Another renewable fuel from corn

How can corn oil be used as fuel?

Vocabulary: Biodiesel, transesterification, biodiesel, petroleum diesel, miscible, glycerin, catalyst, ester, fatty acid chains, glycerol, hygroscopic

Background

Most cars are powered by petroleum-based gasoline and a renewable fuel called ethanol that comes from the fermentation of corn carbohydrates. Another renewable fuel can be made from corn oil that can be blended with petroleum diesel (biodiesel) or can be used as a “drop-in” fuel (renewable diesel).

Diesel engines such as trucks, tractors, and heavy motors rely on No. 2 diesel for power. Diesel is commonly made from petroleum distillation. A renewable substitute for petroleaum diesel is biodiesel, which can be easily made from corn and other vegetable oils, animal fats, and waste grease through a chemical reaction called transesterification to create biodiesel. Biodiesel is created by a hydrotreatment process that cannot be carried out in a typical classroom lab.

Both biodiesel and renewable diesel burn cleaner than petroleum-based diesel and are derived entirely from biological sources. They are completely miscible with petroleum diesel, allowing for blending and more stable storage at low temperatures. Both biodiesel and biodiesel can be combusted in any diesel engine, without needing to modify the engine.

Vegetable oils are **triglycerides** and they have a standard structure. A molecule of any given vegetable oil consists of two parts, a **glycerol** backbone and three distinct **fatty acid chains** that stem from the glycerol. Biodiesel is produced using the chemical process, **transesterification.** Transesterification occurs when one type of **ester,** a corn oil molecule in this case, is changed into another. Today, we will be making biodiesel with corn oil and **methanol.** We will also use a **catalyst** **,** sodium hydroxide, to speed up the reaction. The combination of catalyst and methanol is called **methoxide.** The end product is a combination of biodiesel, unreactive methanol, base, glycerin, and soap.

This synthesis is a simple chemical reaction that produces biodiesel and glycerol. Corn oil is mixed with methanol, while sodium hydroxide is added as a catalyst. The products separate into two layers, with the biodiesel on top. The biodiesel is separated and washed. Then the washed biodiesel is ready for product evaluation.

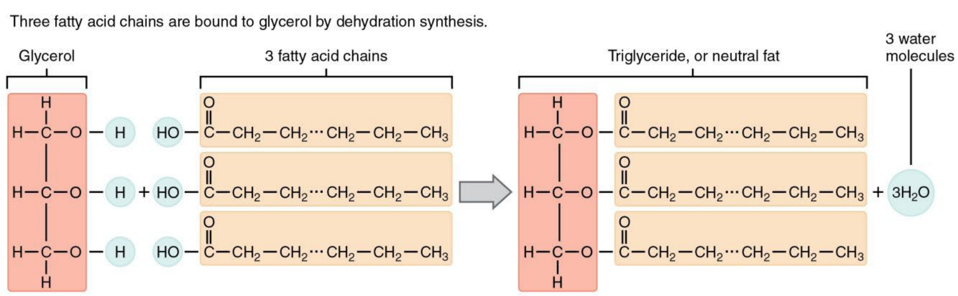

Figure 1: http://cnx.org/content/m46008/latest/220_Triglycerides-01.jpg

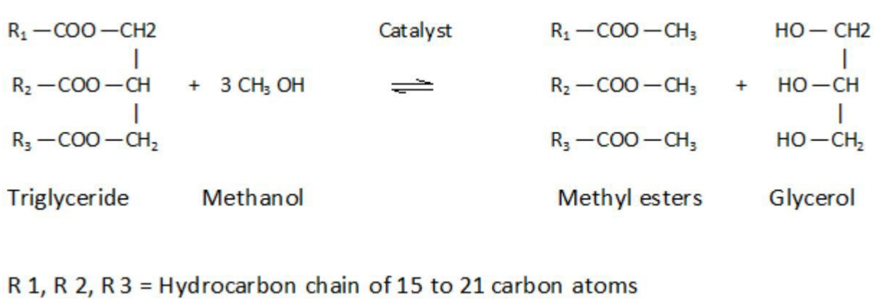

Figure 2: https://commons.wikimedia.org/wiki/File:Transesterification_reaction.pn

Materials

- Corn oil
- Methanol
- Sodium hydroxide
- Glass jar/lid
- 200 mL beaker
- Magnetic stir bar
- Hot plate/stir option
- Separatory funnel, 250 mL
- Ring stand with ring
- Graduated cylinder
- Serological pipette
- Distilled water
- Weigh boats
- Scales

Instructions

Part 1: making biodiesel (day 1)

1. Under a fume hood measure out 60 mL of methanol and pour into the glass jar.
2. Weigh out 1.1g of NaOH (Sodium Hydroxide) and quickly add it to the jar of methanol. Seal jar immediately and shake to dissolve. *Replace the cap of NaOH quickly because it is **hygroscopic.***
3. At the lab station in a clean beaker, warm 150 mL of corn oil to 50 °C. Once oil is at 50 °C, add it to the glass jar of methoxide solution.
4. Turn off the heat on the hot plate. Add a magnetic stir bar to the jar, loosely place the lid on the jar, set on hot plate to stir on high for 15 minutes.
5. Remove the jar from hot plate and pour mixture into a labeled separatory funnel for 24 hours to allow for separation of the raw biodiesel.

Data for Part 1: (day 1)

Visual observations from part 1 of making biodiesel:

1. Immediately upon adding the methoxide, what did you notice about the corn oil? Was there a change in the color of the sample?
2. What did the solution look like after it began stirring?

Part 2 (day 2)

Data from washing biodiesel:

1. Now that the biodiesel has rested for 24 hours in the separatory funnel, describe your sample.
2. Record the following characteristics of your biodiesel sample: color, consistency, odor

As you continue with the procedure below, collect data as follows.

3. Using pH paper or probe, test the pH of the "soapy" layer collected from both washings and record.
4. Measure the quantity of biodiesel in a graduated cylinder and record.
5. Calculate the % yield of your biodiesel production using the following equation:
   % yield = [volume biodiesel / (volume biodiesel + volume glycerin)] × 100%

Initial removal of glycerin:

1. Drain the glycerin from the biodiesel into your jar, using a graduated cylinder record the amount of glycerin retrieved from sample. *Note: Crude biodiesel contains impurities such as soap, incompletely transesterified glycerides, and methanol and must be cleaned/washed prior to use).*

Wash and dry biodiesel

1. Using a serological pipette, slowly add a total of 20 mL distilled water down the side of the separatory funnel to the raw biodiesel.
2. Remove separatory funnel from the ring stand and gently rock the separatory funnel back and forth for five minutes to wash the biodiesel. *(Do not shake vigorously).*
3. Place funnel back into ring stand and wait 10 minutes for the mixture to separate into two layers. Discharge the bottom "soapy" layer. Remove soap/glycerin waste into a waste flask.
4. Repeat washing procedure steps 1–3 for a second washing.

Data

Oil	pH	Color	Odor	% yield
Corn				

Reflection

1. How can biodiesel be incorporated into petroleum diesel? Why is this necessary for different climate zones?
2. Explain the process of transesterification and use your lab data as the example in your explanation. What are the reactants and products? What was the catalyst and why was it necessary for the reaction?