

How To Make Biodiesel

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Background

As more and more scientific evidence accumulates, it is becoming increasingly clear that the use of petroleum fuels and the green house gases associated with them are doing damage to the global climate. Carbon existing in the oils stored within the Earth's crust are burned and released into the atmosphere faster than it is replenished by natural forces. Biofuels, on the other hand, are constructed from carbon taken from the air in the form of plant matter. This leads to a balanced cycle where carbon is taken from the air in equal amounts to that when it is burned as fuel. Due to this more balanced cycle, it is critical for biofuels such as biodiesel to replace as much fossil fuels as possible. The following diagram gives an overview of the processes involved in biodiesel production starting from vegetable oil. The rest of the document is dedicated to explaining biodiesel production more broadly.

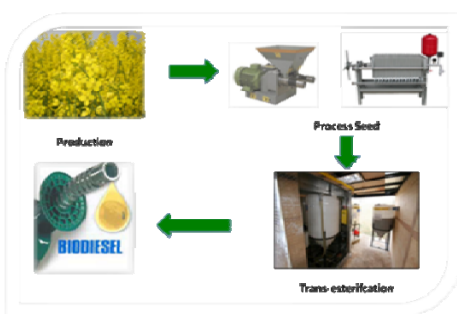


Figure 1: Basic overview of biodiesel production from canola oil

Step 1: Oil Collection

- Oil, the main ingredient in biodiesel, can come from numerous sources
- Often times waste vegetable oil can be collected directly from a restaurant for little to no cost as it is considered a waste as the name suggests (1)
- Oil can also be extracted directly from certain field crops using a number of different known processes
- Crops commonly used to produce oil include soybeans and canola. There exists many more oil producing crops whose oils can produce biodiesel with different characteristics.
- Cold press extruders can be used for oil extraction, where the seeds are put under an immense amount of pressure which squeezes out the oil.
- The remaining part of the seed is called meal and can be used as a protein source for livestock feed
- Large scale biodiesel production sites usually use a chemical method of oil extraction known as hexane extraction

Step 2: Oil Cleaning

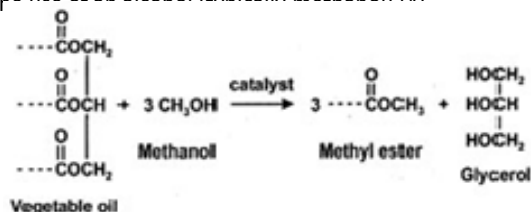
- Most oils need to be cleaned thoroughly before they can be made into biodiesel
- Solid Particles from Waste Vegetable Oil and crushing need to be filtered out
- Water must be removed from the oil for the biodiesel to be of high quality
- Several chemical and physical processes can be used for water removal, but the most common is called head-space desiccation

Step 3: pH Adjustment of Oil

- Titration ensures that the correct amount of catalyst is added to the reaction to allow all of the triglycerides in the oil to be converted into biodiesel
- The amount of catalyst needed for specific scales of production can be calculated using an excel spreadsheet downloadable at bioenergy.msu.edu/processes/portable_biodiesel_unit
- Using data from the titration procedure, mix methanol and catalyst (we have been using potassium hydroxide)
- The methoxide mix goes into the smaller cone bottom tank to be injected into the reactor tank

Step 4: Transesterification

- Transesterification is the name of the reaction that converts vegetable oil into biodiesel
- During the reaction, the oil which is predominately made up of triglycerides are split into glycerol and fatty acid ethers (biodiesel) with the use of an alcohol (usually methanol) (1)



- The reactor tank will heat the oil to 120°F and circulate the oil and methoxide mix for two hours

Step 5: Washing & Cleaning

- Once the oil has been converted into biodiesel, the glycerin must be separated from the mixture
- Glycerin is a byproduct of transesterification, but is of low value so it is commonly disregarded unless the process is large scale
- Gravity separation of glycerin and biodiesel is easy as glycerin will settle and can be drawn off the bottom of the reactor tank
- Water washing is the cheapest way to remove any excess methanol and catalyst. After washing twice, circulate the biodiesel and heat to about 90 degrees F for about 1.5-2 hours until the biodiesel is clear and all water has evaporated
- Dry solids such as sawdust can achieve the same result as water but must be filtered out before the biodiesel can be used

Step 6: Quality Testing

- it is critical to test the quality of the biodiesel before it is used
- Sources of impurities are commonly associated with too much water in the fuel or incomplete conversion of oil to biodiesel
- Kits exist to test for all of the characteristics of biodiesel and should be used for every batch. If the biodiesel is to be burned in cold temperatures you will want to test for cloud point and mix with petroleum diesel at not more than 5% rate