



Biodiesel

A Renewable Fuel

What is Biodiesel?

- Biodiesel consists of alkyl-esters derived from a biological source.
- Biodiesel can be used as a diesel fuel in any existing diesel engine.
- Can be blended with petroleum diesel in any ratio.

What is Biodiesel?

- Vegetable oils, such as soy, rapeseed, and palm, are the most commonly transesterified commercial oils.
- Almost any oil can be converted; hydrogenated oils and animal fats do not work efficiently in cold weather.
- Oil from algae grown on waste water is a highly sustainable possibility.

Why Biodiesel?

- It's Renewable!

Why Biodiesel?

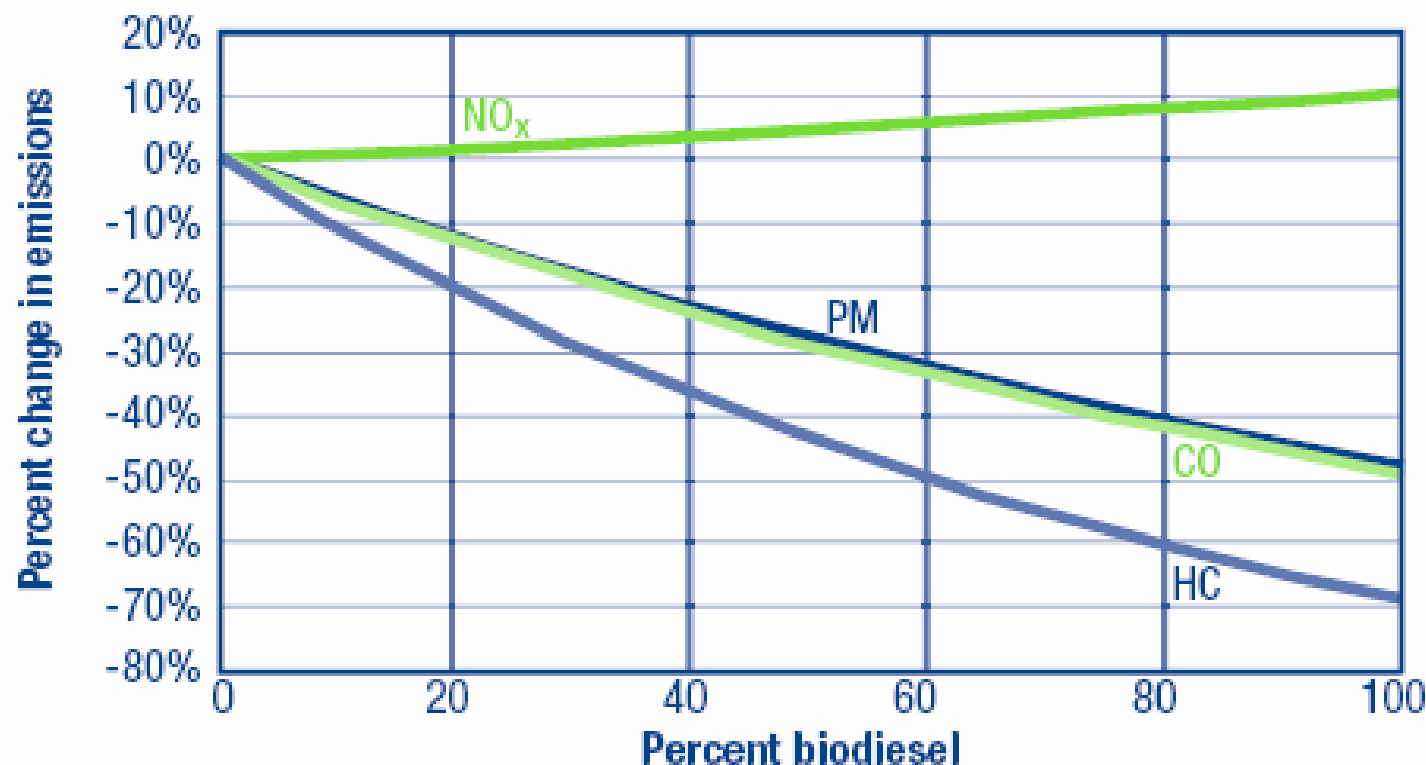
■ Reduced air pollution

- ⊙ Sulfur emissions are essentially eliminated
- ⊙ EPA Criteria pollutants are reduced
(unburned hydrocarbons, carbon monoxide,
and particulate matter)
- ⊙ The Nitrogen oxides (NO_x) issue

Effects on Air Quality

- ◉ Reduces health risks associated with petroleum diesel: 75–85% reduction of polycyclic aromatic hydrocarbons (PAH) and 90% reduction of nitrated polycyclic aromatic hydrocarbons (nPAH).
- ◉ These have been identified as potential carcinogens

Biodiesel Vs Petroleum



Basic Emission Correlation. Average emission impacts of biodiesel for heavy-duty highway engines. Source: U.S. EPA².

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL, ACCORDING TO EPA

Emission Type	B100	B20
<u>Regulated</u>		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
Nox	+10%	+2% to -2%
<u>Non-Regulated</u>		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

* Estimated from B100 result

** Average reduction across all compounds measured

*** 2-nitroflourine results were within test method variability

Source: EPA Emissions Evaluation for the National Biodiesel Board

Why Biodiesel?

■ Non-toxic

- LD50 of 17.4 g/kg
 - ten times less toxic than table salt
- Less skin irritation than a 4% soap solution
 - very mild irritation
- Insignificant aquatic toxicity
 - 1000mg/L is lethal to bluegill

The Methanol Issue

- ◉ Methanol is required in the production of BD.
 - ◉ Methanol is a **flammable neurotoxin**
 - ◉ However, so is gasoline (a quite common fuel)
- similar precautions must be used when handling, transporting, or producing methanol:
- no sparks
 - no smoking
 - proper ventilation
 - proper safety equipment: gloves, goggles, etc.

Environmental Benefits

■ Biodegradable

- In fact, Biodiesel degrades at the same rate as Dextrose, a sugar molecule

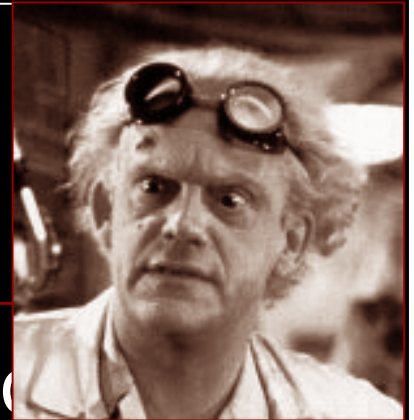
■ Homegrown

- Can be grown from local high oil yielding crops, lots of botanical potential
 - A chance to get creative in oil crops
- Possibly even grown on native high oil algae

Some other important considerations

- **Fits existing fuel infrastructure**
 - Runs in current diesel engines
 - Can be stored at existing petrol stations
 - Can be transported like petroleum diesel
- **Higher flashpoint than petroleum diesel**
 - Classified as non-flammable by OSHA (150 °C)
 - Safer to handle and transport, safer in accidents
- **Provides lubricating properties**
 - Reduces engine wear
 - Extends engine life

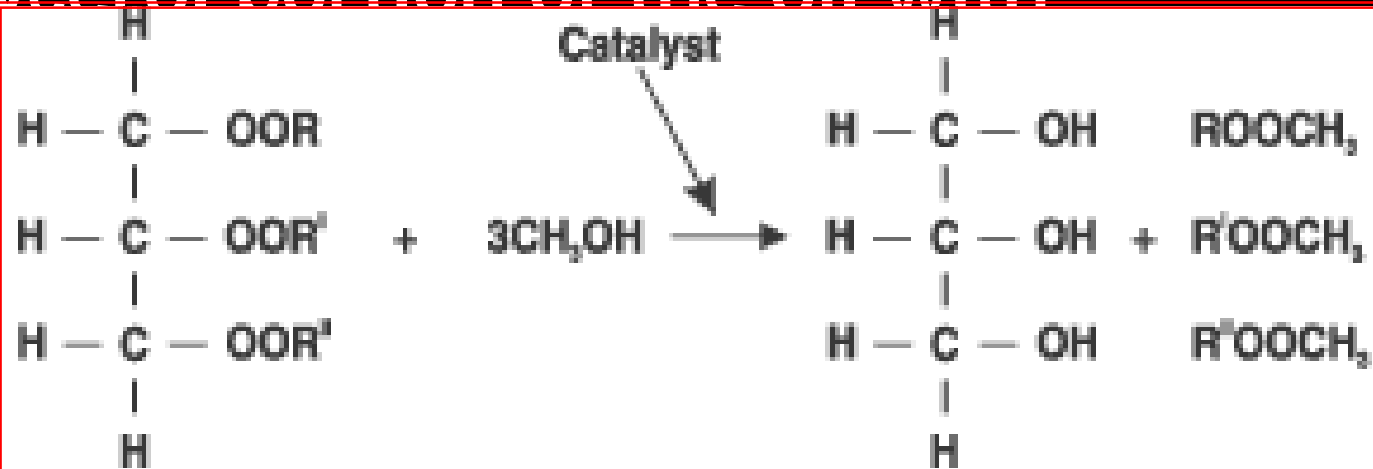
How is Biodiesel Made?



- It is produced by a transesterification reaction of **vegetable** (or **animal**) **oils** with a low molecular weight **alcohol** such as **methanol** or **ethanol**.
- This reaction is catalyzed by a **base**, Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH)

What the Heck is Transesterification?!

- So, Basically you have the reaction:
- Oil + Alcohol = glycerol + Alkyl esters (Biodiesel)
- (It must be catalyzed with a base and heat)
- This is the process of transesterification: **replacing the glycerol portion of the oil with**



Vegetable Oil + Methyl Alcohol \longrightarrow Glycerol + Methyl Ester

Making Biodiesel

