Biodiesel

Mohnish Alishala

The United States produces an estimated 245 million tons of municipal solid waste with close to 2,000 landfills to accommodate this amount. Two-thirds of this consists of organic materials - yard trimmings, food scraps, wood waste, paper and paperboard products. When organic waste is placed in a landfill, the decomposers convert and release the carbon as methane. The US EPA has identified methane as one of the largest sources of greenhouse gasses. If humans continue adding waste at the current rate, the limited quantity of land will run out as population grows. Almost every day a single human produces about 4.5 pounds of garbage. Different types of organic waste can be converted into biodiesel using two different processes.

First generation process is using human food and converting it into fuel. Second generation process uses cellulose instead of human resources to convert into fuel. Both methods use a fermentation process with an organism. The goal is to create techniques in order to help solve the landfill problems, while cleaning the environment through the removal of excess waste. The advantages of using this process is that the biofuel will not increase greenhouse gases and recycles organic waste. The fuel uses readily available organic waste to create high-energy fuel.

Wanodya Kawentar and Arief Budiman produced an experiment involving the synthesis of discarded second-use cooking oil into biodiesel. Some cities in the Indonesian islands produce two types of cooking oil: first use and second use. First use oil is waste oil from fast food restaurants. Street sellers acquire discarded fast food oil and use it, creating second-use oil. Usually, waste oil is treated before disposing, but not always. The untreated waste oil will inevitably pollute the environment given its toxicity. Instead of letting this oil pollute the environment, it would be effective to convert it into biodiesel. This experiment helps to understand the basic parameters required for the conversion of lipids into biodiesel. The experiment concluded that with increasing temperature, the conversion of lipids became more efficient.

Marina O.S. Dias performed an experiment on sugarcane waste through a second-generation process. First, the juice in the sugarcane was separated. The remaining solid waste was further processed to extract more sugars to make ethanol using enzymes. Since it is composed of cellulose and lignin, it may be converted into fermentable sugars through a hydrolysis processes. After hydrolysis, the remaining solid waste was used for either electricity generation or synthesis of refined sugar. This study shows another benefit of using ethanol

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fermentation. There are wide varieties of feedstock that can be used for this process. Second generation involves using cellulose instead of feedstock. This process will not compete directly with human food, eliminating the crisis for exponential dependence on fossil fuels. This experiment also shows how the process can be utilized in the multiple ways; for example, the leftover biomass can be used to produce electricity.

Julie Zimmerman and Lindsay Soh researched the potential of using algal lipids to convert into biodiesel. The lipids were extracted using a supercritical extraction method. The advantages of using this method are that there is no need to use any solvents to extract the lipids. Moreover, algae can propagate quickly, retain higher oil content per unit of dry weight, and utilize wastewater as a feedstock. The oil content of some microalgae can reach 90% of dry biomass weight under extreme growth conditions. From this experiment, centrifugation can be utilized to separate the solids from the fermentation broth. Using centrifugation, harvesting biomass from the liquid broth will be cost effective. An advantage of using centrifugation is the solids in the fermentation liquids can be separated regardless of size. Centrifugation system can be integrated into whole process system without any major modifications.

Biodiesel is the only alternative fuel to have completed the EPA-mandated Tier I and Tier II health effects under the Clean Air Act. These tests demonstrate how significantly the biodiesel can reduce emissions. During the combustion of biodiesel, there is a 67% decrease of hydrocarbons emissions and an 80% decrease of carbon dioxide emissions compared to petroleum. When petroleum is burned, it releases sulfur and nitrogen. When the hydrocarbons are burned, carbon dioxide is increased. Biodiesel contains fewer hydrocarbons, releasing less CO₂ and no traces of sulfur.

Biodiesel is environmentally friendly - it is non-toxic and degrades four times faster than petroleum. During degradation, the reactions of dehydrogenation and oxidation recognize the oxygen atoms. Biofuel is then degraded quickly. Biodiesel can be mixed with petroleum fuels at any ratio and still be functional. Studies show that as there is an increase of biodiesel in the blend, there are reductions in emissions. Moreover, biodiesel can be stored in places where petroleum was previously stored, saving costs. Biofuels are the only alternative fuels that can run on conventional unmodified engines. Unlike solar powered and electric vehicles, the engines don't need to be modified. Biodiesel has a higher oxygen content than petroleum, which improves combustion. Since biodiesel is lubricating, it can actually increase engine life, while cleaning out old diesel residues.

Figure 2: General Transesterification Reaction

Transesterification is commonly used as a technique to produce biodiesel. This process uses both ester and alcohol and exchanges the carbon chains. Esters are chemical compounds usually derived from an acid and an alcohol through a reaction. A catalyst is used in transesterification to increase the rate of a chemical reaction. During the reaction, triglyceride and the alcohol react with each other to separate glycerol, the byproduct, from triglyceride. The fatty acids react with the alcohol and exchange bonds. Generally, biodiesel is called alkyl ester because there is no specific alcohol used.

Fuel is an energy source increasing in demand annually. By the year 2030, Earth's population is expected to be at least eight billion and will require even more resources. Fossil fuels are formed over millions of years. Eighty percent of the world's energy comes directly from fossil fuels. Biofuels are a substitute for oil and petroleum fuels, created from renewable sources, a natural resource that can replenish itself naturally over time. Biodiesel is the future of renewable energy.

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