Biodiesel Emissions

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Submitted to:
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Abstract

The main process involved in creating Biodiesel is transesterfication. Transesterfication is the process of reacting a triglyceride molecule with an excess of alcohol in the presence of a catalyst (KOH, NaOH, NaOCN3, etc.) to produce glycerin and fatty esters. With the power of transesterfication I will make sample batches of Biodiesel from straight vegetable oil and old vegetable oil. With this I will test the emissions of Biodiesel and compare it to the emissions of regular diesel and see which fuel is more environmentally stable. If all goes well most emissions should be cut down by 50% while others 100% and a few under 10%.

History

1985 marked the creation of the first diesel engine created by Rudolf Diesel. In 1990 he showed the engine in 1900 the catch is that engine was not running on diesel but actually Peanut Oil proving that the diesel engine was made to run on forms of vegetable oil. Why do a project on Biodiesel well the interest is there.

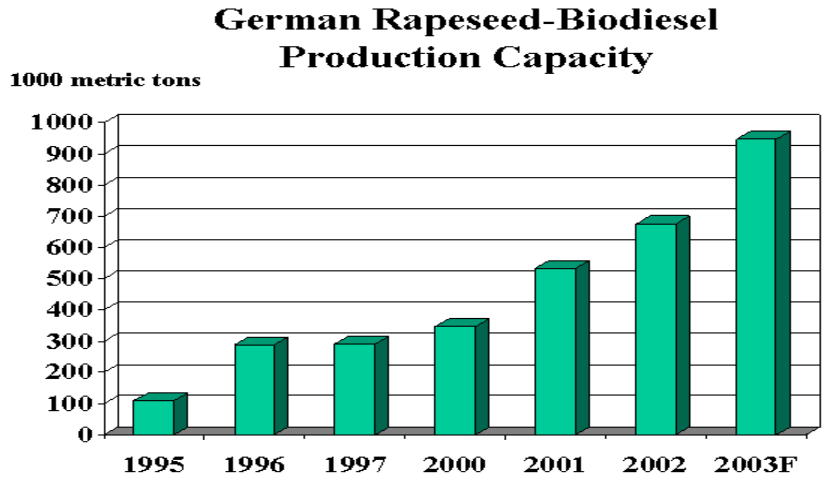
The main reason is the recent peak prices in regular fuel and diesel also the increase in sales of diesel because they are reliable and get far more miles to the gallon than regular fueled cars. As well the greenhouse effect is reason for an increase in non-petroleum fuels.

The greenhouse effect refers to the ability of the gases in the Earth's atmosphere to keep the planet warm. Evidence shows that we have amplified the greenhouse effect by emitting billions of tons of greenhouse gases. For example every gallon of gasoline that a car burns 22 pounds of carbon dioxide are released into the atmosphere. So if you

have a car that holds around 13 gallons of gasoline you burn 286 gallons of carbon dioxide.

The levels of carbon dioxide in the atmosphere today are higher than they have been in 160,000 years. In the graph below you can see the increased interest in biodiesel in Germany.

In the 1970s and early 1980s, where when problems concerning high petroleum prices began to rise. This is when experimentation with fats and oils as alternative fuels began. Which primarily focused on directly using fats and oils as either a fuel or in blends with diesel fuel. In the end it flopped because it led to gradual engine degradation.



Source: Union for the Promotion of Oil and Protein Plants

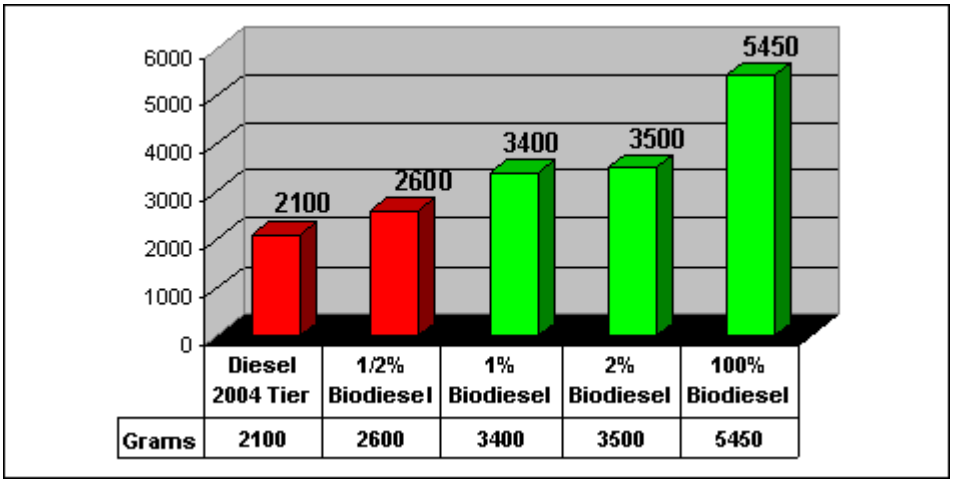
F: forecast

Renewable Fuel Advantages

The solution is biodiesel. Biodiesel has lower greenhouse emissions and it gets more miles to the gallon than regular diesel. The first advantage of biodiesel is that there is and infinite supply of renewable energy. For example every hour that sun hits the earth it creates enough energy to fuel all of humankinds activities for one year.

The next advantage is that renewable fuels strengthen the economy. The renewable fuels industry has the ability to provide over a million jobs, and add over 50 billion to the economy each year.

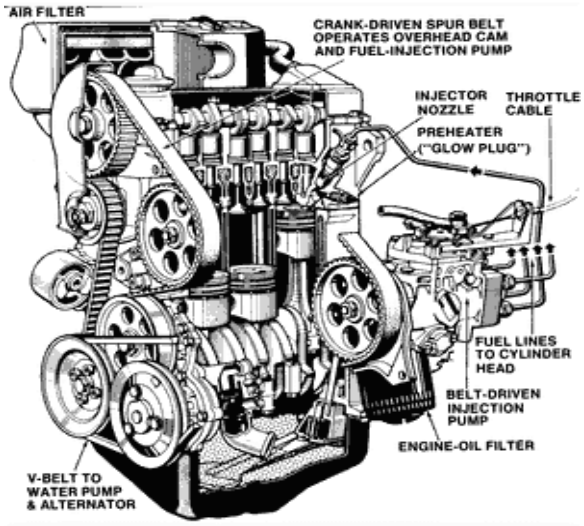
Finally the third advantage is that renewable fuels are carbon neutral, which means that plants capture all the carbon dioxide emitted by renewable fuels turning it into oxygen and returning some carbon dioxide back to the ground. Basically the plants naturally balance the carbon dioxide emissions. Now you may want to now where your money goes when you buy diesel or gasoline well 34% goes to crude oil, 26% to the refinery, 13% to federal excise tax, 13% to state excise tax, 7% to state sales tax, and 7% to the dealer. So more than 1/3 of the money spent at the pump goes overseas. Another advantage is that biodiesel adds lubrication to the cars engine which is always a great benefit.



Diesel Engines

There are some engines that are not compatible with biodiesel. For starters you can not put it in gasoline fueled cars, or diesel engines with turbo interjectors because they can burn diesel like regular fuel and biodiesel is to thick to be burned in such a way.

The best is to have your standard diesel engine it has the best success with any form of vegetable oil you can even pour straight vegetable oil into the car and it will run.



Biodiesel Advantages

The benefits of biodiesel are endless. As I stated before biodiesel adds lubrication which restore lubrication the fuel which is good replacement for sulfur it also increases the life of an engine. Before diesel engines were lubricated to with sulfur but when diesel fuel was burned it emitted sulfur into the air, which is a leading contributor to acid rain.

Next biodiesel has a favorable energy balance ratio. An energy balance ration is a comparison of energy stored in fuel to energize the requirement to grow, process, and distribute the fuel. The energy balance ration for biodiesel is 2.5 to 1. So for every unit of energy put into fuel, feedstock, extraction, refining, processing, and transporting there is at least 2.5 units of energy contained in biodiesel. Biodiesel has such a positive ration because it is an efficient carrier of solar energy.

Next is that biodiesel can be mixed with regular diesel. The most common blend is B20, which is 20 percent biodiesel and 80 percent diesel. Which is used in most

vehicles involved in transporting, as well the Army, and the Navy are making it a standard to have vehicles and boats compatible with biodiesel.

On top of all this biodiesel is biodegradable and non-toxic. A study was down and showed that biodiesel degrade up to four times faster than standard petroleum diesel with up to 98% biodegration in three weeks.

Vegetable Oil Production (Billion pounds/yr)	
Soybean	18.340
Peanuts	0.220
Sunflower	1.000
Cottonseed	1.010
Corn	2.420
Others	0.669
Total Veg. Oil	23.659
Animal Fats (Billion pounds/yr)	
Edible Tallow	1.625
Inedible tallow	3.859
Lard & Grease	1.306
Yellow Grease	2.633
Poultry Fat	2.215
Total Animal Fat	11.638

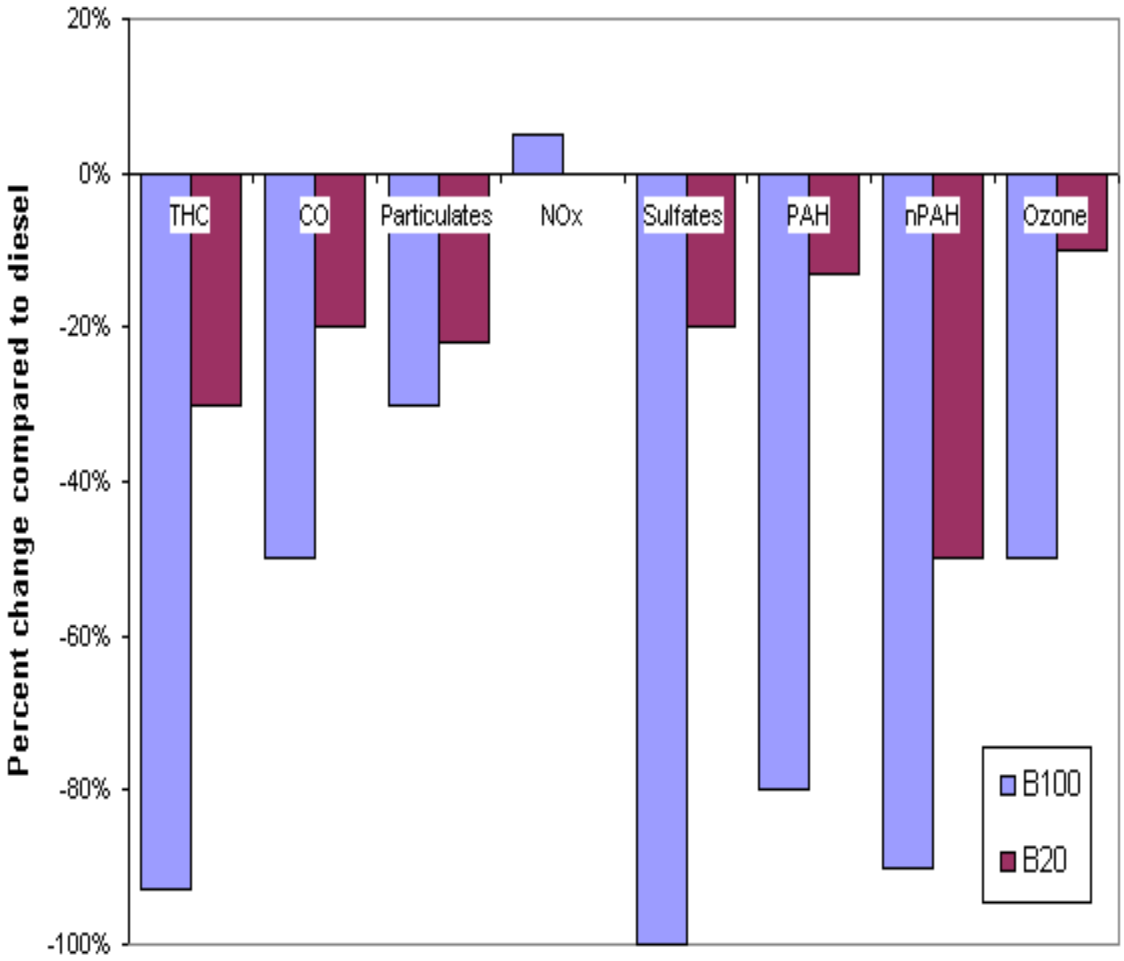
The fifth advantage is that transporting biodiesel is extremely safe. Biodiesel wont spontaneously explode or ignite because of the fuels high flash point. Biodiesel must be at least 300 degrees F to ignite. While diesel will ignite at 125 degrees F.

Finally the sixth advantage is that biodiesel can be stored anywhere that diesel is stored also biodiesel can be made from waste vegetable oil from restaurants like your local McDonalds.

Biodiesel Emissions

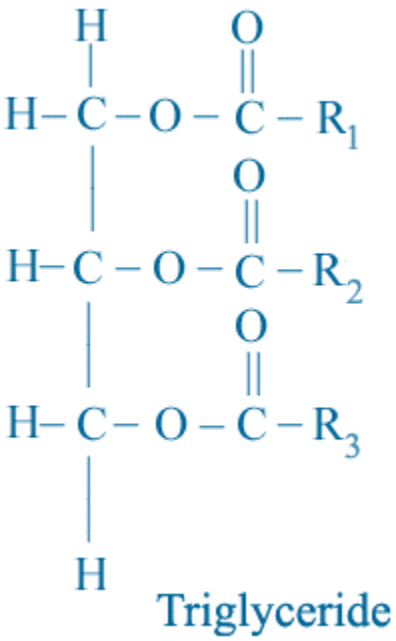
The reason I took interest into biodiesel is how much of an effect it has on emissions compared to petroleum diesel. Biodiesel reduces carbon dioxide emissions by 100%, sulfur reduces by 100%, soot emissions reduces between 40-60%, carbon monoxide reduces between 10-50%, a reduction of all polycyclic aromatic hydrocarbons,

phenanthren by 97%, benzofloroanthen 56%, benzapyren by 71%, aldehydes and aromatic compounds by 15%, and nitrous oxide emissions between 5-10%. (the amount of nitrous oxide depends on how old the engine is and how well the engine turns)



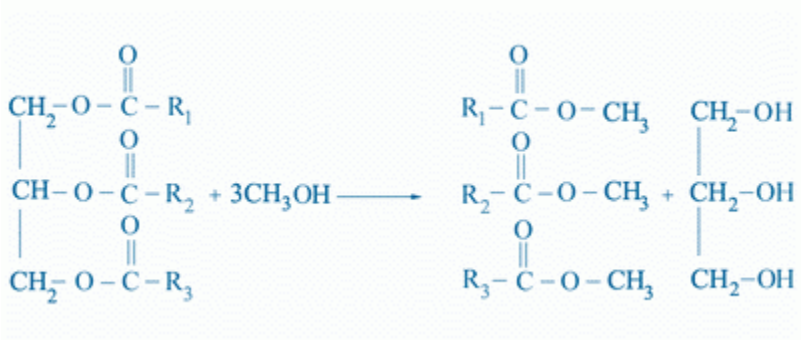
The Chemistry

Biodiesel is fairly easy to understand. First the basics: All vegetable oils and animal fats consist of triglycerides as shown below.



Triglyceride

Triglycerides are glycerides in which the glycerol is esterified with three fatty acids. They are the main constituents of vegetable oil and animal fats. Biodiesel consists of the monoesters formed when the triglycerides react with an alcohol such as methanol. Which is the most common made biodiesel made with methanol. Now most people make biodiesel through a process called tranesterfication. Transesterfication is the process of reacting a triglyceride molecule with an excess of alcohol in the presence of a catalyst (KOH, NaOH, $NaOCN_3$, etc.) to produce glycerin and fatty esters. The chemical reaction with methanol as shown below.



In the transesterification reaction above one mole of a triglyceride reacts with 3 moles of methanol to produce three moles biodiesel and one mole of glycerol. The mole of triglyceride will weigh about 884 grams, and the three moles of methanol will weigh about 96 grams becoming three moles of biodiesel, which will weigh close to 888 grams. Then the mole of glycerol will weigh about 92 grams. When making biodiesel it is better to add from 1.6 to 2.0 times the amount of methanol to ensure that the reaction is completes. This means that you will have to separate the left over methanol and glycerin from the biodiesel.

Economics

The next big thing about biodiesel is that it is far more inexpensive than standard diesel. The main expense for biodiesel is the feedstock which can cost anywhere between 1.10 and 1.83 a gallon of biodiesel. Now if you choose you can make biodiesel on your own costing you anything from free or to the amount a restaurant would charge you for taking their vegetable oil, which could run you in the 79-cent range. Which is far more inexpensive than the going rate of biodiesel that is roughly 1.60-1.80 a gallon. A benefit from this is biodiesel byproduct glycerin that can be sold to manufactures for the use of soap and fragrances. Or if you choose you can make your own soap.

Saponification

To make soap from glycerin it is a fairly simple process. First you must heat the mixture past 148 degrees F that is the boiling point of methanol. This will boil any alcohol out of the mixture. (do under a vent hood or well ventilated area) Then allow the mixture to boil for 10 minutes to evaporate any water that might be in the mixture after this let the mixture sit and harden. (Fragrances can be added) one the mixture has harden you have officially created usable soap.

The Future

What does the future have in store for us in the world of diesel engines and fuels well there are many things. First things first is that Ford, Chrysler, and Navistar are getting involved in a joint research project and development of a NEW breed of diesel engines. Because of their super low emissions and amazing efficiency automakers are calling these engines “green Diesels” the name hinting at how much they would be for the Earth’s atmosphere.

Hybrids are also works of the present and future. Hybrid engines are two engines; one engine is electric and the other diesel or gasoline powered. Gasoline powered hybrids have come out and have become a large fad amongst environmentalists. Some hybrid diesel vehicles have been made but only for trucks for companies such as UPS. The hybrid in sedan form with a diesel engine is predict to put almost a 100 miles to the gallon saving many a person a lot money. But that amount of mileage can only be gained if you are running the car on biodiesel.

Procedure

To make a mini batch of biodiesel with new vegetable oil, first you need to measure out 3.5 gm of NaOH out on a petri dish. Then pour one liter of vegetable oil into a 1500ml graduated cylinder and pour 200ml of methanol into a 2000ml flask. Afterwards you want to add the NaOH to the methanol as soon as the NaOH dissolves add the vegetable oil into the methanol NaOH mix, you want to mix this for 15 minutes on the highest setting possible. Let everything settle for 8 hours, after the reaction has

settled for 8 hours you want to separate the by product glycerin from the mix and store the biodiesel. You can also keep the glycerin to make soap.

To make a mini batch of biodiesel from waste vegetable oil it is all the same step except for the amount of NaOH. You have to perform a Titration to find out how much NaOH you need to dissolve the extra fatty acids from the waste vegetable oil (WVO). Measure 1 gm of NaOH on a petri dish then pour 1 liter of water into a 2000ml flask and dissolve the NaOH (0.1% lye solution) in it. Pour 10ml of isopropyl alcohol into a 200ml beaker then add 1ml of cooled. Warm the beaker on a hot plate slowly and stir the mix until all the oil dissolves and turns clear. Add 2 drops of phenolphthalein solution so you can test the ph. Use a graduated syringe an add 0.1 NaOH solution one drop at a time to the solution keep stirring at the same time. Keep adding the 0.1 NaOH solutions until the oil mix turns pink and stays pink for 15 seconds. Take the number of milliliters of 0.1 NaOH solution you used and add 3.5 grams of NaOH to that and that is the number of gm you need per liter of WVO.

How to make soap. Heat glycerin past 148 F and keep it heated for 10 minutes. To make the soap hard you must add NaOH to your solution. You must divide the amount of grams of NaOH used by how many liters of glycerin where produced that will be called Then you take C and minus that from 70 that’s L. you take L*4 liters of glycerin= 180 g of NaOH. Then just let it settle and harden for a week.

Materials

- 500 mL Beaker
- Stopcock Valve
- Mixer
- Straight Vegetable Oil 1 Liter
- Used Vegetable Oil 1 Liter
- 200 mL Methanol
- 3 g of Lye (NaOH)

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