International Journal of Scientific Research and Modern Education (IJSRME)
ISSN (Online): 2455 – 5630 & Impact Factor: 3.110
National Conference on Recent Trends in Applied Chemistry (NCRTAC–2016)
Easwari Engineering College, Ramapuram, Chennai, Tamilnadu

A MINI REVIEW – BIODIESEL PRODUCTION AND APPLICATIONS

J. Vigneshwaran*, S. Sakthi Prakash*, N. Yogesh*,
N. S. Karthikeyan, M. Kumar** & C. Ravichandran****
* Department of Information Technology, Easwari Engineering College, Ramapuram, Chennai, Tamilnadu
** Department of Chemistry, Easwari Engineering College, Ramapuram, Chennai, Tamilnadu

Abstract:
Bio-diesel is a type of fuel obtained from the vegetable oil which is a renewable source. This bio-diesel can be used in a diesel engine without any modification made to the engine. This fuel can even be blended with the other variety of oil. Transesterfication is one of the most effective methods in preparation of bio-diesel. This fuel has a great application over the other fuels. Research is being conducted to make this fuel successful over any automobile in countries like USA, Europe etc., In this review we discussed about the bio-diesel and its production &application in day to day life.

Key Words: Bio-diesel, Blending, Production & Applications

1. Introduction:

Energy is a major need for the development of country and the increase in population needs more energy for both economic and social development. The petroleum products and fossil fuels are a predominant source of energy, but the scarcity of those items and the environmental pollution caused by petroleum fuels are the major uncertainties in the challenging world. Biodiesel is considered to be an alternative fuel to petroleum-based fuel resulting in numerous environmental, economic, and social benefits. Biodiesel benefits include bio-degradable, non-toxic, free from sulphur (< 0.001 %) and 60% less net carbon dioxide emissions. In addition, it has high flash point (greater than 160 ^{0}C) which helps biodiesel by transportation and storage. The important quality that biodiesel posses is that it decomposes more easily when they expose to environment and most importantly they can be produced easily compared to petrol and diesel. Another advantage of using biodiesel is that it eliminates the compound such as polycyclic aromatic hydrocarbons (PAH) and nitrated PAH that causes cancer in humans. The lubrication property of biodiesel dominates more when compared to the diesel fuel and increases the engine life. Biodiesel causes less emission of carbon dioxide (CO2), hydrocarbon (HC) and particulate matter (PM), which are the dominant factors while compared with diesel. The origin and history of biodiesel were described briefly in this paper.

(a) Biodiesel: Biodiesel refers to a vegetable oil or animal fat based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, soybean oil, animal fat (tallow) with an alcohol producing fatty acid esters. Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used alone, or blended with diesel in any proportions. Biodiesel blends can also be used as heating oil.

(b) Evolution of Bio-Diesel: Transesterification of a vegetable oil was conducted as early as 1853 by Patrick Duffy, four decades before the first diesel engine became functional. Rudolf diesel's prime model, a single 10 ft (3.0 m) iron cylinder with a flywheel at its base, ran on its own power for the first time in Augsburg, Germany, on 10

august 1893 running on nothing but peanut oil. In remembrance of this event, 10 august has been declared "international biodiesel day".

2. Blends:

Bio-Diesel Sample

Blends of biodiesel and conventional hydrocarbon-based diesel are products most commonly distributed for use in the retail diesel fuel marketplace. Much of the world uses a system known as the "b" factor to state the amount of biodiesel in any fuel mix.

- ✓ 100% biodiesel is referred to as b100
- ✓ 20% biodiesel, 80% petro diesel is labelled b20
- ✓ 5% biodiesel, 95% petro diesel is labelled b5
- ✓ 2% biodiesel, 98% petro diesel is labelled b2

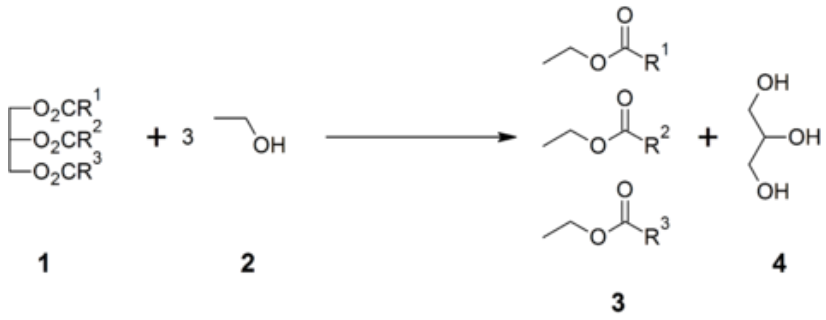
3. Production of Bio-Diesel by Transesterification Process:

(a) Sources of Biodiesel: Biodiesel is manufactured from the vegetable oils like soya, canola, jatropha, sunflower seed, algae and animal fats. The chemical name for biodiesel is fatty acid alkyl esters. There are a few methods for production of biodiesel, but the most commonly used method for production of biodiesel is known as transesterification. It is the chemical conversion process of vegetable oil or animal fats to biodiesel.

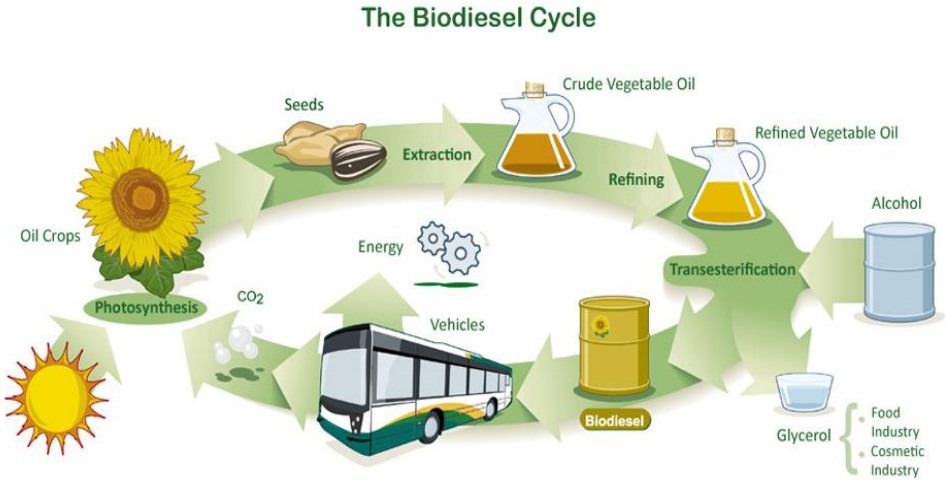
(b) Chemical Components of Vegetable Oil: The main components used for production of biodiesel are vegetable oil or animal fats. Vegetable oils are triglycerides that are composed of three chains of fatty acids all connected together by a glycerine molecule. The triglycerides are not the individual atoms; instead they are esters. The esters in turn are the acids, say like fatty acids that have been combined with alcohol.

(c) Process of Transesterification: Transesterification is a chemical reaction used for the conversion of vegetable oil to biodiesel. In this process vegetable oil is chemically reacted with an alcohol like methanol or ethanol in presence of a catalyst like lye. After the chemical reaction, various components of vegetable oil break down to form new compounds. The triglycerides are converted into alkyl esters, which is the chemical name of biodiesel. If Methanol is used in the chemical reaction, methyl esters are formed, but if ethanol is used, then ethyl esters are formed. Both these compounds are biodiesel fuels with different chemical combinations. In the chemical reaction alcohol replaces glycerine. Glycerine that has been separated during the transesterification process is released as aby-product of the chemical reaction. Glycerine will either sink to the bottom of the reaction vessel or come to the surface depending on its phase. It can be easily separated by centrifuges, and this entire process is known as transesterification. The biodiesel produced by the process of transesterification has much lower viscosity, which makes it capable of replacing petroleum diesel in diesel

engines. In earlier years when the process of transesterification was not known, the viscosity of vegetable oil was the major hindrance for its use as a fuel for motor engines. The transesterification process has been able to remove this hindrance. Triglycerides (1) are reacted with an alcohol such as ethanol (2) to give ethyl esters of fatty acids (3) and glycerol (4).



R^1, R^2, R^3 - Alkyl group



4. Production Levels:

In 2007, biodiesel production capacity was growing rapidly, with an average annual growth rate from 2002-06 of over 40%. For the year 2006, the latest for which actual production figures could be obtained, total world biodiesel production was about 5-6 million tonnes, with 4.9 million tonnes processed in Europe (of which 2.7 million tonnes was from Germany and most of the rest from the USA. In 2008 production in Europe alone had risen to 7.8 million tonnes. In July 2009, a duty was added to American imported biodiesel in the European Union in order to balance the competition from European, especially German producers. The capacity for 2008 in Europe totalled 16 million tonnes. This compares with a total demand for diesel in the US and Europe of approximately 490 million tonnes (147 billion gallons). Total world production of vegetable oil for all purposes in 2005/06 was about 110 million tonnes, with about 34 million tonnes each of palm oil and soybean oil.

Us biodiesel production in 2011 brought the industry to a new milestone. Under the Environmental Protection Agency (EPA) renewable fuel standard, targets have been implemented for the biodiesel production plants in order to monitor and document production levels in comparison to total demand. According to the year-end data released by the EPA, biodiesel production in 2011 reached more than 1 billion gallons.

This production number far exceeded the 800 million gallon target set by the EPA. The projected production for 2020 is nearly 12 billion gallons.

5. Biodiesel Feed Stocks:

A variety of oils can be used to produce biodiesel. These include:

- ✓ Virgin oil feedstock – rapeseed and soybean oils are most commonly used, soybean oilaccounting for about half of US production. It also can be obtained from pongamia, field pennycress and jatropha and other crops such as mustard, jojoba,flax, sunflower, palm oil, coconut and hemp.
- ✓ Waste vegetable oil (wvo)
- ✓ Animal fats including tallow, lard, yellow grease, chicken fat, and the by-products of the production of omega-3 fatty acids from fish oil.
- ✓ algae, which can be grown using waste materials such as sewage and without displacing land currently used for food production.
- ✓ Oil from halophytes such as salicorniabigelovii, which can be grown using saltwater in coastal areas where conventional crops cannot be grown, with yields equal to the yields of soybeans and other oilseeds grown using freshwater irrigation
- ✓ Sewage sludge - the sewage-to-biofuel field is attracting interest from major companies like waste management and start-ups like InfoSpi, which are betting that renewable sewage biodiesel, can become competitive with petroleum diesel on price.
- ✓ Many advocates suggest that waste vegetable oil is the best source of oil to produce biodiesel, but since the available supply is drastically less than the amount of petroleum-based fuel that is burned for transportation and home heating in the world, this local solution could not scale to the current rate of consumption.

6. Properties:

Biodiesel has promising lubricating properties and cetane ratings compared to low sulphur diesel fuels. Depending on the engine, this might include high pressure injection pumps, pump injectors (also called unit injectors) and fuel injectors.

Older diesel Mercedes are popular for running on biodiesel

The calorific value of biodiesel is about 37.27 MJ/kg. This is 9% lower than regular number 2 petrodiesel. Variations in biodiesel energy density are more dependent on the feedstock used than the production process. Still, these variations are less than for petro diesel. It has been claimed biodiesel gives better lubricity and more complete combustion thus increasing the engine energy output and partially compensating for the higher energy density of petro diesel. The colour of biodiesel ranges from golden to dark brown, depending on the production method. It is slightly miscible with water, has a high boiling and low vapour pressure. The flash point of biodiesel (>130 °c, >266 °f) is significantly higher than that of petroleum diesel (64 °c, 147 °f) or gasoline (−45 °c, -52 °f). Biodiesel has a density of ~ 0.88 g/cm^3, higher than petro diesel(~ 0.85 g/cm^3).Biodiesel contains virtually no sulphur, and it is often used as an additive to ultra-low sulphur diesel fuel to aid with lubrication, as the sulphur compounds in petro diesel provide much of the lubricity.

7. Fuel Efficiency:

The power output of biodiesel depends on its blend, quality, and load conditions under which the fuel is burnt. The thermal efficiency for example of b100 as compared to b20 will vary due to the BTU (British thermal unit) content of the various blends. Thermal efficiency of a fuel is based in part on fuel characteristics such as: viscosity, specific density, and flash point; these characteristics will change as the blends as well as the quality of biodiesel varies. The American has set standards in order to judge the quality of a given fuel sample. Regarding brake thermal efficiency one study found that b40 was superior to traditional counterpart at higher compression ratios (this higher brake thermal efficiency was recorded at compression ratios of 21:1). It was noted that, as the compression ratios increased, the efficiency of all fuel types - as well as blends being tested - increased; though it was found that a blend of b40 was the most economical at a compression ratio of 21:1 over all other blends. The study implied that this increase in efficiency was due to fuel density, viscosity, and heating values of the fuels

8. Current Challenges in Biodiesel:

The current challenges that the world is looking forward for new fuel should satisfy the following conditions such as environmental friendly, economically supported, readily available and easily decomposable. Further, the price of petrol and diesel is increasing day by day. So a need for alternative fuel is a must needed one. Biodiesel is struggling hard to survive in the world in which researches are looking forward to eliminate the disadvantages that biodiesel posses. Biodiesel has the potential of overcoming the challenges that is prevailing today. The disadvantages that biodiesel has to overcome was deposit formation in engine which results in clogging of fuel filters. So better refining techniques has to be followed in order to remove more fatty acids and glycerine completely. The other disadvantages that biodiesel posses was emission of high percentage of NOx emission. So reduction of NOx in biodiesel will results in commercial usages in engines. More non edible crops have to be encouraged for production of biodiesel than considering the edible crops. Biodiesel plants have to be planted around the country in order to produce more biodiesel. Simultaneously environmental factors have to be considered to prevent from pollution.

9. Conclusion:

Biodiesel is the most promising fuel in the near future as an alternative to fossil diesel. Despite of its advantages, it still has some disadvantages such as source for massive feedstock, relatively poor low-temperature properties, increase in

NO_x emissions, etc. These issues should be sorted out before biodiesel is applied into diesel engines in a large scale. Therefore, in-depth studies on the application of biodiesel into diesel engines are necessary. The research on alternative feed stocks is also an important area and the second-generation biodiesel is more promising made from algae and the genetic modification is a potential way to solve this problem of source of massive feedstock. The low-temperature fuel properties can be improved by additives or the production routine. In addition, diesel engines should also be optimised in order to achieve the optimal performance and emissions.

10. References:

1. An overview of biodiesel and petroleum diesel lifecycles, may 1998, Sheehan, et al. Nrel, 60pp.
2. Business management for biodiesel producers, January 2004, Jon Von Gerpen, Iowa state university under contract with the national renewable energy laboratory, 210pp.
3. Energy balances in the growth of oilseed rape for biodiesel and of wheat for bio ethanol, June 2000.
4. Life cycle inventory of biodiesel and petroleum diesel for use in an urban bus, 1998, Sheehan, et al. 314pp.
5. Algae - like a breath mint for smokestacks, January 11, 2006, Mark Clayton, Christian science monitor
6. Tyson, R.L. "2006 biodiesel handling and use guide third edition".
7. Biodiesel's bright future from the July–august issue of the futurist magazine.
8. Details about Biodiesel are collected from creative world website.