Biodiesel:The New Energy Lifeline

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Introduction

The world's energy demand continues to increase as we use more and more machines in our day-to-day lives. Short supplies of fossil fuel energy are already being strained to capacity to meet the burgeoning demand of energy posed by developing countries such as India and China. How we supply our energy needs and with what fuels is becoming more and more of an issue, both economically and environmentally.

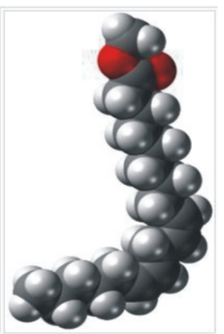
Digging into the past annals we found that, during the twentieth century, energy consumption increased dramatically and an unbalanced energy management came into being. As a result of this inequilibrium and rapid declining of fossil fuels, a considerable interest was focused on the further development and expansion of an alternative source of energy.

The most early attention was trapped by using nonfossilized organism or byproducts of these organisms. These were categorized as biofuels, a sustainable energy source with continuous growth/burn cycle.They have emerged as a new alternative source of energy, satisfying both economic and environmental requirements.

Earlier, the focus of commercial sector was on ethanol,but interest is now growing in the area of biodiesel production. Reasons for this growing interest include its potential for reducing noxious emissions, contribution to rural economy, as a demand center for agricultural commodities and a way to reduce reliance on foreign oil.

What is Biodiesel?

Biodiesel generally refers to the mono-alkyl esters of fatty acids, which can be derived from a variety of vegetable oils and animal fats. It is the product of chemical reaction between the basic feedstock (vegetable oil or animal fat) and alcohol (methnol) in the presence of a catalyst (NaOH or KOH)1. The reaction results in a compound called fatty acid alkyl ester (biodiesel) and a byproduct, glycerol.



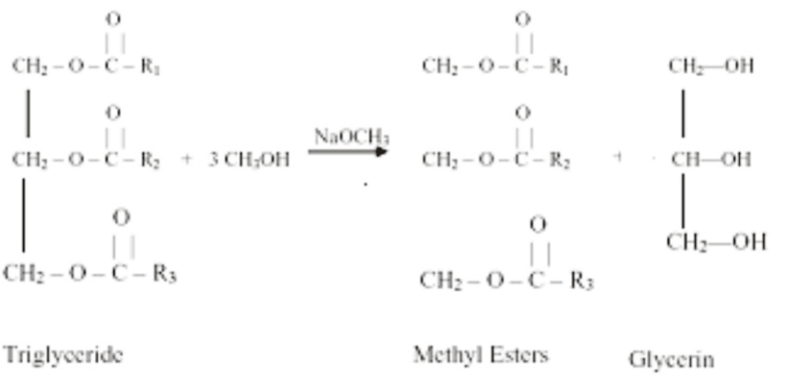
Space filling model of Linoleic acid methyl ester (biodiesel)2

The general conversion of feedstock to biodiesel

100 lbs. of feedstock+ 10 lbs. of methanol → 100 lbs. of biodiesel + 10 lbs. of glycerol

The chemical reaction includes Transesterification :

During transesterification a basic catalyst breaks the fatty acids from the glycerin one by one. If a methanol contacts a fatty acid they will bond and form biodiesel.



Transesterification of Triglyceride with Alcohol

Sources of Biodiesel:

A variety of oils that can be used to produce biodiesel are as follows:

- Virgin oil feedstock: Rapeseed and soybean oils are most commonly used, soybean oil alone accounting for about 90% of all fuel stocks in the US. It also can be obtained from field pennycress, Jatropha, other crops such as mustard, flax, sunflower, palm oil and hemp.
- Waste vegetable oil (WVO).
- Animal fats, including tallow, lard, yellow grease, chicken fat, [3] and the byproducts of the production of Omega-3 fatty acids from fish oil.
- Algae, which can be grown using waste materials such as sewage[4] and without displacing land currently used for food production.

How to Make Biodiesel?

Biodiesel is made by chemically altering the molecular structure of any organic oil through the use of a chemical catalyst and an alcohol.

Biodiesel production involves the following procedure[5]:

A.Prerequisites :

Determining the pH of biodiesel:

Myth : It is not possible to truly determine the pH of biodiesel because it is not an aqueous solution (and pH is the measurement of hydrogen ions in water).

Fact : Biodiesel is hygroscopic and will always have a tiny bit of water (about 1200 ppm) absorbed from the atmosphere, if from nowhere else. It is possible to measure its pH.

Titration

A method of determining the concentration of a dissolved substance (vegetable oil), in terms of the smallest amount of a reagent (potassium hydroxide) to bring about a given effect (i.e., Neutralize the FFAs) is the aim of titration. Phenolphthalein is a great indicator for titrating biodiesel. It is colourless unit pH 8.3, then it turns pink (magenta), and red at its maximum of pH of 10.4 (accurate titration pH 8.5).

B.Steps Involved

Step 1: *Titration method for determining how much catalyst needed to neutralize the fatty acids in the used vegetable oil.*

- Dissolve 1 gram of KOH in 1 liter of distilled water.
- Dissolve 1 ml of waste vegetable oil into 10ml isoprophyl alcohol.
- With an eyedropper, set the pH of WVO to 8-9 by adding NaOH one milliliter at a time. you will see an eventual rise in the ph level.
- Record the quantity of KOH solution added until the colour of the oil changes pink and holds for at least 5 seconds (This represents a pH of between 8 and 9).

Step 2: *Preparation of potassium methoxide.*

- Carefully pour the KOH solution into 100 ml methanol.
- Agitate the mixture until the KOH is completely dissolved in the methanol.

Step 3: *Mix the reactants*

- Continue mixing under the lab fume hood.
- Carefully pour the potassium methoxide on top of the vegetable oil in the large mason jar and shake vigorously for 15 minutes.

Step 4 : *Allow the glycerin to settle*

- Settle the mixture overnight.
- The successful chemical reaction between the oil, alcohol, and the catalyst will have broken down the oil into several layers. The top layer will be biodiesel, chemically called an Ester, the next layer may contain soap, and the bottom layer will be glycerin.(For every 50 gallon batch, we end up with about 11 gallons of glycerine and 50 gallons of fuel.)

Step 5: *Purification of Biodiesel:*

- Once the layering has occured, the glycerin and soap are drained off. The biodiesel is then washed with either a mist-wash, a bubble-wash, or both. The washing is done to remove any additional soap, alcohol, or other impurities in the biodiesel. After it's been washed, it is then dried to remove any water. Commonly it is then filtered through fuel filters and is then ready to be used.

Algae as a Source of Energy

- Algae can prove to be a cheap and renewable source of energy for internal combustion engine. Tropical countries such as India favor algae production, due to high temperature and dry weather coupled with strong winds. Algae can be induced to produce more lipids by controlling supply of nitrogen and silicon, which helps in converting over two-third of its mass into lipids. For instance, in a pond of 20 meters about 80% of the converted lipids can produce 3000 liters of fuel each year. Lipids, in turn, produce fuels such as diesel and petrol. These lipids are hydolyzed on boiling with concentrated hydrochloric acid to fatty acids. Then they are esterified with methyl alcohol by a process called 'transesterification.'

Power generation from algae consists of three stages:

- Algae is grown in a vessel known as biocoil.
- Algae grown is milled to fine powder so that it burns with same efficiency as the fine sprays of fuels and oils traditionally used in engines.
- Wet algae can also be used as a fuel for internal combustion engine after filteration, drying, and milling operation.

Advantages of Biodiesel

Biodiesel has several advantages some of which are enumerated as below:

It helps in reducing the levels of toxins from air and water and also can reduce the advance of global warming.

The plant-based biodiesel adds no CO_2 to the atmosphere. They are 'carbon neutral'.

The ozone harming potential of biodiesel emission is almost 50% less than conventional diesel fuel.

Sulfur dioxide and nitrous oxide emissions are eliminated by using biodiesel.

Biodiesel has a significantly lower flash point than petroleum diesel. This reduces risk of fire in transport, storage, and delivery.

Use of biodiesel results in increased lubricity, adding to overall engine life. Recent research shows that even a 2% biodiesel blend increases lubricity significantly[6].

In addition, research has also verified that exhaust emissions from biodiesel are substantially less than those from petroleum-based diesel. Further, as the percent of biodiesel in a bio/petroleum diesel blend increases, the benefits of reduced emission increase (Figure 1).According to the environmental protection agency (EPA), a

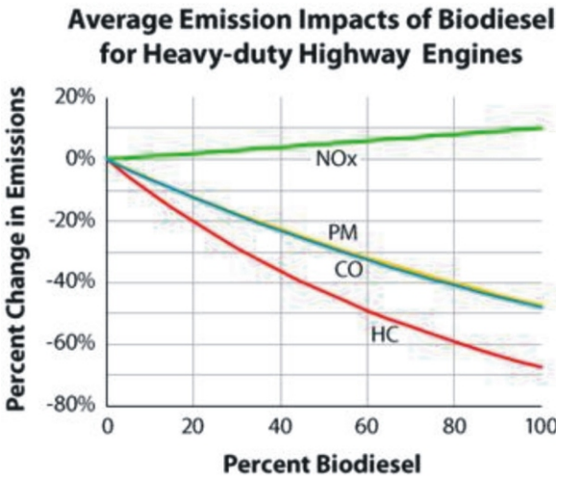


Figure *1Average emission impacts of biodiesel for heavy-duty highway engines. Source: EPA.*

soybean oil diesel product (20% bio/80% petroleum) results in a reduction of 10.1% in total particulate emissions (PM), 21.1% in hydrocarbons (HCs), and 11% in carbon monoxide (CO) emissions. These are offset by a 2% increase of nitrous oxide (NOx) and a reduction in fuel efficiency of 1-2%, but environmental impacts are positive nonetheless.

Disadvantages

In addition to advantages, there are couple of disadvantages posed by biodiesel:

Contamination by water

Biodiesel may contain small but problematic quantities of water. Although it is hydrophobic, it is said to be, at the same time, hygroscopic to the point of attracting water molecules from atmospheric moisture[7]. Hygroscopic biodiesel is formed due to the persistence of mono- and diglycerides left over from an incomplete reaction.

In addition, there may be water that is residual to processing or resulting from storage tank condensation, which may lead to following problems:

- Water reduces the heat of combustion of the bulk fuel. This means more smoke, harder starting, less power.
- Water causes corrosion of vital fuel system components (fuel pumps, injector pumps, fuel lines, etc.).
- Water and microbes cause the paper element filters in the system to fail, which in turn results in premature failure of the fuel pump due to ingestion of large particles.
- Water freezes to form ice near 0 °C. These crystals provide sites for nucleation and accelerate the gelling of the residual fuels.
- Water accelerates the growth of microbe colonies, which can plug up a fuel system. Biodiesel users who have heated fuel tanks therefore face a year-round microbe problem.

Flow properties

Flow properties in biodiesel are increased relative to petroleum diesel. This means that the biodiesel will gel at a higher temperature than 100% petroleum diesel. However, a study conducted in the winter of 2001/02 in Hennepin County, Minnesota found that snow plows burning a B20 product composed of 10% biodiesel manufactured from yellow grease, 10% biodiesel manufactured from soyabean oil, and 80% petroleum diesel performed as well as snow plows powered by 100% petroleum diesel[8].

Conclusion

To move toward a future with a sustainable energy supply and healthy consumer goods production, every solution is important. For this reason, energy use must become more and more efficient, production processes must be improved and the full potential of new technologies must be realized. Fuel biotechnology with its competitive, clean, and clever use of bio-based technologies can play a key role in making biofuels more sustainable.

"Earth is ours and preservation of fuel our utmost duty"
"One good invention today results in a revolution tomorrow"
"If bios be saved from dying it is biodiesel

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