Student Reference Sheet: Engineering Solution

Growing Algae for Biodiesel Use

Many companies all over the world are trying to answer this question: How can we produce enough algae to meet the ever-increasing demands for biodiesel? The most natural method of growing algae in large quantities is through open-pond growing. Algae can be grown in open ponds in hot, sunny areas of the world to get maximum production. This growing technique is safe for the environment. However, bad weather can hinder algae growth. Contamination from bacteria or invasive species can also stunt the algae's growth. The water in which the algae grows also has to be maintained at a certain temperature.

Biofuel companies have developed another method for growing algae called vertical growth/closed loop production. Algae is placed in clear, plastic bags, so that it receives sunlight on two sides. The bags are then stacked and covered to protect them from the rain. The extra exposure to the sun increases the productivity rate of the algae. The algae is also protected from contamination. Another method for growing algae is the closed-tank bioreactor. These plants are built with large, round drums in which algae can grow under ideal conditions. Researchers are also testing how adding sugar to the closed tank promotes algae growth. However, obtaining enough sugar without creating problems remains a challenge.

Algae Biodiesel Engineering: Extracting Oil from Algae

Getting oil from algae is kind of like getting juice from a lemon, with a chemical reaction thrown in. Once the algae is harvested, the lipids are extracted from the cell walls. The oils can be extracted in several ways. The simplest and most popular way to extract the lipids is by pressing, which is done in a manner similar to the olive press. An oil press can extract up to 75% of the oil from the algae being processed.

Another method of extracting lipids from algae is called the hexane solvent method. After the oil is pressed out of the algae, the leftover algae is mixed with hexane, filtered, and cleaned so that no chemicals are left in the oil. This method removes about 95% of the oil from the algae being pressed.

The supercritical fluids method can extract 100% of the oil from the algae. In this method, carbon dioxide is used as a supercritical fluid (when a substance is pressurized and heated to change its composition into a liquid as well as a gas). When this occurs, the carbon dioxide is mixed with the algae, turning them completely into oil. This method requires specialized equipment and requires extra effort, making it less popular.

Once the lipids are extracted, they are refined using fatty acid chains in a process called transesterification. A catalyst such as sodium hydroxide is mixed with an alcohol such as methanol. This creates a biodiesel fuel combined with glycerol. The glycerol is removed through another refining process. The final product is algae biodiesel fuel.

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The Pros and Cons of Algae Biodiesel

It seems like using algae to make biodiesel is a perfect alternative to petroleum—an abundant, natural material is grown, pressed, chemically altered, and blended into a clean, efficient fuel. However, there are some cons to using algae to produce biodiesel.

First, open-pond growing is a risky business. The water has to be at an exact temperature. Carbon dioxide has to be pumped into the ponds, and there is a high risk of contamination. Many biodiesel labs are solving these problems by using the closed bioreactor. Another problem is that there hasn't been any real testing done with algae biodiesel and actual cars. However, companies worldwide are in the process of making deals with oil companies to produce and test the algae biodiesel. Whatever happens, the search for a cleaner, renewable fuel for our cars is exciting! Maybe, you will be the scientist or researcher who makes this fuel usable in the future.