Biodiesel Fuel from Palm Oil

Too Good to Be Used as Fuel?

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The high prices for oil and gas have spotlighted other sources of fuel for internal combustion engines. Biofuel, a fuel derived from ethanol, and biodiesel fuel, a diesel-equivalent derived from biological sources, are 2 possible substitutes for petrochemical fuel. Palm oil is increasingly used as feedstock for the production of biodiesel, but certain palm oil fractions have other uses, e.g., in the cosmetics and food industries. Sulzer Chemtech's technology supports the separation of crude palm oil (CPO) in its valuable constituents.

Biodiesel is composed of fatty acid methylesters (FAME) from transesterified vegetable or animal fats and oils. In organic chemistry, transesterification is the process of exchanging the alkoxy group of an ester compound by another alcohol. Biodiesel fuel produced from recovered domestic, gastronomic, and industrial waste vegetable oils (WVO) is already established on the market. For large-scale production, however, different sources are currently being tested, with straight vegetable oils (SVO) becoming more and more important.

Palm oil, which currently has an annual global production of more than 30 million tons, is increasingly used as base feedstock for biodiesel (Fig. 1 and box). Stock

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market prices for refined, bleached, and deodorized (RBD) palm oil are in the region of USD 600 per ton, making it an attractive option in the view of high petroleum prices.

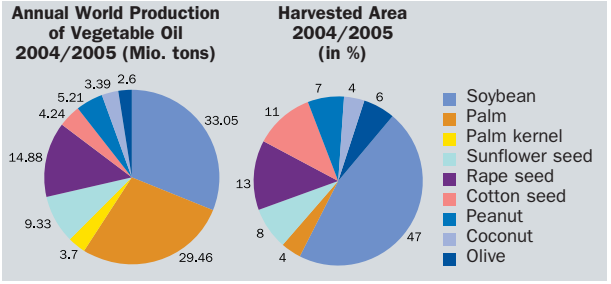
For biodiesel production, Sulzer Chemtech supplies packages for the methanol recovery and in certain cases glycerol purification.

Palm Oil Suitable for Winter Use

For use in nontropical countries, however, biodiesel fuel based on palm oil has the disadvantage of a high pour point of around 12 °C, which can lead to blockage of the fuel injection system. The main cause for this behavior is methylpalmitate, which is present in high quantities and has a high melting point of 30–33 °C. Therefore, it is necessary to further blend or process such biodiesel.

The adaptation of biodiesel fuel for cold-climate use, also called winterization, lowers the pour point. In the case of palm-oil based biodiesel, winterization is accomplished by removing a fraction, if not all, of the methylpalmitate. During this process, the methylpalmitate is purified to a high degree (Fig. 2).

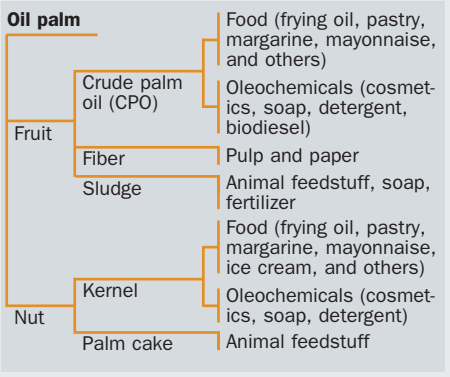
Pure methylpalmitate is a valuable raw product for further processing



1 Palm oil will soon pass soybean oil as the most produced vegetable oil worldwide. Sulzer Chemtech has technology and equipment that help to separate the oil into its various valuable fractions.

Palm Oil: Food and Fuel

The oil palm (Elaeis guineensis) grows in a tropical belt of about 10° latitude north and south of the equator. Especially in Malaysia and Indonesia, the cultivated area has grown rapidly in recent years, mostly from conversion of plantations of other economic crops. The trees are productive for up to 25 years. Each year, large bunches of palm fruits are harvested from the mature trees. These fresh-fruit bunches (FFB) contain up to 3000 plum-sized fruits. Each fruit consists of a hard kernel inside a shell. The crude palm oil (CPO), a yellow-red liquid, is extracted from the flesh of the palm fruit. In the harvested fruit, fatty acids build up rapidly, making the oil rancid and sour. Therefore, the processing mills for the flesh have to be located close to the plantations. The kernel is processed in kernel crushing plants, where the palm kernel oil (PKO) and palm kernel meal (PKM) are extracted. CPO and PKO differ in their chemical compositions. CPO contains about 50% saturated fats while PKO contains about 80% saturated fats and a high content of lauric acid, which, due to its melting properties, makes PKO very well suited for the use in food production. Twenty percent of CPO and 70 % of PKO are used for non-food (oleochemical) applications. Palm oil and palm kernel oil have 2 major nonfood uses—using the oils directly or processing them to oleochemicals. Oleochemicals are chemicals derived from biological oils or fats; they have uses similar to those of petrochemicals, which are chemicals derived from petroleum. CPO is used directly in soaps, plastics, drilling mud, and palm-based biodiesel. The oleochemical applications of CPO include soap, detergents, rubber, skin care products, rubber, and cleaning products.



Annual production of palm oil in million tons

Indonesia	14.00
Malaysia	15.19
Nigeria	0.79
Thailand	0.76
Colombia	0.65
Papua New Guinea	0.38
Ivory Coast	0.34
Ecuador	0.34
Costa Rica	0.24
Congo, Democratic Rep.	0.18
Others	1.17
Total World	**34.04**

The oil palm has a wide range of uses as fuel and in the food, cosmetics, and chemical industries.

2 Crude palm oil (CPO) and purified biodiesel (front) processed in the Sulzer Chemtech fractional crystallization plant in Buchs (CH). The solid fractions of CPO are important raw material for the oleochemical industry.

into higher alcohols, e.g., isopropyl-, 2-ethylhexyl, glycolesters. These alcohols have a wide range of applications as technical oils in cosmetics, food, pharmaceuticals, etc.

Smooth Distillation Process

As a product from a natural source, CPO is less stable than petroleum. Therefore, the temperature during the distillation must be controlled precisely to avoid destroying any ingredients of the palm oil during the process.

CPO contains up to 5% free fatty acids (FFA), which must be removed by a physical refining process in order to produce RBD palm oil. Without this process, the oil would be practically inedible, have a short shelf life, and decompose further due to an autocatalytic reaction promoted by the FFA themselves. The fatty-acid stripping, partial bleaching, and deodorization are done in a palm oil stripper.

Preheated CPO enters the stripper column, which is equipped with structured packings and operated at very low pressure. There, the FFA are stripped off by introducing stripping steam in the bottom and then condensed in the scrubbing section on the column top.

3 A palm oil stripper with Sulzer internals on its way to the refinery.

No Thermal Degradation

Today, even the industrial-scale purification of nonsaturated C18 methylester (methyloleate, methylinolate, etc.) to reasonable purity is possible due to a much smoother distillation process. Thermal degradation can be avoided, because the boiling point of an equivalent methylester is about 20 °C lower than that of the free fatty acid, and the use of state-of-the-art column internals allows much smoother operating conditions.

Palm-based biodiesel contains a high concentration of tocotrienol, a potential source of natural vitamin E. Tocotrienols are potent antioxidants; in some cell culture and animal studies, they have exhibited anti-cancer properties. Once further purified, they can be used, e.g., as supplements to cattle food, but also as sun blockers in cosmetic products.

Other interesting components are carotene and phytosterol. Phytosterol, a natural cholesterol-lowering agent used in functional food, is purified to a high degree by fractional crystallization (see STR 1/2006, p. 4).

All these ingredients accumulate in the heavy residue of the distillation.

High-Value By-Products

Palm-oil based methylesters must be split into several different products for further processing before the palm oil can be used as biodiesel fuel. The by-products are high-value raw materials and have their main applications in market segments other than fuels. Therefore, fluctuations in fuel prices can be evened out with earnings from other palm oil fractions.

Long Experience

Sulzer Chemtech—with several decades of experience in oleochemical processing—can offer solutions that satisfy the requirements of distillation technology using the high-capacity and high-efficiency structured packings MellapakPlus™ and BXPlus™.

A pilot and demonstration plant for these applications is currently under construction in South East Asia. Additionally, Sulzer Chemtech has supplied more than 300 palm oil strippers and 500 columns for oleochemical distillation in recent years (Fig. 3). Installed refining capacity based on Sulzer supplies alone is estimated to be between 18 and 20 million tons per year. ◀

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