IJIRR

International Journal of Information Research and Review
Vol. 05, Issue, 08, pp.5632-5636, August, 2018

REVIEW ARTICLE

INVEST LESS EARN MORE: DISCOVERY OF INDIA'S TRIVIAL SOURCES FOR THE PRODUCTION OF BIOFUEL; ACCESSIBILITY TO BIODIESEL IS A BOON NOT A CURSE IN INDIA

***Vipul Shrivastava**

Automobile Engineering, Madhav Institute of Technology and Science, Gwalior, Madhya Pradesh, India

ARTICLE INFO

Article History:

Received 12th May, 2018
Received in revised form
24th June, 2018
Accepted 19th July, 2018
Published online 30th August, 2018

Keywords:

Transestrification, jatropha curcas, sorghum, sugar beet

ABSTRACT

With the advancement of the 21st century the world has witnessed a drastic change in field of industrialization. Rapid boost in the demand of energy sources has projected to accession the prices due to expanding urbanization and rapid increase in population. This has lead to the depletion of energy resources i.e. fossil fuels and many countries are suffering from energy crises due to lack of crude petroleum within the country. So the time has come where we have to find an alternative source of fuel which can be produced with the help of resources available within the countries. In present scenario bio- fuels are becoming more and more attractive because of the relevancy it earns from its low price and its environmental advantages. This paper reviews the history of biofuel vehicles. This paper will evaluate the cheap and easiest method for biodiesel production and various results will show "Jatropha" as the main contender for biodiesel feedstock. This paper also gives an eyeful view on the more economically viable and sustainable feedstock for ethanol. Based on various analysis it will also predict the opportunities for greening the countryside and creating rural employment and income in India.

INTRODUCTION

Today we are in a state of energy turmoil. Everyone from producers to consumers from government to society is focusing on the consumption of energy and the direction of its further development. It is believed that transportation heralds the development of a region. But with the excessive use of fossil fuels and increasing population has made us to confront with the twin crises of fossil fuel depletion and environmental degradation. According to a survey world will need about 50% more energy in 2030 than today and it is expected that energy consumption will increase from 1.8% per year up to 2035, of which second largest energy consuming sector is transportation sector and out of which 80% is road transportation. These circumstances have made us to go in a search for an alternative fuel. In 80's century, when the first diesel engine was invented, it was E. duff and J. Patrick who did it with the help of peanut oil. Then in 1911 in world fair in Paris, Dr. R. diesel ran his engine with the vegetable oil. But in 1913 after his unpredictable death, his engine was modified and diesel became one of its main feedstock. In 1930's and 1940's vegetable oils were used as diesel substitute from time to time, but usually only in emergency situations.

****Corresponding author:*** **Vipul Shrivastava,**
Automobile Engineering, Madhav Institute of Technology and Science, Gwalior, Madhya Pradesh, India.

Today, there are mainly two types of biofuel, Biodiesel and Bioethane. Biodiesel should be a good substitute for diesel and bioethanol for petrol. A process of chemically combining a natural oil or fat with an alchahol i.e. methanol, it is the most suitable alchahol in the primary production of biodiesel. The central problem in using plant oil as diesel fuel is that plant oil is much more viscous (thicker) than conventional diesel fuel. It is 11 to 17 times thicker. Plant oil also has very different chemical properties and combustion characteristics to those of conventional diesel fuel. The process of transestrification reduces the high viscosity of plant oil, resulting in a higher quality fuel. The cetane number increases because the molecular chain is cut into 1/3.biodiesel had become the first alternative fuel which has successfully completed the health effect requirement of clean air Act34. A comparison chart shows the properties of biodiesel and diesel in Table 1. Due to high cetane No. it has better flammability than the diesel which helps conventionally and more safely transportation of biodiesel. Its high flash point helps in becoming a safe good. A good lubrication helps in lowering the water rate injection pump, cylinder and engine connecting and increase the use-life-span of the engine. Biodiesel can be used as fuel for vehicles in the its pure form, but its is usually used as a petroleum diesel blend to reduce levels of Particulate matter, carbon monoxide, hydrocarbons of air and air toxics from diesel-powered vehicles.

Table 1.

Fuel properties	Biodiesel	Diesel
Density at 15°C, g/cm3	0.8834	0.8340
Viscosity at 40°C,mm2/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,°C	178	62
Cetane number	56	47
Net calorie value, KJ/Kg	37.243	42.588

Table 2.

Sr. no.	Load (kgf)	Manometer reading(cm)	Time taken for 20cc of F.C(sec)	F.C (Kg/hr)	S.F.C (kg/k Whr)	B.P (kW)	B.Th (%)	A/F Ratio	EGT (°C)
1	0	2.6	135	0.416	-	0	0	56.4	190
2	2	2.6	98	0.573	1.154	0.496	7.45	40.9	260
3	4	2.6	85	0.661	0.670	0.992	12.83	35.5	270
4	6	2.6	75	0.750	0.503	1.488	17.1	31.3	290
5	8	2.6	68	0.826	0.416	1.984	20.65	28.4	320
6	10	2.6	61	0.921	0.372	2.480	23.15	345	230
7	12	2.6	60	0.936	0.314	2.977	27.35	25.06	365
8	14	2.6	58	0.968	0.279	3.473	30.85	24.2	380

Table 3.

Sr. no.	Load (kgf)	Manometer reading(cm)	Time taken for 20cc of F.C(sec)	F.C (Kg/hr)	S.F.C (kg/k Whr)	B.P (kW)	B.Th (%)	A/F Ratio	EGT (°C)
1	0	2.6	153	0.402	-	0	0	59.51	175
2	2	2.6	134	0.459	0.926	0.496	9.3	52.10	190
3	4	2.6	122	0.505	0.509	0.992	16.9	47.40	200
4	6	2.6	114	0.540	0.362	1.488	23.7	44.30	205
5	8	2.6	106	0.58	0.298	2.480	31.8	36.20	240
6	10	2.6	93	0.662	0.270	2.977	36.53	34.20	250
7	12	2.6	88	0.700	0.235	2.297	36.53	34.20	250
8	14	2.6	84	0.733	0.210	3.473	40.9	32.70	260

Process and Production of Biodiesel: For understanding the process of making biodiesel, first we have to understand what transestrification is? In the transestrification process, vegetable oil reacts with alcohol (methanol or ethanol) in the presence of a catalyst (usually sodium hydroxide). The oil molecules (triglycerides) are broken apart and reformed into methyl esters and glycerin, which are then separated from each other and purified. Transestrification is crucial for producing biodiesel from biolipids. The process of transestrification makes a drastic change in the viscosity of the biodiesel. The process of making biodiesel is as follows

Raw material

Solvent: methanol or ethanol
Catalyst: Sodium hydroxide/potassium hydroxide/sodium methoxide
Oil: Required quantity of oil one or two liters crude pure oil or refined oil preferably refined oil shall give pure transestrification without any soaps content.

Procedure

- Take one or two liters of pure crude or refined oil and pre-heat up to 20°C to 30°C and cool it down naturally to room temperature.
- Take the pre-heated oil after cooling down pour into the glass flask.
- Take 250ml of methanol and with 10ml – 20ml of oil and pour it in the round bottom flask and stir it with stirrer for about 10-15 min.
- Take plastic beaker with 150ml of methanol into it and add 30 gram of catalyst and mix it vigorously with the help of plastic spoon.
- Pour the mixture of methanol and catalyst into the flask containing oil and stir it well up to room temperature that moves well with the oil.
- Slowly raise temperature and stir the oil mixture till the required temperature. After some time we can observe the orange colour which is an indication of reaction and cool it down to room temperature.
- After cooling, pour the repeated oil mixture into a separator which is fixed to the stand.
- Now 3 layers are clearly visible is the separator. The layer on the upper position is methyl ester (biodiesel) in the middle is methanol and third layer is semi solid sate of glycerol which is white or creamy colour.
- Now put 3 different beakers under the nose of separator and take out all the three layers in 3-different beakers respectively.
- Give a water wash to biodiesel. To remove any impurities left, heat up to 20-30°C, the remaining impurities will evaporate and pure biodiesel is obtain which can be used purely with mineral diesel as a blend.

Reaction showing the production of bio-diesel

```
CH2 OCOR1R1                    COOCH3   CH2OH
 |                              |          |
CHO COR2   + 3CH3OH        Catalyst
 |                      ---------R2COOCH3  +  CHOH
                              OH       |          |
CH2 OCOR3                      R3COOCH3   CH2OH
Oil or fatty      + Methyl       Bio-diesel   +   Glycerine
Try- glyceride   +  alcohol   =   methyl-ester   +  C38HO3
```

Table 4.

Sr. no.	Load (kgf)	Manometer reading(cm)	Time taken for 20cc of F.C(sec)	F.C (Kg/hr)	S.F.C (kg/k Whr)	B.P(kW)	B.Th (%)	A/F Ratio	EGT (°C)
1	0	2.6	160	0.368	-	0	0	65.1	180
2	2	2.6	142	0.414	0.835	0.496	10.3	57.76	190
3	4	2.6	127	0.464	0.467	0.992	18.4	51.56	200
4	6	2.6	117	0.503	0.338	1.488	25.44	47.6	210
5	8	2.6	110	0.535	0.270	1.984	31.86	44.74	219
6	10	2.6	103	0.571	0.230	2.480	37.3	44.9	224
7	12	2.6	74	0.795	0.267	2.977	32.2	30.1	263
8	14	2.6	60	0.981	0.283	3.473	30.4	24.4	272

Table 5.

Sr. no.	Load (kgf)	Manometer reading(cm)	Time taken for 20cc of F.C(sec)	F.C (Kg/hr)	S.F.C (kg/k Whr)	B.P (kW)	B.Th (%)	A/F Ratio	EGT (°C)
1	0	2.6	151	0.426	-	0	0	56.25	174
2	2	2.6	128	0.502	1.012	0.496	8.5	47.7	185
3	4	2.6	117	0.550	0.223	0.992	15.5	43.6	195
4	6	2.6	110	0.584	0.392	1.488	21.9	4.10	205
5	8	2.6	102	0.630	0.317	1.984	27.0	38.0	220
6	10	2.6	92	0.699	0.282	2.480	30.5	34.3	230
7	12	2.6	84	0.765	0.257	2.977	33.4	31.3	250
8	14	2.6	78	0.824	0.237	3.473	36.2	29.1	255

General representation will be:

100kg of oil + 24kg of methanol + 2.5kg of NaoH --------100kg of biodiesel + 26kg of glycerine

Feed stock for biodiesel and its properties

Globally, there are about 350 oil bearing crops indentified as potential for biodiesel production.

They are classified as

- Edible vegetable oil
- Non edible vegetable oil
- Waste or recycled oil
- Animal fat

According to the analysis made on certain factors like

- Availability of land
- Cultivation practices
- Energy supply and balance
- Emission of greenhouse gases
- Injection of pesticides
- Soil erosion and fertility
- Contribution to biodiversity value losses
- Logistic cost(transportation and storage)
- Direct economic value of feedstock taking into account the co-products
- Creation or maintain of employment
- Water requirement and availability
- Effects of feedstock on air quality

It was found that non- edible oils are the promising fuels for agricultural applications and because they have properties comparable to diesel and can be used to run CI engine with little or no modifications. One of the most discussed non-edible biodiesel feedstock is 'JATROPHA'

JATROPHA CURCUS

This non-edible oil being singled out for large scale for plantation on wastelands.

Jatropha is easy to establish, grows relatively quickly and is hardy. Being drought tolerant, it can be used to reclaim eroded areas and grown as live hedge in arid or semiarid areas. Its water requirement is extremely low and can stand long periods of drought by shedding most of its leaves. It grows best when planted at the start of the rainy season. The seeds are 2 cm long and 1 cm thick. The yield per tree (fresh weight) ranges from 4-12 kg. The usual average yields by year are in the following order of magnitude: 0.4 tons/ha during the first 2-3 years, 2-3 tons/ha in 3-4 years, 5-6 tons/ha in 5 years to 50 years10. The dry seed is about 15% of the fresh weight of the fruits and generally contains 32% meal, 30-38% crude oil, and 30-38% seed coat. The only limitation to this crop is that the seeds are toxic and the press cake cannot be used as animal folder. The press can only be used for nutritional purposes without detoxification makes its use as energy/fuel source very attractive. Given below table explores technical feasibility of jatropha oil in direct injection compression ignition engine without any substantial hardware modifications. Fuel properties of mineral diesel, jatropha biodiesel and jatropha oil were evaluated. Three blends were obtained by mixing diesel and estrified jatropha in the following proportions by volume:

75% diesel + 25% estrified jatropha, Table 3
50% diesel + 50% estrified jatropha, Table 4
25% diesel + 75% estrified jatropha, Table 5

For comparison purpose experimental values of 100% diesel are given in Table 2.

For comparison purpose experimental values of 100% diesel are given.

100% diesel

75% Diesel + 25% Esterified jatropha oil
50% Diesel + 50% Esterified jatropha oil
25% Diesel + 75% Esterified jatropha oil

Higher viscosity is a major problem in using vegetable oil as fuel for diesel engines, but viscosity was reduced after transestrification process, viscosity of jatropha oil decreases remarkably with increasing temperature and it becomes close to diesel at temperature above 90°C. The methyl ester of jatropha oil along with diesel may reduce the environmental impacts of transportation, the dependency on crude oil imports and may offer business possibilities to agriculture enterprises for periods of excess agricultural production. Second most important ingredient for the production of biodiesel is "ETHANOL". It is a form of alchahol and plays vital role in the transestrification process. India's ethanol programme depends to a larger extend on the economic viability of molasses-ethanol conversion. The supply of molasses in turn depends on the sugarcane production in India. The cost of production of ethanol was decided by government was Rs9.74/litre in 2003 and then it increased to Rs21.50/litre in 2006 and then it reached to Rs27/litre in April 2010. It was declared blending of ethanol at this rate would be uneconomical as the cost of petrol sans taxes was around Rs23 a litre. An analysis suggests that around 648.4 million tons of sugarcane will be required for blending of 5% ethanol and about 736.5 million tons for 10% blending up to 2020-21. The current demand for the sugar in India is 23.3 million tons, highest in the world. Therefore it is high time to think about alternate sources of both sugar and ethanol, which will be both resource saving and sustainable.

Sweet Sorghum: It is a variant of grain sorghum. Second largest producer of sweet sorghum is India. It is more economical than sugarcane molasses because of rapid growth, wider adaptability, low water demand, high yield and biomass producing ability with sugar rich stalks. It has high fermentation efficiency of around 90%. Sweet sorghum has been noted for its potential as an energy crop. Sweet sorghum can be cultivated in nearly all temperature and tropical climatic conditions. The growing period (four month) and water requirement (8000m3 over two crops) of sweet sorghum are four times lower than that of sugarcane. At present, rates of feedstock cost for production of sweet sorghum based-ethanol (Rs17-19Ltr) are considerably lower than that of molasses based ethanol (Rs24-32Ltr).

Sugar beet: Sugar beet is another potential feedstock found suitable for ethanol production, even though the scope of commercial exploitation has not so far been widely tested in India. Tamil Naidu based agriculture university has shown that tropical sugar beet can be successfully cultivated in India at large scale. The ethanol yield from sugar beet (6000-6400Ltr/ha) is far higher than sugarcane molasses and sweet sorghum, and can be realized at a very low cost of production (Rs12-14/Ltr). Above all around 10,000-20,000 m3 of water/crop can be saved over sugarcane. Sugar beet can also be explored as a source of sugar in addition to ethanol as it contains greater sugar content.

Conclusion

For the production of biodiesel transestrification is the important process, jatropha and ethanol are the vital ingredients of the process. A recent study suggest that the analysis of the ethanol production was based on assumptions: (I) all the ethanol would be produced from molasses, (ii) recovery of molasses from sugarcane: 4%, (iii) recovery of ethanol from molasses: 25% (iv) molasses utilization pattern: 85% for ethanol production and rest for other uses, (v) average yield of sugarcane: 70% tons/ha, and (vi) sugarcane utilization pattern: 60% for sugar and ethanol production and rest for other. The demand for land cultivation of jatropha is 13.4 million ha but unfortunately only 0.5 million ha is put under jatropha cultivation so far. Various issues like confusion over transfer of ownership of community and government wastelands, lack of good quality planting materials, low confidence in farmers on the profitability from jatropha, lack of an integrated approach for promoting cultivation etc. are hindering expansion of area under jatropha cultivation. These are the two most discussed hurdles which our country is facing in implementing biodiesel in India. Apart from these two problems we need an improved technology and management practices to maximize the efficiency from the existing feedstock, lower plant capacity, use of batch process technology, insufficient byproduct and effluent management practices etc. are major technological constraint faced by the industry currently. There are also various engine modifications has been suggested for using biodiesel in diesel engine.

India is not only the first country facing these problems in implementing biodiesel in the country, various countries like brazil, Malaysia, Indonesia, Thailand, peoples republic of china(PRC), USA etc. most of countries among them are Asian countries which has successfully implemented biodiesel in their countries. Brazil is the leader among them; about 80% of Brazil transportation runs on biofuel which are FFV (flexi fuel vehicles) i.e. dual fuel vehicle All these problems are feasible and can be rectify easily if we move our research on right track. First there are many discussions on why we need a biofuel vehicle when we have a better option in the form electric vehicle. Yes electric vehicles are better option ahead of any alternate resource because of easily availability of solar energy. But we have to mark these points also that in future there would be a lot of pressure on solar energy resources to meet the ever increasing demands as it is widely applicable in various applications of our daily day to day life. We have to understand that we cannot rely fully on electric energy for our needs otherwise in future result will be same as the price for solar energy, solar cells or solar plant will be sky high. Even electric vehicles are preferably good for light weight vehicles but when we talk about heavy weight vehicle it is still not compatible for use as it needs more power and more power consumption than normal use. So we need to move on to another source called biodiesel. Results show that jatropha will be the best alternate in India for biodiesel production because about 35-40% land in our country is marginal or wasteland. Most of our farmers land has lost the fertility due to over usage of fertilizers, chemicals and wrong techniques. Rajasthan and Madhya Pradesh are the top two states in this list. Jatropha needs very less irrigation, high water productivity, moderate yield and is non edible. It is very useful and feasible for farmers fighting in field with infertile land.

Our government has to take step in implementing this policy in country and should encourage researches for developing a biodiesel supply chain. The results show that ethanol production focused over sugarcane molasses as a primary feedstock is neither economically viable nor sustainable with the available technologies. It is therefore, imperative to prioritize the various options available so that the efforts are not only directed toward making it sustainable and economically viable, but also pro-poor and source saving. If prompted sugar sorghum based ethanol may prove to be a better option, which would be pro-poor in marginal and rainfed areas and so in case with tropical sugar beet. Estrification has been found to be an effective technique to prevent some long term problems associated with engine modifications such as fuel filter plugging, injector cooking, formation of carbon deposits on piston top and injector cooking substantially reduced in biodiesel-fueled system. The wear of various vital parts reduced up to 30% because of additional lubricity properties of biodiesel. These results of wear measurement by physical methods were also confirmed by atomic absorption spectroscopy. Oil analysis proved to be powerful tool to estimate not only the condition of the engine but of other moving parts as well. About 80% of the biodiesel problems can be rectify scientifically with a good research in right direction. Rest can be done by government and private entrepreneurial efforts. These two sectors should be tuned for successful biodiesel implementation. Government of India should re-think over their existing taxation policies for better and smooth pathway for biodiesel. At present, yes it is true; pollution has now become major problem in our country. We are at a stage of depletion of our energy resources due over utilization by over population in our country, which is one more major problem. We are at a risk and we have to take some decision, biodiesel seems to be a brilliant concept for future fuel, many countries have successfully adopted it and many countries are successfully implementing it in their countries. With the acceptance of Kyoto protocol and clean development mechanism, it seems to be international pressure will be on India in coming years if any further cannot be taken. From this overview it can be concluded that jatropha a non edible oil and sorghum are emerging to be very promising feedstock for biodiesel production. Biodiesel can also become economically feasible if government help in promoting biodiesel research policies and technology advancement. With the support of government it is possible the cost per litre of biodiesel will be Rs25 to Rs40 which is much lesser than current price of diesel. We have to make a system where from farmers to young entrepreneurs and government can work all together in this field in chain which will be beneficial for everyone and for reduction in pollution level as well in cost of fuel.

REFERENCES

An Overview of Biofuel as a Renewable Energy Sources: Development and Challenges, Masjuki Hj. Hassan, Md. Abdul kalam

Biodiesel: A Promising Alternative Energy Resource, A.E. Atabani

Biodiesel: An Alternative to Conventional Fuel, Daming Huang, Haining zhou, Lin Lin

Biofuel (Alchahol and Biodiesel) Applications as Fuel for Internal Combustion Engines, Avinash Kumar Agrawal

Bio-Fuel as Alternative Fuel for the Internal Combustion Engines, M. Srinivasnaik, Dr.T.V.V. Sudhakar, Dr.B. Balunaik

Biofuel From Marginal Lands: Some Insights for India, Deepak Rajagopal

India's Biofuel Production Programme: Need for Prioritizing the Alternative Options, P Shinoj, SS Raju and PK Joshi

Internal Combustion Engines, V Ganeshan, the McGraw –Hill Companies

Prospects of Ethanol & It's Costing by Narendra Mohan, National Sugar Institute, Kanpur

Use of Jatropha Oil Methyl Ester and its Blends as an Alternative Fuel in Diesel Engine.

****