A Review of Production, Properties and Advantages of Biodiesel

Prof. Pushparaj Singh[1], Prince Jaiswal[2]
[1]*Rewa Institute of Technology, Professor, REWA, MP, INDIA*
[2]*Rewa Institute of Technology, M.Tech Scholar, REWA, MP, INDIA*

Abstract- **Energy is considered as one of the most important factors for economic and industrial growth. With the increased use and depleting problem of fossil fuels there is a huge demand for an alternative and better source of energy. This demand promoted the emergence of biofuels among which biodiesel is considered to be the most accepted and best alternative for the depleting energy resources. Biodiesel has become more attractive recently because of its environmental benefits and the fact that it is made from renewable resources. The cost of biodiesel, however, is the main hurdle to commercialization of the product. The used cooking oils are used as raw material, adaption of continuous transesterification process and recovery of high quality glycerol from biodiesel by-product (glycerol) are primary options to be considered to lower the cost of biodiesel. There are four primary ways to make biodiesel, direct use and blending, micro emulsions, thermal cracking (pyrolysis) and transesterification. The most commonly used method is transesterification of vegetable oils and animal fats. In this present review, the importance, history, properties, sources and techniques for production of biodiesel are described.**

Index terms- Biodiesel, Compression Ignition, Engine, Palm Oil, Renewable

1. INTRODUCTION

Liquid fuel is a valuable asset utilized inexhaustibly and by one way or another unpredictably by present day man. The essential wellspring of fluid fuel is at present unrefined petroleum which is getting to be more diligently and increasingly costly to recoup as customary stores are exhausted and as outside providers increment the cost for their declining reserves [1].The extreme bounce in oil costs somewhere in the range of 1973 and 1979 began the unsettling that made numerous legislatures to embrace approaches to create elective vitality sources. With the wide greater part of air researcher currently concurring that an Earth-wide temperature boost is as of now well in progress ,there are presently increasingly strident calls to supplant raw petroleum as our fluid fuel source so as to diminish the development of ozone depleting substances in the environment[1].Thus an extra accentuation is being set on the advancement, generation and the utilization of elective fuel considered being friendlier to the earth than non-renewable energy source.. In the survey of[2], need as far as possible the an Earth-wide temperature boost was profoundly accentuated of which quickened arrival of fossil buried CO2 has been commonly acknowledged as a noteworthy contributor[3].

Dr. Rudolf Diesel actually invented the diesel engine to run on a myriad of fuels including coal dust suspended in water, heavy mineral oil, and, vegetable oil. Dr. Diesel's first engine experiments were catastrophic failures. But by the time he showed his engine at the World Exhibition in Paris in 1900, his engine was running on 100% peanut oil. Dr. Diesel was visionary. In 1911 he stated "The diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries which use it." In 1912, Diesel said, "The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in course of time as important as petroleum and the coal tar products of the present time." No doubt, this statement has come to stay. Since Dr. Diesel's untimely death in 1913, his engine has been modified to run on the polluting petroleum fuel we now know as "diesel." Nevertheless, his ideas on agriculture and his invention provided the foundation for a society fuelled with clean, renewable, locally grown fuel. Today throughout the world, countries are returning to using this form of fuel due to its renewable source and reduction in pollution.

Generally, bio-sourced energizes are named biofuel instances of which are bio methanol, bioethanol, bio butanol, bio methane, bio hydrogen, biodiesel and so forth. This paper fixates on biodiesel not just in light of the fact that its shows characterized substance and physical properties to satisfy the needs of motor application but since it is by and by delivered as a fuel on modern scale. The usefulness of biodiesel as a conceivable and likely possibility to supplant non-renewable energy sources as essential vitality hotspot for hardware and vehicular stream stays a main impetus for researchers to continue investigating into the universe of biodiesel.

Biodiesel refers to a processed fuel resulting from the biological sources and it is equivalent to petro-diesel. Biodiesel acts as a safe alternative fuel for substituting traditional petroleum diesel. It is a clean burning fuel with high lubricity. Biodiesel produced from renewable sources acts like petroleum diesel but produces significantly less air pollution. It is bio-degradable and very safe for the environment. Biodiesel production can be achieved in different methods. Biodiesel is a mono alkyl ester of fatty acids produced from both edible and non-edible vegetable oils or animal fat and various other bio fuels such as methanol, ethanol etc.

In recent times biodiesel has been produced from sources like vegetable oils, animal fats, soap stock and also recycled frying oils. In order to know which vegetable oil is best suited for the production of biodiesel, certain factors like geography, climate, and economics must be considered. Vegetable oils are considered as the renewable forms of fuel and they are more attractive in environmental benefits as they are made from renewable resources. Vegetable oil potentially forms the unlimited source of energy; with an energy content equivalent to that of diesel fuel. Direct use of vegetable oil in diesel engines gives rise to many problems such as jamming and gumming of filters, lines and injectors; engine knocking; starting problem during cold weather; coking of injectors on piston and head of engine; extreme engine Wear; carbon deposition on piston and head of engine [8]. Vegetable oils are of high viscosity and in order to reduce their viscosity and to overcome their problems to enable their use in many diesel engines, a process called transesterification must be carried out. The product so formed after transesterification is called as biodiesel. Biodiesel has relatively higher heating values. Biodiesel is 100% pure and hence it is referred as “neat fuel” or “B100”. The high heating values (HHV’s) of biodiesel ranges from 39 to 41MJ/kg. Biodiesel can be utilized by blending with petrol diesel and those blends are referred as BXX where XX represents the amount of biodiesel in the blend. Pure biodiesel can be denoted as B100.

1.1 Bio-Diesel Production

Biodiesel are produced through a simple technology called trans-esterification reaction. Degummed oil free of all forms of impurities is reacted with a reasonable alcohol (ethanol, methanol, butanol etc.)

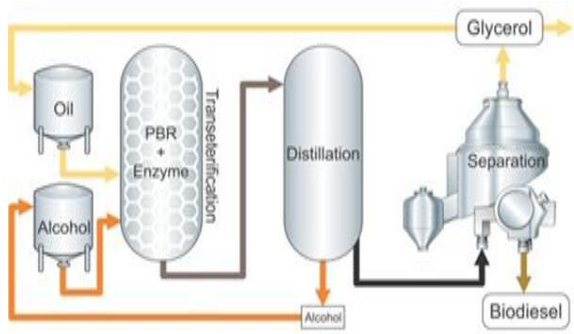

Figure 1: Biodiesel Production method

Several other side reaction occurs which if uncontrolled hampers conversion, product yield and quality. Usually 3 parameters have effect on the trans-esterification, namely;

- Temperature (T), reaction
- Time (t) and
- Ratio of oil to alcohol.

The reaction temperature plays an important role on the quality of the products. It is reported that normally, the range of the temperature used in the process is between. 50 0C – 65 oC. The temperature which is higher than the normal boiling point of methanol (68 oC) causes more vaporization of methanol (loss). On the other hand, the temperature which is lower than 50 oC causes higher viscosity of biodiesel[34].The ratio of methanol to oil also affects the reaction, the higher molar ratio, the higher conversion of alcohol. The ratios, normally used, are between 5:1 to 10:1. However using too high excess methanol can obstruct glycerine separation.

Figure 2: Palm Biodiesel

Table 1: Biodiesel production methods applicable for different sources

Sources	Best applicable methods
Soybeans (Glycine max)	Pyrolysis, transesterification
Rapeseed (Brassica napus L.)	Enzymatic transesterification
Coconut	transesterification
Rice bran oil (Oryza sativum)	Lipase-Catalyzed Interesterification
Barley	Lipase-Catalyzed Interesterification
Wheat Abutilon	Lipase-Catalyzed Interesterification
Peanut	transesterification
Corn	Saponification and Hydrolysis
Olive oil	transesterification
Pea nut oil	Saponification and Hydrolysis
Sunflower	Catalytic Pyrolysis
Palm oil	catalytic cracking
Jatropha	transesterification

Table 2: Estimated oil content and yields of different biodiesel feedstocks

Feedstocks	Oil content (%)
Jatropha seed	35-40
Kernel	50-60
Linseed	40-44
Neem	20-30
Pongamia pinnata (karanja)	27-39
Soybean	15-20
Calophyllum inophyllum L	65
35 Moringa oleifera	40
uphorbia lathyris L.	12-29
Sapium sebiferum L.	12-29

II. LITERATURE REVIEW

In the study carried out by Hossain and Boyce inspite of higher yield, using NaOH as catalyst during biodiesel synthesis from waste sunflower cooking oil causes more emulsion than KOH and makes complicated to separate biodiesel from glycerine. For this reason, KOH has been screened as a catalyst whose effect in terms of concentration can be studied with respect to biodiesel production. The solution of alkaline catalyst in methanol was recommended to be prepared freshly in order to avoid the moisture absorbance and to maintain the catalytic activity.

In the article of Twar et al; the essence of the titration process to get the number of gram of NaOH that will be used per liter of oil in the trans-esterification process was stated. This will give a rough guide on the amount of catalyst that will give an optimum yield. The experimental details goes thus; Dissolve 1 gram of NaOH in 1 liter of distilled water solution (0.1% NaOH). Phenolphthalein solution was used to get the end point. In a smaller beaker, 1ml of oil was dissolved in 10ml of pure isopropyl alcohol. The beaker was warmed gently by standing it in some hot water, stir until all the oil dissolves in the alcohol and the mixture turns clear. 2 drops of phenolphthalein solution was added. Using a burette, 0.1% NaOH solution was added drop by drop to the oil alcohol phenolphthalein solution, stirring all the time, until the solution stays pink for 10 seconds. The number of mls of 0.1% NaOH solution used added to 5.0 will give the number of NaOH to be used per liter of oil.

Leung and Gau reported that the conversion of waste cooking oil using sodium hydroxide catalysts was approximately 86%.

Zheng et al. showed that methyl ester conversion of waste cooking oil in acid catalyzed transesterifications can reach up to 99%. This process was carried out using a very high methanol to oil ratio of 250:1. In an attempt to reduce the problems with separation and soap formation associated with biodiesel production, some non-enzymatic heterogeneous catalysts have been investigated. ZrO2, ZnO, SO42-/SnO2,SO42-/ZrO2, zeolite, and KNO3/ZrO2 are some solid catalysts that were studied in the trans-esterification of palm and coconut oil. The reaction was carried out at 200 ℃, 50 bar, 3 wt% catalysts, and a 6:1 molar ratio of methanol to oil. All the solid catalysts exhibited some activity for both palm and coconut oil. The sulfonated metal catalysts gave the highest fatty acid methyl ester yields overall. ZrO2 gave 86.3 % yield for coconut oil and 90.3 % yield for palm oil.

Obed M. Al.i has considered that the Depleting non-renewable energy source sources joined by constantly developing vitality requests lead to expanded enthusiasm for elective vitality sources. Mixed biodiesel fuel has been endorsed as a business fuel at a low mixing proportion. Be that as it may, issues identified with fuel properties are diligent at high mixing proportions. Thus, in this examination, the achievability of biodiesel created from palm oil was researched. Portrayal of mixed fuel properties with expanding palm biodiesel proportion is led to assess motor execution test outcomes. The passing of mixed fuel properties was utilized to show the most extreme mixing proportion reasonable for use in unmodified diesel motors as per the mixed fuel standard ASTM D7467. The property test outcomes uncovered that mixed fuel properties satisfy mixed fuel guideline necessities at up to 30% palm oil biodiesel. Moreover, mixing is productive for decrease of the pour point from 14 for unblended biodiesel to not exactly at a 30% biodiesel mixing ratio. However, the vitality substance decreases by about 1.42% for each 10% augmentation of biodiesel

KhiraiyaKrunal B. et al. has contemplated that India has extraordinary potential for creation of biodiesel from non-eatable oil seeds. From around 100 assortments of oil seeds, just 10-12 assortments have been tapped up until now. The yearly assessed potential is around 20 million tons for every annum. Wild harvests developed in the west land likewise structure a wellspring of biodiesel creation in India and as per the Economic Survey of Government of India, out of the developed land zone, around 175 million hectares are delegated waste and corrupted land. In this manner, given an interest based market, India can without much of a stretch tap its potential and produce biodiesel in a huge scale.

Stewart et al. has considered that the vegetable oils incorporate soyabean oil, cottonseed oil, sunflower oil, rapeseed oil, palm oil, linseed oil, jatropha oil, neem oil and mahua oil. There are in excess of 350 oil bearing harvests recognized whose cetane number and calorific worth are practically identical with those of diesel energizes and are perfect with material vehicle fuel framework. Vegetable oil is of exceptional intrigue since it has appeared to fundamentally diminish particulate discharge in respect to oil diesel. Late examinations demonstrates that cetane number, sweet-smelling substance and type, sulfur content, thickness are significant factor for outflow control.

Donghui Lu et al. This paper is to learn about the various kinds of folios utilized for pelletization for various sorts of biomass various covers, for example, bentonite, rough glycerol, wood buildup and lignosulfonate were tried and see the advantages of utilizing these covers in pellets for the capacity and transportation. Pellets of wheat straw with bentonite, wood buildup, and lignosulfonate were gotten and the properties, for example, explicit vitality utilization, compound sythesis, rigidity, slag content, calorific worth and dimensional soundness of the pellets were resolved. Results demonstrated that the particular vitality utilization for wheat straw palletisation fundamentally diminished with the expansion of lignosulfonate, bentonite, wood build-up, and pre-treated wood build-up with rough glycerol. With the expansion of folios the elasticity of wheat straw pellets was improved with qualities going from 1.13 to 1.63 MPa. The expansion of both pre-treated and non-pre-treated wood build-up fundamentally diminished the fiery debris substance of wheat straw pellets.

III.CURRENT STATUS OF BIODIESEL

The current research is on finding more appropriate crop sources and to enhance the oil yield for biodiesel production. With respect to the present yield, large amount of fresh water and land is necessary to produce sufficient oil in order to completely replace the use of fossil fuels.

Almost 0.53billion m3 of biodiesel is necessary in order to replace all the transport fuel in US as per the present rate of consumption but sources like oil crops, waste cooking oil, soap stock, jatropha oil cannot meet this demand. Therefore by using microalgae this situation can be overcome. Microalgae grow well in the aquatic environment as it provides necessary water, CO_2 and nutrients. When comparing with land crops, Microalgae have simple structures and can be grown very abundantly throughout the year.

They have high photosynthetic efficiency with a growth doubling time less than 24hrs. Valuable products such as animal feeds, proteins, pigments, polysaccharides, fertilizers etc. can be produced by microalgae. The contribution of microalgae biodiesel to emit Carbondi-oxide and sulphur into the atmosphere is nearly zero. This is the only microorganism that can completely replace the usage of fossil fuels.

They are not specific to climatic conditions or environmental conditions hence can be grown in all conditions. Microalgae have rich oil content about 20% to 50% than others. Dry biomass weight of some microalgae may exceed 80%. Open ponds, raceway pond and tubular photo bioreactors are some of the sensible methods used for the large scale production of microalgae]. When coming to the source s microorganisms, microalgae is preferred as the best source in production of biodiesel as it can easily synthesize lipids that can convert into biodiesel. Microalgae also removes nitrogen, carbondi-oxide in air, phosphorous content in waste water and the concern about global warming makes the micro algal biodiesel more attractive.

As there is techno-economic constraints microalgae-based biodiesel is not realized commercially particularly in areas of mass cultivation and downstream processing. The biodiesel obtained from micro algae has many advantages. It's non-toxic, bio-degradable and doesn't contain any sulphur. Certain species can be cultivated daily. The oil extracts of algae can be processed into ethanol and can be used as livestock feed. The carbon emissions can also be reduced depending on where it's grown.

In recent years, trials on automobiles using biodiesel have been conducted by several institutions in India which have confirmed that biodiesel can reduce wear and tear of engines and reduce oil pollution significantly.

IV.CONCLUSIONS

Energy is an essential factor in industrial growth and in provision of required services that improve the quality of life of mankind. Biodiesel, of the family of biofuel, has been described in this review as a fuel with necessary potentials to replace fossil diesel in future. The trials biodiesel and its blend have undergone is a confirmatory test to all advantages including environmental benefits accrued to it thereby plays a vital role in meeting future fuel requirements. The availability of major feedstock namely oil from bio-sources and simplicity of the trans-esterification technology that ensures its conversion to biodiesel are added advantage in terms of the future needs of biodiesel. The use of inedible oil and waste frying/cooking oil has equally assisted in establishing a balance between energy and food security. However, serious efforts have to be intensified on design of large scale bio-refineries for future biodiesel production.

Enzymatic transesterification process using lipases gave high yield of biodiesel but because of the high cost of lipases, enzymatic transesterification is not much followed. But catalytic transesterification has several problems like removal of catalyst and product purification etc., so non-catalytic transesterification such as BIOX process, supercritical process have become the most preferable method for biodiesel production. Recent studies show that microalgae are the best and an ever green source for biodiesel production as microalgae has many advantages over other conventional sources.

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