CDM Infrastructure & Environmental, Inc.

Biodiesel Manufacturing Plant

• Producing fuel from waste cooking oil, thereby contributing to solving problems of waste disposal and protecting the environment

Main Features

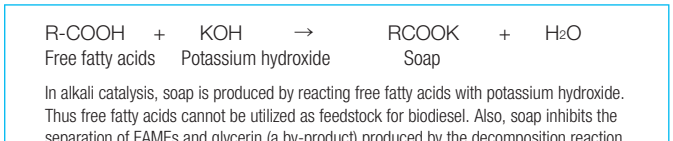
- **Compact plant for continuous production of biodiesel fuel using cooking oil as the feedstock.**
- **Manufacturing plant for high-quality FAMEs (fatty acid methyl esters) enables nearly 100% transesterification of triglycerides, the main component of cooking oil.**
- **Catalytic cracking plant for cooking oil that produces fuel equivalent to light diesel oil from cooking oil without the use of chemicals such as methanol and acids/alkalis (new technology).**

Summary

Our company provides technologies for biodiesel production that use cooking oil as the feedstock based on two different systems. It should also be noted that fatty acid methyl esters (FAME) are often commonly referred to as biodiesel, but we broadly refer to fuels similar to light diesel oil produced from biological sources as biodiesel.

One of the technologies we provide is a system that produces FAMEs using an esterification reaction and transesterification reaction. Specifically, our company has adopted FAME production technology that combines acid catalysis or enzyme catalysis, and alkali catalysis. Waste cooking oil is mainly composed of triglycerides, and contains some free fatty acids. Alkali catalysis has a proven track record around the world as a technique to transesterify triglycerides and alcohols in the presence of an alkali catalyst, but there are problems in efficiently producing FAMEs in the presence of high concentrations of free fatty acids (Figure 1). Accordingly, we have adopted a technology that produces FAMEs by esterifying free fatty acids and an alcohol as a first step using an acid or enzymes as a catalyst (Figure 2), and then immediately producing FAMEs from triglycerides using an alkali as a catalyst (Figure 3). The technology our company provides has the outstanding feature that it is an inline design that efficiently mixes the triglycerides, methanol, and catalysts, enabling the transesterification reaction to proceed rapidly. Also, of the numerous FAME system manufacturers who claim triglyceride-FAME exchange performance of around 97%, the system that our company provides can achieve a nearly 100% reaction completion rate. The triglycerides, methanol, and catalysts are efficiently mixed, and the result is an economically superior system.

The other method that our company provides is a production technology for biodiesel based on a new system—catalytic cracking. The biodiesel produced by this method differs from FAMEs in that it has constituents very close to those of light fuel oil derived from petroleum sources. The strength of FAME production is the fact that it is a technology with a



In alkali catalysis, soap is produced by reacting free fatty acids with potassium hydroxide. Thus free fatty acids cannot be utilized as feedstock for biodiesel. Also, soap inhibits the separation of FAMEs and glycerin (a by-product) produced by the decomposition reaction of the triglycerides, and the yield of the FAMEs declines.

Figure 1: Effect on the FAME production process by alkali catalysis of free fatty acids

Figure 2: FAME production process based on acid catalysis or enzyme catalysis using free fatty acids as feedstock

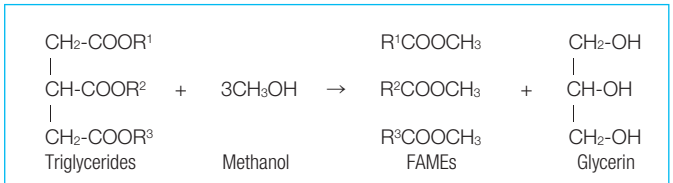


Figure 3: FAME production process based on alkali catalysis of triglycerides

proven track record using alkali catalysis as the representative process, but there are also shortcomings of FAMEs. Because the physical properties of FAMEs and light fuel oil are different, FAMEs have higher cloud points than light fuel oil and depending on the type of engine, certain problems occur as a result of engines running on them.

However, this new system is a technology that yields products equivalent to light fuel oil from waste cooking oil based on a catalytic cracking technique used in petroleum refining, etc., and thus, such problems do not occur. Specifically, when the waste cooking oil is fed in droplet or spray form in the presence of a heated catalyst under near-normal atmospheric pressure conditions, a decarbonization reaction takes place on the catalyst, causing much of the triglycerides to form light fuel oil constituents (for example, $C_{17}H_{32}$, $C_{17}H_{34}$, $H_{17}H_{36}$, etc.). Other by-products generated include carbon monoxide or carbon dioxide, and C2-to-C4 lower olefins (Figure 4). The C2-to-C4 lower olefins can be effectively used as a heat source for the reaction furnace. Another of the major advantages of this system is that, because it uses no chemical products other than waste cooking oil, it does not use chemicals such as methanol or acids/alkalis, etc., and its negative environmental impacts are extremely low.

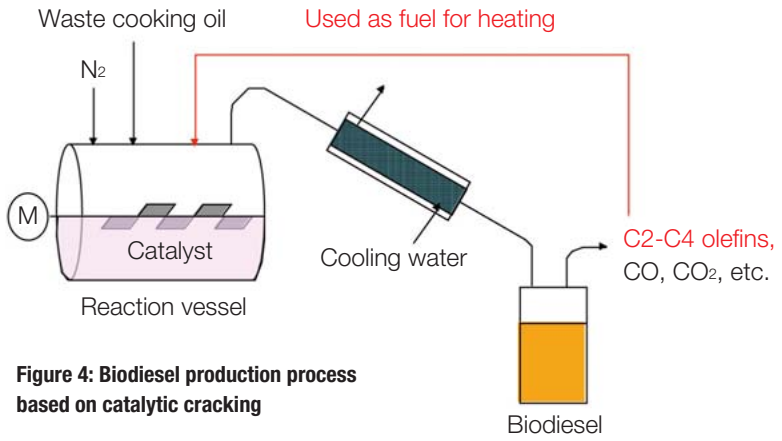


Figure 4: Biodiesel production process based on catalytic cracking

Benefits

Biodiesel differs from light fuel oil refined from petroleum in that it is produced from renewable plant or animal oils and fats. Therefore it is beneficial in reducing the level of greenhouse gas emissions by reducing the amount of petroleum used. In addition, exhaust gases from engines that use biodiesel typically have a lower impact on the environment compared to using light fuel oil. Also, in times of sharp rises in the price of petroleum, biodiesel is economically useful as substitute fuel. For reasons such as these, biodiesel is attracting attention around the world.

In particular, we intend to focus on spreading the use of biodiesel production facilities that use waste cooking oil as a feedstock. In addition to the advantages of using biodiesel itself, there are the added advantages of being able to effectively use waste cooking oil as a feedstock. Much of this waste cooking oil is discharged into sewer systems or rivers, or is disposed of as waste. Making it into a feedstock for biodiesel recycles a waste product and works to utilize waste in the most effective manner. Reducing the amount of waste oil entering the sewer system minimizes the burden on wastewater treatment plants, and can also reduce the amount of waste disposed of as sludge, etc. Also, reducing the amount of waste oil discharged into rivers and streams is directly linked to improved water quality in rivers and streams. Also, when feedstock for biodiesel is made by growing oil-bearing crops, problems such as the destruction of the natural environment to develop this cropland, and competition between food and oil-bearing crops become apparent, but no such problems occur with waste cooking oil. Points such as these are the specific benefits of producing biodiesel using waste cooking oil.

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