

Chemistry 110 – Experiment 11 - Biofuels

Prelab Lecture

Dr. Abrash

What is the goal of this experiment?

In this experiment we're going to synthesize a biofuel and examine some of its properties.

What's a biofuel?

A biofuel is any fuel that is both renewable and derived from plant sources.

Why are we interested in biofuels?

The key word is renewable. With peak oil either approaching rapidly or already passed, the cost of transportation fuel is set to go up rapidly in the foreseeable future. If we can replace oil from petroleum with oil from renewable sources, it will help ameliorate a significant energy problem. The one caveat here is that we'll need to change the way that we do agriculture so that it is no longer such a massive consumer of fuel oil – either by changing the methods, or by changing the initial energy source to some other renewable source.

You said we're going to synthesize the fuel. I thought came from plants!

Biofuels are typically derived from plant oils. However, the plant oils themselves don't have the necessary properties for a good fuel, so they need to be chemically modified before they can be used in an engine. While some vegetable oils can be used directly in diesel engines, at low temperatures they tend to flow badly and gel. This is the primary reason the modification is needed. These modified oils can be used in current diesel engines.

What is the modification that we need to make?

Most vegetable oils are chemicals called triglycerides. They're long hydrocarbon chains connected to a glycerol molecule. We're going to do a reaction that separates them from the glycerol, and combines them with an alcohol, methanol, to make a molecule called an ester. The ester will be the biofuel.

What kinds of properties does a good biofuel need to have?

Since biofuels are primarily used in transportation, they need to flow well, not freeze or congeal easily, and need to have a relatively high energy density.

How do we measure how well they flow?

We'll measure a quantity called the viscosity, which is a measure of the ease of flow. Water and gasoline are two liquids that flow easily and have low viscosities. Molasses and honey have high viscosities and flow poorly.

Well, how do we measure the viscosity?

We'll fill a Pasteur pipette and see how long it takes for a fixed volume to flow out under gravity. For comparison we'll also make the same measurement for our original vegetable oil.

How do we measure how easily it freezes?

We'll chill it, and look to see when it gets cloudy or begins to clump. As we chill it we'll measure the temperature, so we can fix the temperature for this undesirable behavior.

How do we determine the energy density?

We'll use the same technique we did in the "Energy Content of Fuels" experiment.

Are the energy density calculations the same as well?

Yep.

Do you have any experimental tips for me?

Yes, of course!

- 1) Since the methanol and sodium hydroxide solution is polar and the oil is nonpolar they won't mix easily. Be sure that you have your stirrer on a high enough speed to ensure that they mix as well as possible or your yield will be poor. On the other hand, don't mix so fast that you cause splashing, because the NaOH is caustic. Safety glasses are essential.
- 2) The centrifuging can be challenging. Make sure that you have clear separation between the layers before you pour off the biofuel layer. The biofuel layer should be on top, however, you should check to make sure that this is the case. The biofuel layer should be the larger layer and should have a yellowish color.
- 3) Pour off the biofuel layer carefully! It's better to lose some of your biodiesel than to mix in some of the original oil. You should have enough to fill a small beaker (your burner) and a little more.
- 4) When filling the pipette for the viscosity test, use the bulb to pull liquid past the top line, and then use your finger to control the rate of flow until the liquid falls to the line. Then release your finger and begin your timing.
- 5) When checking the gel/clouding behavior, observe what happens when your biofuel is cooled in a test tube in an ice/salt bath. If you see something clearly happening, describe your observation and note the temperature at which it occurs.

- 6) When wrapping the wick for your burner, make sure that part of it is immersed in the liquid and part of it exposed.

What do we have to do for a lab report?

Answer the questions on page 76, and fill in the data sheets on pages 77 and 78.

Honor: All work including the lab report may be done collaboratively with your lab partner. However, you should not work with anyone else.