend can be used as a substitute of petro-diesel fuel to reduce enslavement on fossil fuel as well as the exhaust emissions of the engine.[7,8]

The effects of variations in engine operating parameters on the emissions of NOx while operating with pure biodiesel (Jatropha methyl ester). At standard operating parameters, the emissions of NOx are found to be lesser with JME as compared to diesel as fuel. It is observed that increase in compression ratio tends to raise the emission level of NOx whereas increase in injection pressure leads to reduction in NOx emissions. While using pure JME as fuel, high compression ratio related with high injection pressure, results in lower NOx emissions as compared to diesel emissions. At lower speeds of engine, the emissions increases peaking at 1440 rpm. The effect of retarding the injection timing is positive as emission of NOx tends to decrease with retardation. Thus NOx emissions can be decreased by increasing compression ratio, increasing injection pressure, maintaining engine speed and retarding injection timing from standard values of these parameters.[10]

The results of experimental study with biodiesel blends were compared with that of standard diesel. The results indicate that the CO emissions were slightly higher, HC emissions reduced from 12.8 % for B20 and 2.85 % for B40, NOx emissions decreased up to 39 % for B20 and 28 % for B40. The efficiency decreased slightly for the blends in association with diesel. The BSEC was slightly more for B20 and B40. From the investigation it can be concluded that biodiesel can be used as an alternative to diesel in a compression ignition engine without any engine modifications.[11]

Palm biodiesel-diesel blend (20% palm biodiesel-80% diesel) with the help of ethanol, n-butanol and diethyl ether as additives regarding emission and performance features. The improved blends consisted 80% diesel, 15% palm biodiesel and 5% additive. Use of additives highly improved brake power, decreased BSFC (brake specific fuel consumption) and increased BTE (brake thermal efficiency). Diethyl ether showed highest 6.25% increment of brake power, 3.28% decrement of BSFC and about 4% increment of BTE than 20% palm biodiesel-diesel blend when used as additive. Other two additives also showed interesting improvement regarding performance. All the blends with additives showed lessened NO and CO emission but HC emission indicat a slight increment. However, this experiment reveals comparative suitability of these three additives on improving biodiesel-diesel blend.[12]

The results of performance and emission tests are compared for various blends of castor oil biodiesel with that of neat diesel. The results indicate that at blend B60, Brake

Specific Energy Consumption is lowest with highest exhaust gas temperature and lowest smoke opacity as compared to other blends. [13]

According to the combustion analysis of KO biodiesel as fuel in a single cylinder diesel engine, ignition delay for KO biodiesel and their blends showed the opposite tendency with diesel .The increase in viscosity for petro diesel indicate to poor atomization, slow mixing, and increase in spray penetration and decrease in spray angle. These result in longer ignition delay. [14].

The fuel physical characteristics are between the most important parameter to determine the quality of each fuel. Though biodiesel can replace diesel adequately, problems related to fuel properties persevere. In this study diethyl ether (DEE) was used as additive to the palm biodiesel-diesel blended fuel B30 and B40 in the percentages of 2% and 6% by volume and tested for their properties enhancement according to ASTM D7467 standard procedures. The tested fuel samples were compared with diesel fuel diesel and palm biodiesel (B100). The minimum pour point for the blended fuel was -7 ^{o}C for B30DE6 compared to 14 ^{o}C for palm biodiesel, the results shows that the best properties was for B30DE6 where the presence of diethyl ether additive supports to reduce the viscosity by 35%, density by 3.6% and acid value by 57% related to palm biodiesel. But a slight decrease in the energy content has been found with increasing additive as well as blending portion compared to pure diesel and the lower energy content value was for palm biodiesel.[15]

III. ADVANTAGES

The following are some of the advantages of using vegetable oil as I.C. engine in India.

1) Vegetable oil is produced locally which helps to reduce costly petroleum imports.
2) Development of the bio-diesel industry would reinforce the domestic, and particularly the rural, agricultural economy of agricultural based countries like India.
3) It is biodegradable and non-toxic.
4) It is a renewable fuel that can be made from agricultural crops and or other feed stocks that are considered as waste.
5) It contains low aromatics.
6) It has 80% calorific value compared to that of diesel.
7) It has a reasonable cetane number and hence possesses a smaller amount knocking tendency.
8) Low sulphur content and hence environment approachable.
9) Personal safety is improved (flash point is 100higher than that of diesel.
10) Enhanced lubricity, thereby no major modification is required in the engine.

IV. LIMITATIONS

1) It contains approximately 8% less energy per gallon.
2) Generally it has a higher cloud and pour point (will freeze at a higher temp) than conventional diesel.
3) It may increase nitrogen oxide emissions.

The most common method used to overcome the limitations of biodiesel is called "blending."

V. CONCLUSION

In this review paper, it is concluded that

1) The use of biodiesel will lead to loss in engine power mostly due to the reduction in calorific value of biodiesel compared to diesel, and it effect in the increase in biodiesel fuel consumptions.
2) By using biodiesel, global warming as well as the exhaust emissions of carbon monoxide, unburned hydrocarbons, and particulate emissions from diesel engines were reduces. However, there are major drawbacks in the use of biofuel blends as NOx tends to be higher
3) The additional improvement in additives which improve consumption of biodiesel should be needed to power recovery, economy and emissions especially for NOx emissions

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