Biofuel For the Community

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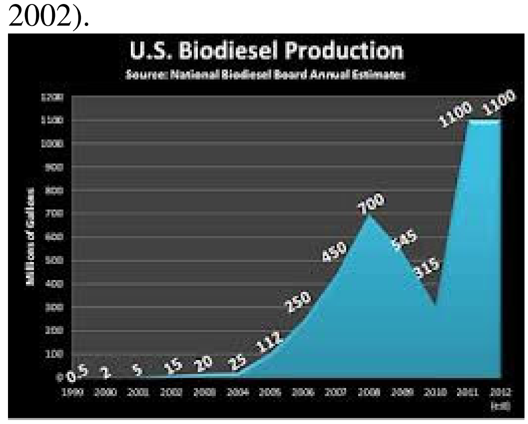
Each year, Americans waste over 40% of all food imported or produced (Gunders, 2012). Over the past several months, our team has been working on a solution to this wasteful process, as well as fuel pollution, fuel productivity, and the prices of these fuels. By turning our school's cafeteria leftovers into biodiesel, we would create a sustainable fuel source and remove much of the wasted food.

Biodiesel has become a very popular alternative fuel source in many of the European countries (Macalister, 2012). There are several methods to create a biofuel, each of which yields slightly different results. We have decided to test if we can take wasted foods and turn them into biodiesel; doing this would reduce the amount of wasted food and reduce pollution as well (Press, 2013). Due to the current oil crisis, many people are searching for an alternate way to power their lives. As scientists and engineers conduct experiments to find a good source, biodiesel emerges as one of the top contenders. U.S. production of biodiesel was 57 million gallons in November 2012 (fig. 1) (Energy, 2013). These numbers are great, but they don't even come close to the amount of fuel produced through conventional methods. The U.S. is the third highest oil-producing country in the world, with 10.1 million barrels a day. Total, the world's top 5 producers produce over 40 million barrels of oil a day (Koch, 2012). If, we keep burning through oil at this rate we will eventually run out, and we will not be able to replenish it. Current projections show that gasoline will likely peak around 2020 (Campbell, 2002).



(Fig. 1) *Chart showing the increase in biodiesel production since 1999 (biodiesel.org, 2013)*

There is also the dilemma of our wasted food. In the U.S., we waste about 40% of our food (Gunders, 2012). So, while we are using too much fossil fuel, and wasting all this food, others have been taking advantage of the biodiesel industry. We decided to take the best of both situations, and create a biodiesel out of our school's leftover lunch food. If the process we have used was spread throughout the country, the amount of wasted food would dramatically decrease. We believe that people would happily embrace this change, as there would be countless benefits and very few drawbacks. There would also be new jobs created in this field. Factories would be a great production environment for our biodiesel, and the fuel would be much easier to come by as production increases.

There would also be major benefits in the efficiency of the fuel. The benefit of using biodiesel is proportionate to the blend level of biodiesel used. Substituting B100 for petroleum diesel in buses reduces the life cycle consumption of petroleum by 95%. A 20% blend of biodiesel and petroleum diesel (B20) causes the life cycle consumption of petroleum to drop 19% (Sheenan, 1998). There is also quite a reduction of the CO2 emissions. Biodiesel reduces net CO2 emissions by 78.45% compared to petroleum diesel. For B20, CO2 emissions from urban buses drop 15.66% (Sheenan, 1998). These statistics are very difficult to argue.

We began in November of 2012, and decided we wanted to create something that would benefit our local community, and decided on this experiment based on the benefits we saw. We could reduce the amount of food sent to our local landfills, while also creating a clean natural fuel source.

Research and Procedures

We set out to know what reaction is taking place. We found that it was the transesterification process that was exchanging the organic group R″ of an ester with the organic group R′ of an alcohol. And this reaction is usually catalyzed by the addition of an acid or base catalyst (Romanski, 2012) (Fig. 2).

We began by seeking help from Utah Biodiesel Supply Company located in Syracuse, Utah. We found out the rather simple process through a tutorial video. (Blair, 2011) This taught us the basics of creating a biodiesel sample. We also spoke with Professor Tim Herzog at Weber State University. He then said to add the methanol (alcohol reactant) and the potassium hydroxide (catalyst) to the blended mix of leftover food at the same time. This proved to be a great help.

Materials

- Blender (with a glass jar)
- McDonald's French fries
- 100ml. KOH
- 70 milliliters Methanol
- Dropper
- Graduated Cylinder
- Beaker
- Vegetable oil
- Assorted lunchroom waste (from the T.H. Bell Jr. High School Cafeteria)

Procedure

For our sample of assorted lunchroom waste, we began by blending up the food for 20 minutes. Once it was liquefied, we then added our 70 ml of methanol and 100 ml of our catalyst, potassium hydroxide. After the chemicals were added, we left the mixture for 24 hours. After this time period, we returned to extract the fuel from the mixture. To remove fuel from a sample of vegetable oil, get 350 ml of oil. Put the oil in a glass container, and then add 70 ml of methanol and 100 ml of the potassium hydroxide. Leave it to separate for 24 hours. Then return and remove the fuel from the wastes. The biodiesel is the densest of all other products, so it will have settled to the bottom of the container.

To begin the French fry experiment, place the 117 grams of French fries which is a medium serving into the blender (nutritiondata.com, 2012). Blend the fries and add water in amounts of 20 ml at a time until the fries become liquefied. While waiting for the fries to liquefy, pour the 100 ml of potassium hydroxide into the 70 ml of methanol. Once the potassium hydroxide dissolves, pour it into the liquid fries. Blend the mixture for 20 minutes. Then let the blended mixture sit for 24 hours, so it can separate into a glycerin layer, biodiesel layer, and the degraded proteins, carbohydrates and other solutes layer.

Results

In our first test of lunchroom waste, we received a total of 122 ml of biodiesel. However this biodiesel was horribly refined and left large amounts of residues and particulate buildups. For this reason, our first sample would not be fit for a combustion engine.

In the test of McDonalds French fries, the fuel gelled, and prevented the particulates from settling.

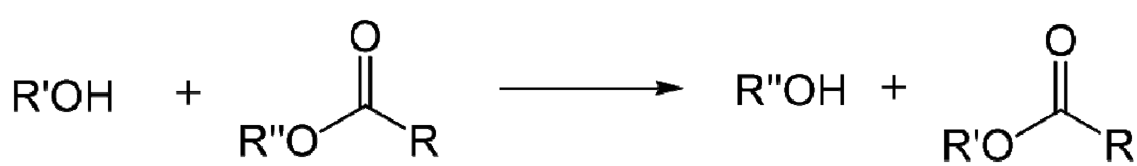
The test of the vegetable oil, we had the same problem with the fuel gelling in the bottom.

Only one of our experiments yielded any biodiesel. However, we lacked the equipment and expertise to really refine the product. It was flammable but left large amounts of residues and particulate buildups. We were not able to filter it; we would only call this a partial success. To make this more of a success, we would definitely conduct a filter test. If we knew the viscosity of our biodiesel, we would then be able to determine if our biodiesel is fit for an engine. The other thing we were unable to determine is how pure our fuel is. We would have to conduct chemical analyses to identify the purity.

Conclusion

In our three experiments, one showed promising results. Sadly, that test was our first test in which we included several different food items. We didn't know the nutrition facts so we can't tell how much of the food was actually turned into biodiesel fuel. The other two experiments failed to yield a successful form that would be safe to put into an engine. To form a useable product we would have to use a solid form of our catalyst, potassium hydroxide instead of a liquid catalyst. We would also find the nutrition facts for other foods, and food blends. That way, we could find the efficiency of turning food to fuel.

In future experiments, we would test other foods with the proper catalyst, to see which one yields the purest fuel. We would also test how they react in a combustion engine vs. a diesel engine. We would test other catalysts and use an engine that constantly creates biofuel. We have a tremendous opportunity to turn tons of wasted food into biodiesel. Doing so would power America to a brighter and cleaner tomorrow.



(Fig. 2) *This diagram shows the transesterification process.*

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