© 2015 IJEDR | Volume 3, Issue 2 | ISSN: 2321-9939

CI Engine Using Alternative Fuel: Review

[1]Ravindra a Patil, [2]Thushar A Koli
[1]P.G.Scholar, [2]Assistant Professor,
[12], Department Of Mechanical Engineering, GF's Godavari College of Engineering Jalgaon, India

---

***Abstract* – The rapidly depleting conventional energy source has promoted researchers to concentrate on alternative fuel sources. Compression Ignition (CI) engines are the drivers of economy, hence attention is focused to find out alternatives fuels for these engines. Among various possible options, liquid biodiesels seems to be most promising and suitable alternative to diesel fuels in CI engine. The chemistry of biodiesels is entirely different from diesel. Diesel is basically hydrocarbons however biodiesels constitutes oxygen mass along with carbon and hydrogen in its chemical structure. The presence oxygen mass in biodiesels has dramatic effect on the physical and chemical properties of biodiesels. The structural oxygen content in biodiesels improves combustion efficiency due to increase in the homogeneity of oxygen with fuel during combustion; however presence of oxygen in fuel also lowers the energy content of fuel. Biodiesels production is a promising and important field of research.**

***Index Terms* – CI Engine, Alternative Fuel, Properties.**

I. INTRODUCTION

The constant increase in the rate of consumption of the fossil fuels, consequent upon the ever increasing population and the urbanization in the present day world, has made the depletion of these conventional fuel resources in the near future a quite inevitable fact. Also, the Greenhouse Gas emissions from these fossil fuels are constantly degrading the planet and causing global warming and other pollutant emission related problem. As such, the situation demands for an alternate source of energy that can be used to overcome the forecasted future energy crisis. In addition to this, if the energy source is clean and renewable, it will reduce the environmental issues as well. In this quest for an alternate and renewable energy resource, scientists have come up with a variety of options among which Biodiesel-diesel blends as alternative fuels has become a popular option and is gaining the attention of many researchers. This is because scientists have seen that the properties of Biodiesel prepared from vegetable oils are very close to commercial diesel and thus it has a promising future as an alternative fuel for diesel engine. Biodiesel being renewable, biodegradable and green fuel can reduce our dependence on conventional/ non-renewable fossil fuels as well as improve environmental quality in metro cities, urban and rural sectors by reducing obnoxious automotive/vehicular emissions. As such Biodiesel has the potential to replace petroleum diesel in near future. A lot of research work pointed out that Biodiesel has
received a significant attention and it is a possible alternative fuel. Biodiesel and its blends with diesel were employed as a fuel for diesel engine without any modifications in the existing engine.

Biodiesels are simply said to be fuels derived from biological sources. Biodiesels are available either in liquid form such as alcohols, Biodiesels etc. or gaseous form such as biogas, hydrogen etc. Cereals, grains, sugar crops and other starches can be fermented to produce alcohols, mainly ethanol, which can be used either as a motor fuel in pure form or as a blending component in gasoline. Cellulosic materials, including grasses, trees, and various waste products from crops, wood processing facilities and municipal solid waste, can also be converted to alcohols. But this process is more complex than processing sugars and grains into alcohols. Research is on to develop techniques that can effectively convert cellulosic crops and crop wastes to ethanol. Cellulose can also be gasified to produce a variety of gases, such as hydrogen, which can be used directly in some vehicles or can be used to produce synthesis gas. This synthesis gas is further converted to various types of liquid fuels, such as dimethyl ether and even synthetic gasoline and diesel. Oil derived from tree borne oil seeds are, in general, known as Straight Vegetable Oil (SVO). These oils can also be converted into methyl esters, known as Biodiesels. Both of these liquid oils can be either blended with conventional petro diesel or burnt in their pure forms [1].

Energy obtained from biodiesels through combustion does not add to the level of CO_2 in the atmosphere that causes global warming. The reason for this is that plants use CO_2 from the atmosphere to grow (photosynthesis) and the CO_2 formed during combustion is balanced. In the case of fossil fuels, the carbon content of these fuels has been fixed and contained in the earth's crust for millions of years. By burning these fossil fuels the formerly harmless carbon buried in the earth's crust is released into the atmosphere as CO_2 resulting in a net increase in the carbon concentration that leads to global warming.

Organic waste materials like waste cooking oil, animal fats, animal manure, and organic household wastes etc. can be converted into fuels which can be used as automotive fuel. Available quantities of these fuels may be small in many areas, but raw materials are generally of low cost or even free. Converting organic waste material to fuel can also diminish waste management problems [2-5].

II PRODUCTIONS OF BIODIESELS

Direct use and blending

Conventional methods of the application of vegetable oil in diesel engines are direct mixing and micro emulsion. These two physical methods can lower the viscosity of vegetable oil, but they can not solve the problem of carbon deposits and lube pollution, and the high temperature pyrolysis cracking is hard to be controlled by its reactant at high temperature. The most relevant process parameters in these kinds of operation are reaction temperature, ratio of alcohol to vegetable oil, amount of catalyst, mixing intensity (RPM), catalyst, and the raw oils used.

Transesterification

Transesterification is a process of reacting a triglyceride such as vegetable oil with an alcohol in the presence of an alkaline catalyst to produce fatty-acid esters and glycerol. Among the alcohols, methanol and ethanol are used commercially because of their low cost and their physical and chemical advantages. They are easily dissolved in and react quickly with tri-glycerides and NaOH. A catalyst is used to improve the reaction rate and yield. An alkaline-catalyzed transesterification process is normally adopted for Biodiesel production because alkaline metal alkoxides and hydroxides are more effective than acid catalysts. Sodium and potassium methoxide are much more effective catalysts for the base-catalyzed transesterification of triglycerides.

Biodiesel is produced through a process known as transesterification, a well-known reaction in organic chemistry. This is a chemical process whereby an ester is reacted with an alcohol to form another ester and another alcohol and is given by Eq, where R1, R2, and R3 are long hydrocarbon chains, sometimes called fatty acid chains. The triglyceride contains three separate ester functional groups. So, it can react with three molecules of methanol to form three molecules of methyl ester and glycerol, which is a tri-alcohol. The catalyst for this reaction is usually a strong base such as sodium or potassium hydroxide. These hydroxides cause the methanol to dissociate and produce the methoxide ion, which is the actual catalytic agent. Most producers prefer to use sodium methoxide concentrate, which can be purchased as a liquid and which does not contain the water that is created when hydroxides are used to produce the methoxide. The industrial-scale processes for transesterification of vegetable oils were initially developed in the early 1940s to improve the separation of glycerin during soap production.

$H_2C - OCOR^1$ | $ROCOR^1$ | $H_2C - OH$

| | |

$HC - OCOR^2 + 3ROH \rightarrow ROCOR^2 + HC - OH$

| Alcohol | |

$H_2C - OCOR^3$ | $ROCOR^3$. | $H_2C - OH$

Triglyceride | Mixture of alkyl esters | Glycerol

III.PROPERTIES OF DIFFERENT BIODIESELS

Some important properties of various vegetable oils are listed in Tables. It is seen that the CN values are in the range of 37–42 showing that almost all vegetable oils shown here do not vary much. When compared with diesel these are about 28–15%lower than diesel. The kinematic viscosity of vegetable oil varies in the range of 30–40 cst at 38.80C. The high viscosity of these oils is because of their large molecular mass in the range of 600–900. This is about 20 times higher than that of petrodiesel. The flash point of vegetable oil is very high (above 200^{0}C). The heating values (Calorific Value), in the range of 39–40 MJ/kg, are not far behind when compared to diesel fuel (about 45 MJ/kg). The presence of chemically bound oxygen in vegetable oil lowers their heating values by about 10%. However its presence also helps in combustion.

Table 1. Some Common properties of Biodiesel and Diesel

Fuel properties	**Biodiesel**	**Diesel**
Density at 15^0 C, g/cm^3	0.8834	0.8340
Viscosity at 40^0 C mm^2/s	4.47	2.83
Sulfur Content %	<0.005	0.034
Carbon %	76.1	86.2
Hydrogen %	11.8	13.8
Oxygen %	12.1	--
Flash Point, ^{0}C	178	62
Cetane Number	56	47
Net Calorific Value kj/kg	37,243	42,588

Table2. Properties of vegetable oils easily found in India

Vegetable oil	Kinematic viscosity at 38°C (mm2/S)	Cetane number (CN)	Heating value (MJ/kg)	Cloud point (^{0}C)	Pour point (^{0}C)	Flash point (^{0}C)	Density (kg/l)
Corn	34.9	37.6	39.5	-1.1	-40.0	277	0.9095
Cottonseed	33.5	41.8	39.5	1.7	-15.0	234	0.9148
Crambe	53.6	44.6	40.5	10.0	-12.2	274	0.9048
Linseed	27.2	34.6	39.3	1.7	-15.0	241	0.9236
Peanut	39.6	41.9	39.8	12.8	-6.7	271	0.9026
Palm	39.6	42.0		31.0		267	0.9180
Sunflower	33.9	37.1	39.6	7.2	-15.0	274	0.9161
Soya Bean	32.6	37.9	39.6	-3.9	-12.2	254	0.9138
Sesame	35.5	40.2	39.3	-3.9	-9.4	260	0.9133
Diesel	3.06	50.0	43.8		-16.0	76	0.8550

IV.ADVANTAGES OF BIODIESEL USED IN CI ENGINES

Biodiesel can replace fossil fuel as a "clean energy source". It can protect the environment by reducing CO2, SO2, CO, HC. Plants absorb CO2, which is more than those discharged by the Biodiesel combustion process. Thus, using Biodiesel can more effectively reduce the emission of CO2, protect the natural environment and maintain the ecological balance, compared to the use of fossil fuel. The emission of SO2 in the combustion process of Biodiesel is much lower than normal diesel oil because of the low sulfur content in it. Thus, the use of Biodiesel instead of normal diesel oil will effectively reduce acid rain, which represents a serious threat to the environment and human infrastructure in forms of acidification of soil, surface and ground water forest and vegetation damage, and increased corrosion of buildings and historical monuments made from calcium containing stones. Furthermore, CO, HC and particulate matters will be less discharged, because ester compounds in Biodiesel contains oxygen promoting clean burning.

Using Biodiesel can also reduce air pollution. The use of Biodiesel in a conventional diesel engine results in a substantial reduction of hydrocarbons, aromatic hydrocarbons, carbon monoxide, alkenes, aldehydes, ketones, and particulate matter. Nitrogen oxide emissions are slightly increased if the engine management remains unchanged. However, this can be optimized using special software and *Daming Huang et al. / Energy Procedia 16 (2012) 1874 – 1885* 1877 *Author name / Energy Procedia 00 (2011) 000–000* Biodiesel sensors. Using Biodiesel decreases solid carbon fraction particulate matter and eliminates the sulfate fraction. Increasing the percentage of Biodiesel blended with petroleum diesel fuel progressively eliminates sulfates. Biodiesel works well with new technologies such as catalysts, particulate traps, and exhaust gas recirculation. Soy Biodiesel reduces carbon dioxide by 78 percent on a life cycle basis. In addition, diesel engine exhaust from Biodiesel was found to have a lower mutagenic potential than that from conventional diesel fuel. This effect is believed to result from a lower content of polycyclic aromatic hydrocarbons in the particle emission of Biodiesel; Biodiesel is the first alternative fuel that has fully completed the health effects testing requirements of the Clean Air Act.34 [6].

The flammability of Biodiesel is better than that of diesel oil because of its high Cetane number which is an index of flammability. It also can be transported conveniently and more safely than diesel oil, due to its high flash point which enables it to be identified as safe goods. Biodiesel has a high viscosity and is composed of fatty acid methyl ester of high unsaturation. It has a good lubrification which can lower the water rate of injection pump, cylinder and engine connecting, and extend the use-life-span of the engine. Biodiesel can be directly used in conventional existing diesel engines due to its similar combustion performance with diesel oil, and also be widely sold using restore and sales network of diesel oil.

All major U.S. manufacturers of diesel engines endorse the use of Biodiesel. Biodiesel is not simple vegetable oil. Using unmodified vegetable oils in diesel engines can cause excessive carbon buildup in combustion chambers and reluctance to start. Biodiesel burns more cleanly than petroleum diesel and is a better lubricant and detergent. However, its high detergency can loosen [7].

V. APPLICATION OF BIODIESEL

1. In conclusion, Biodiesel production is set to rise drastically in the coming years. Biodiesel offers the promise of numerous benefits related to energy security, economics, and expansion of the agriculture sector and reduction of pollutant emission. Despite its many advantages as a renewable alternative fuel, Biodiesel presents a number of problems that must be resolved before it will be more attractive as an alternative to petroleum diesel.

2. These problems include improving the relatively poor low-temperature properties of biodiesel as well as monitoring and maintaining biodiesel quality against degradation during long-term storage (due to its unstable double bond). Maintaining fuel quality during long-term storage is a concern for biodiesel producers, marketers, and consumers. The most cost-effective means for improving oxidative stability of biodiesel is the treatment with antioxidant additives, e.g. the combination with hydrogen to reduce the double bond. This method will, make biodiesel more stable for storage, similar to the diesel oil. However, this method will consume a sheer bulk of hydrogen, so the resource of hydrogen and the rising cost could be a concern. At the same time, care

must be exercised in cleaning storage tanks before filling them with biodiesel and in monitoring storage conditions inside the tanks such as temperature, moisture content, exposure to direct sunlight, and the atmosphere (nitrogen “blanket” is preferable) in which the fuel is stored.

3. The cost of biodiesel, however, is the major hurdle to its commercialization in comparison to petroleum diesel (use of edible oil as biodiesel feedstock costs about 60–70% of raw material cost).The high value of soybean oil or canola oil as a food product makes production of a cost-effective fuel very challenging. Use of such edible oil to produce biodiesel is not feasible in view of a big gap in the demand and supply of such oils in the producing countries for dietary consumption. In addition, food prices are expected to continue to rise over the next decade in response to biofuel consumption targets adopted in the world. Therefore, development of alternative feed stocks for biodiesel production is another important area of current and future research [8].

REFERENCES

[1] Daming Huang1, Haining Zhou, Lin Lin1, “Biodiesel: an Alternative to Conventional Fuel.

[2] Apostolakou, A.A.; Kookos, I.K.: Marazioti, C.; Angelopoulos, K.C. Techno-economic analysis of a Biodiesel production process from vegetable oils. Fuel Processing Technology 2009, 90, 1023-1031

[3] Usta, N.; Oztcurk, E.C.; Can, C.O.; Conkur, E.S.; Nas, S.; Con, A.H.; Can, A.C.; Topcu, M. Combustion of Biodiesel fuel produced from hazelnut soap stock / waste sunflower oil mixture in a diesel engine. Energy Conversion and Management 2005, 46,741–755.

[4] Hayyan, M.; Mjalli, F.S.; Hashim M.A.; AlNashef, I.M. A novel technique for separating glycerin from palm oil-based Biodiesel using ionic liquids. Fuel Processing Technology 2009, Article in Press.

[5] Pedrojevic, Z.J. The production of Biodiesel from waste frying oils: A comparison of different purification steps. Fuel 2008, 87, 3522-3528.

[6] Agarwal, A.K. Biodiesels (alcohols and Biodiesel) applications as fuels for internal combustion engines. Progress in Energy and Combustion Science 2007, 33, 233-271.

[7] Lapuerta, M.; Armas O.; Fernandez, J.R. Effect of Biodiesel Fuels on diesel engine emissions. Progress in Energy and Combustion Science 2008, 34, 198.

[8] Karmakar A., Karmakar S., Mukherjee S.. Properties of various plants and animals feed stocks for biodiesel production. Bioresource Technology, 2010, 101, 7201-7210.