International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

BIODIESEL: THE FUTURE FUEL

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Abstract - *Due to increasing use of petroleum fuels in automobiles and industrial sectors, in the past few years, the world has started facing severe problems like environmental pollution, ozone layer depletion, global warming. Also the fossil fuels resources are going on decreasing due to which people are becoming aware and thus have started finding new alternative fuel sources. Renewable fuels have received more attention in the last few decades since the fuel demand is constantly increasing. Many research works have been going on so as to use biodiesel as an alternative fuel. Biodiesel is an important and promising field of research because of its environmental friendly and cheaper prices. Biodiesel is a renewable fuel which is derived from vegetable oil, animal oil/fats, and waste cooking oil. The largest source of suitable oil comes from oil crops such as palm, soybean, karanja, jatropha, mahua, neem, simarouba etc. the non-edible oils contain the fatty acids like stearic acid, palmitic acid, oleic acid etc. Vegetable oils blended in various proportions with diesel are products mostly distributed in the retail diesel fuel marketplace. Depending upon the amount of diesel, the various types of biodiesel are B2 (2% biodiesel,98% petro diesel), B5 (5% biodiesel,95% petro diesel), B20 (20% biodiesel,80% petro diesel), B100 (100% biodiesel). However, with a high rise on level of biodiesel/diesel blend, it may happen that, this fuel becomes harmful, reducing its life time ,as such there have to be made modifications on vehicles to avoid engine damage. In a developing country like India, it is possible to grow the vegetable oils, but not economically feasible to convert them to methyl esters by the chemical processes. In the present paper the production and emission characteristics of Jatropha oil has been studied.*

Key Words: Biodiesel, transesterification, methanol, edible.

1. INTRODUCTION

Liquid bio-fuels such as bio-ethanol and biodiesel may offer promising alternative, because with the increase in petroleum usage, the fossil fuel storage has depleted, and also the prices have increased especially after petrol crisis in 1973 and gulf war in 1991has reduced the availability of petroleum[1]. The use of these bio-fuels decreases the external energy dependence, promotion of regional engineering and increase in R&D.

Biodiesel is defined as mono-alkyl (methyl ,ethyl or propyl) esters of long chain fatty acids derived from vegetable oils or animal fats, biodiesel is mainly made by reacting lipids (vegetable oils, soya bean oil, animal fats) with alcohol producing fatty acids esters. It is renewable, domestically produced and biodegradable, thus it has no adverse effects on the environment like those fossil fuels, also it is renewable resource which means it can be used repeatedly without the fear of exhaustion. Thus, biodiesel proves to be a more convenient fuel to be used in the vehicles. This biodiesel conforms to ASTM D6751 (American society of Testing Materials) specifications for use in diesel engines[2].

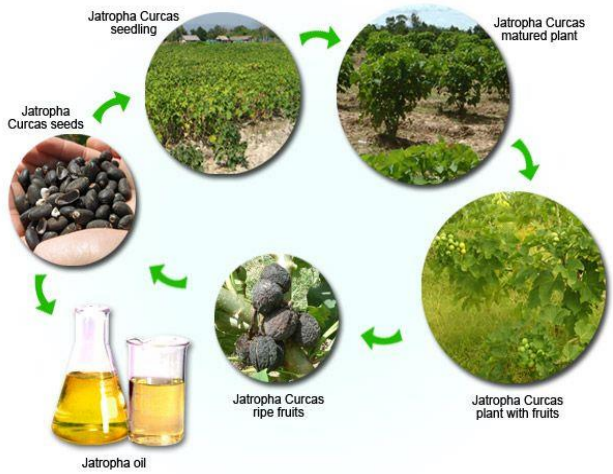

Fig 1. Jatropha life cycle

One of the most important reasons why biodiesel should be used in vehicles is because of its environment beneficial properties. It can be described as 'carbon neutral'. This means that the fuel produces no net output of carbon in form of carbon dioxide (CO2). This happens because when the crop oil grows it absorbs the same amount of CO2 as is released when fuel is combusted[3].

The typical oil crops that have been found useful for biodiesel production are –

- Soybean
- Oil Palm
- Coconut
- Olive
- Jatropha
- Rapeseed and Carnola
- Sunflower
- Karanja
- Mahua
- Waste cooking oil

2. SOURCE OF JATROPHA

Jatropha is a profitable seed which can be grown in less fertile soils and the demand for jatropha seeds is increasing day by day to meet the needs of the people. It is used in automobiles as fuel and in pharma as skin care[4]. It can be cultivated in all the states in India, as it has the capability of adapting to different climatic conditions.

Tab 1. State wise Jatropha plantation

State	Plantation (ha.)	State	Plantation (ha.)
Andhra Pradesh	355	Mizoram	500
Arunachal Pradesh	185	Meghalaya	113
Bihar	10	Maharashtra	1635
Chhattisgarh	604	Madhya Pradesh	741
Gujarat	1129	Nagaland	442
Haryana	460	Rajasthan	174
Jharkhand	700	Tamil Nadu	463
Karnataka	377	Uttar Pradesh	778
Kerala	50	Uttrakhand	618
Manipur	250	West Bengal	100
Sikkim	100	**Grand Total**	**10083**

3. ADVANTAGES OF JATROPHA

i. Jatropha is mainly used in production of biodiesel.
ii. It can be grown in poor soils, waste lands
iii. Jatropha is suitable for preventing the soil erosion
iv. Fertility of soil increases throughout the lifecycle
v. This plant can also be used for medical purposes

4. DISADVANTAGES OF JATROPHA SEEDS

i. Jatropha compounds are highly toxic
ii. The Jatropha plant cannot produce the nut, if there is too little water.

Fig 2. Jatropha seeds

5. BIODIESEL PRODUCTION PROCESS

Biodiesel is produced from both edible and non-edible oils. The developing countries like India uses non edible oils for the production of biodiesel because edible oils are eatable and they form a major part of diet[5]. Production of biodiesel involves different stages and among them the most important stage is transesterification process.

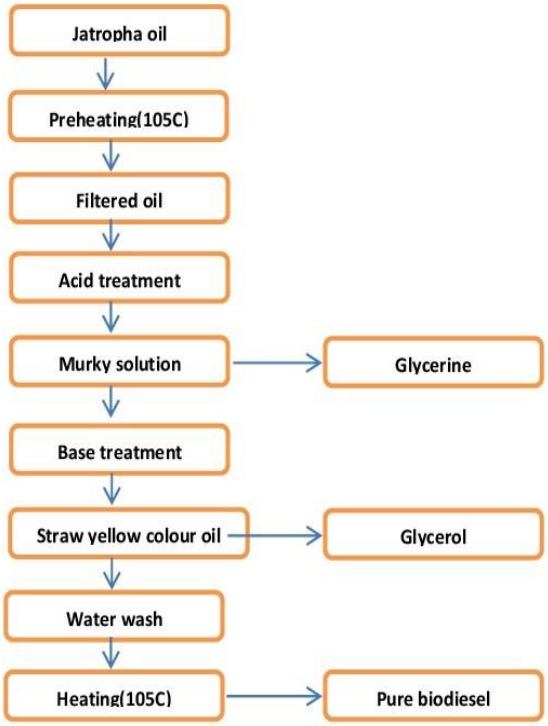

Fig 3. Layout chart of biodiesel[1]

Biodiesel is produced from edible, non-edible, animal fats and algae. Algae contain more than 70% of oil in it and this result in higher amount of oil production. Mixture of fatty acid methyl esters (FAME) is purified to produce biodiesel. Catalyst is used in order to increase the rate of reaction. Almost all biodiesel is produced using base catalyzed transesterification as it is the most economic process requiring only low temperature and pressure and producing a 98% yield[6].

Tab 2. Process parameters[1]

SI No	Process parameters	Description
1	Sample oil used	1000 ml Jatropha oil
2	Methanol used	200ml/kg of alcohol
3	Process selected	Alkali catalyzed transesterification process
4	Catalyst used (KOH)	0.5-1% per kg of oil
5	Reaction temperature	52-55^{0}C
6	Reaction time	1.5-2 hours
7	Settling time	8-10 hours
8	Water wash	3-4 times(40min)
9	Speed of Stirrer	500rpm

Transesterification is a process of producing biodiesel from crude oil in the presence of Methanol and KOH as catalyst. . It can also be defined as the process of interchanging R' of an ester to the organic group R' of an alcohol. This transesterification process is catalyzed by inclusion of acid or base catalyst[7]. Methanol and Ethanol are the majorly used in the process of transesterification, among these two alcohols methanol is most extensively used because of its low price and physicochemical advantages with triglycerides. 3:1 ratio of alcohol to triglycerides is needed for complete transesterification process. The output of transesterification process is pure biodiesel and glycerin[8].

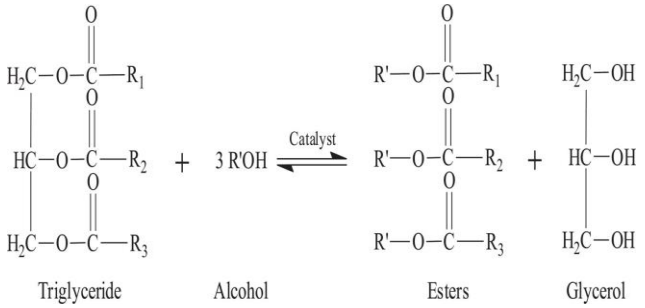

Fig 4. Transesterification reaction with alcohol

6. BIODIESEL REACTOR

This production of biodiesel takes place in reactors called biodiesel reactors. The raw materials are fed into the reactor, where the raw oil is separated into glycerin and methyl esters. Glycerin, the byproduct is collected inside the reactor. It is used for production of soaps, etc. M Methyl ester is the chemical name of biodiesel[9]. This biodiesel is either refined to create other biofuels or mixed with petroleum diesel to create diesel blend or used immediately without any blend or extra processing. A schematic diagram of biodiesel reactor is shown below.

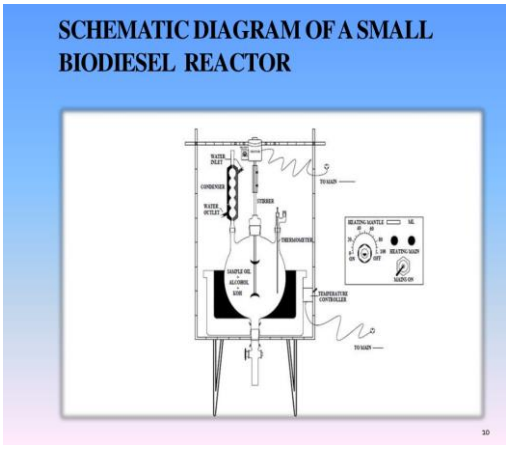

Fig 5. Schematic diagram of a biodiesel reactor[1]

7. ADVANTAGES OF USING BIODIESEL OVER FOSSIL FUELS

The world is entering a period of declining non-renewable energy resources, while the energy demand is increasing. As a result of this unavoidable energy crisis, both the government and private sectors are examining the alternate sources of renewable energy. Our reliance on fossil fuels has caused carbon dioxide (CO2) enrichment of the atmosphere, and is the primary contributor to the worldwide concern, global warming. In order to realize a stable energy alternative that will meet the world demand while maintaining climate change, it is necessary to develop cleaner renewable fuels[10]. Ironically, most renewable energy initiatives are focused on electricity generation, while the majority of world energy consumption, about two thirds, is from liquid fuels. The need for renewable sources of portable, liquid fuel has increased and much attention has been focused on biomass derived liquid fuel or bio-fuel. Because the fuel is derived from biomass, it does not contribute to atmospheric CO2 emissions. Biodiesel emissions are, on the whole, lower than petroleum diesel emissions. Substituting biodiesel for petroleum diesel results in substantial reductions of soot, sulphur, unburned hydrocarbon, and polycyclic aromatic hydrocarbon emissions. With the increasing use of biodiesel, the amount of carbon dioxide emission to the air also decreases, thus reducing global warming. The amount of impurities in the air decreases, thus resulting in escape from many environmental issues. Thus, biodiesel has low toxicity and it is biodegradable. It is being approved by EPA (Environmental protection agency) and CARB (California Air Resource Board). Since biodiesel is made from organic sources like restaurant waste oil, animal fats and vegetable oils, the waste from the production is very less[11]. Depending on the process it can produce some wastewater, minerals, solid strained out of used oil and glycerin. The wastewater can be used for farm irrigation and glycerin is used to produce soaps.

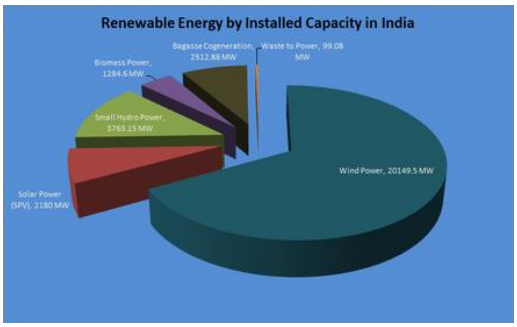

Fig 6. Percentages of different renewable sources available in India

Current usages of biodiesel/Trials & testing of biodiesel: Usages of biodiesel in present status in India are:

- Shatabdi Express was run on 5% blend of biodiesel from Delhi to Amritsar on 31 December, 2002 in association with IOC.
- Field trails of 10% biodiesel were done on Lucknow-Allahabad Jan Shatabdi Express also in association with IOC.
- HPCL is also carrying out field trials.
- Biodiesel blend from IOC (R&D) is being used in buses in Mumbai as well as in Rewari, Haryana on trial basis
- CSIR and Daimler Chrysler have jointly undertaken a successful 5000 km trial run of Mercedes cars using biodiesel as fuel.
- NOVOD has initiated test run by blending 10% biodiesel in collaboration with IIT Delhi in Tata Sumo and Swaraj Mazda vehicles.

8. EXPERIMENTAL SETUP AND EXPERIMENTATION

The present sets of experiments were conducted on a four stroke single cylinder direct injection water cooled diesel engine equipped with eddy current dynamometer. Table 3 shows the test engine specifications. Two separate fuel tanks with fuel flow control valves were used for the operation of the engine on diesel and biodiesel. One of the fuel tanks contained diesel and the other tank was filled with individual fuel blends of JOBD10+PG, JOBD20+PG, JOBD630+PG and D+PG[1]. The engine was operated with full load and constant speed and the performance parameters like brake power, torque, specific fuel consumption and brake thermal efficiency were measured for diesel and all the test fuels. Figure 3 shows the test engine setup[6].

Tab 3. Test Engine Specifications

Particulars	Description
Engine type	Single cylinder, 4-stroke,vertical water cooled diesel engine
Bore diameter	80 mm
Stroke length	110 mm
Compression ratio	16:1
Rated power	3.67 KW
Rated speed	1500 rpm
Dynamometer	Rope brake dynamometer

Fig 7. Single Cylinder, 4-Stroke, Vertical Water Cooled Diesel Engine.

9. REFERENCE RESULTS

The results are obtained by combining biodiesel and producer gas.

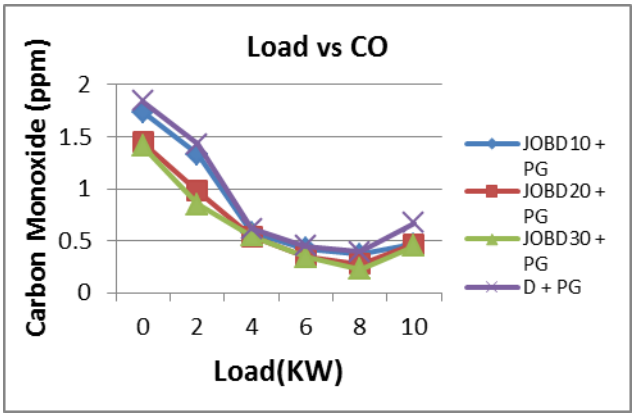

Fig 8. Load Vs CO

As load increases the CO emissions decreases and it is lowest for JOBD30+PG at a load of 8KW. The emission levels of JOBD10+ PG is very less when compared with other blends but as the load increases the emission value of JOBD30+PG is less in comparison with JOBD10+PG [12].

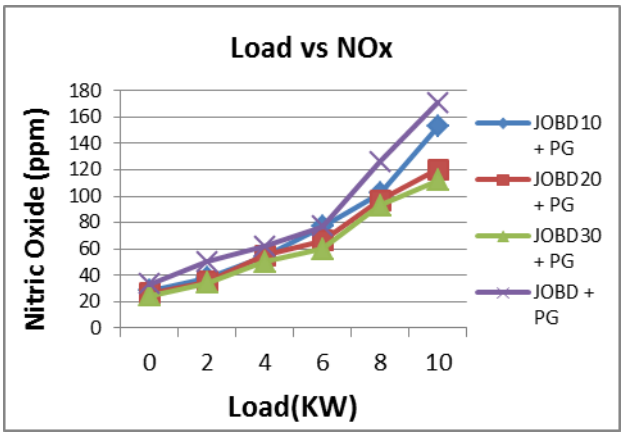

Fig 9. Load Vs NOx

From the above graph it can be clearly seen that JOBD30+PG shows reduced emissions of NOx when compared with other blends. As load increases NOx emissions increases and it is low for JOBD30+PG

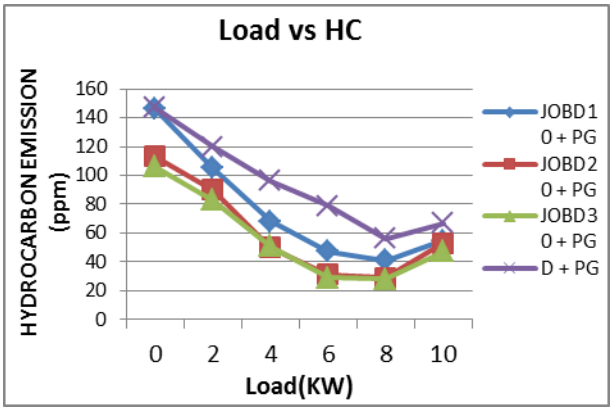

Fig 10. Load Vs HC

Considering the above graph, it is clear that as load increases the HC emissions reduce gradually and it is high when the engine runs with pure diesel and PG followed by JOBD10+PG, JOBD20+PG and JOBD30+PG.

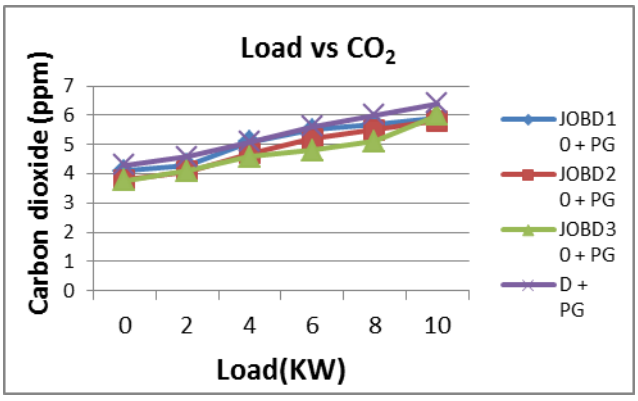

Fig 11. Load Vs CO_2

So taking into consideration the data at those loads one can come to a conclusion that CO_2 shows reduced emissions when the engine runs with JOBD30+PG.

10. CONCLUSION

The increasing industrialization and motorization has led to a steep rise for the demand of petroleum products. But the quantity of petroleum and other fossil fuels has been decreasing, thus there is necessity for an alternative fuel which can be produced from indigenous sources. The best alternative fuel is biodiesel. It is renewable, biodegradable and non-harmful to the environment and it properties are exactly like those of fossil fuels. Thus biodiesel production and use has been receiving much attention from all around the globe. Many countries have started production of biodiesel and have started using in everyday lives. The world is moving in right direction so as to achieve the desired goal of replacing diesel and petrol with biodiesel.

ACKNOWLEDGEMENT

The modification of engine may be necessary so that it can generate the necessary ignition power for the burning of biodiesel and producer gas

REFERENCES

[1] G. Hemanth, B. Prashanth, Nayan Benerjee, Tuhin Choudhuri, Mrityunjay, "Dual fuel mode operation and its emission characteristics in diesel engine with Producer gas as primary fuel and Jatropha biodiesel as pilot fuel",International journal of mechanical engineering and technology, Volume 8, Issue 4, pp:138-147, April 2017.

[2] Nayak,S.K.,Behera,G.R.,Mishra,P.C.,Kumar,A., "Functional characteristics of jatropha biodiesel as a promising feedstock for engine application", Volume 39, Issue 3, pp: 299-305,2017.

[3]Nayak,S.K.,Mishra,P.C.,Kumar,A.,Behera,G.R.,Nayak,B,." Experimental investigation on property analysis of karanja oil methyl ester for vehicular usage", Volume 39,Issue 3,pp 306-312, 2017.

[4] Prashanth, B., Saiteja,R., Sunil Kumar,B.,Swarup Kumar Nayak., 'Performance Characteristics of a four Stroke Single Cylinder Diesel Engine Fuelled with Waste Cooking oil and Diesel Blends", Proceedings of International Conference on Emerging Trends in Mechanical Engineering(ICETIME-2016).pp:747-751, 2016.

[5] Nayak,S.K.,Mishra,P.C.,"Investigation on jojoba biodiesel and producer gas in dual-fuel mode", Volume 38, Issue 15, pp:2265-2271, 2016.

[6] Nayak,S.K.,Mishra,P.C., 'Emission from utilization of producer gas and mixes of jatropha biodiesel", Volume 38,Issue 14,pp:1993-2000, 2016.

[7] P. Sirisomboon , P. Kitchaiya, T. Pholpho., W. Mahuttanyavanitch, "Physical and mechanical properties of *Jatropha curcas* L. fruits, nuts and kernels", Volume 97, Issue 2, , pp:201–207, June 2007.

[8] Nayak, C., Pattanaik,B.P.,Nayak, S.K.,"Effect of preheated Jatropha oil and Jatropha Oil methyl ester with producer gas on diesel engine performance", Volume 9,Issue 1, ,pp: 1709-1722, 2014.

[9] K. Openshaw. "A review of *Jatropha curcas*: an oil plant of unfulfilled promise", Biomass and Bioenergy, volume19 Issue 1, pp. 1–15,2000.

[10] K. Pramanik., "Properties and use of *Jatropha curcas* oil and diesel fuel blends in compression ignition engine", Renewable Energy Journal, Volume 28,Issue 2,pp. 239–248, 2003.

[11] J. Martínez-Herrera, P. Siddhuraju, G. Francis, G. Dávila-Ortíz, K. Becker., "Chemical composition, toxic/antimetabolic constituents, and effects of different treatments on their levels, in four provenances of *Jatropha Curcas",* L. from Mexico,Food Chemistry, Volume 96, Issue 1, pp. 80–89, 2006.

[12] G.D.P.S. Augustus, M. Jayabalan, G.J. Seiler, "Evaluation and bio induction of energy components of *Jatropha Curcas* Biomass and Bioenergy", Volume 23, Issue 3, pp. 161–164, 2002.