

BONDING AND POLARITY: The Molecules of Biodiesel

Georgia Performance Standards:

National Science Standards:

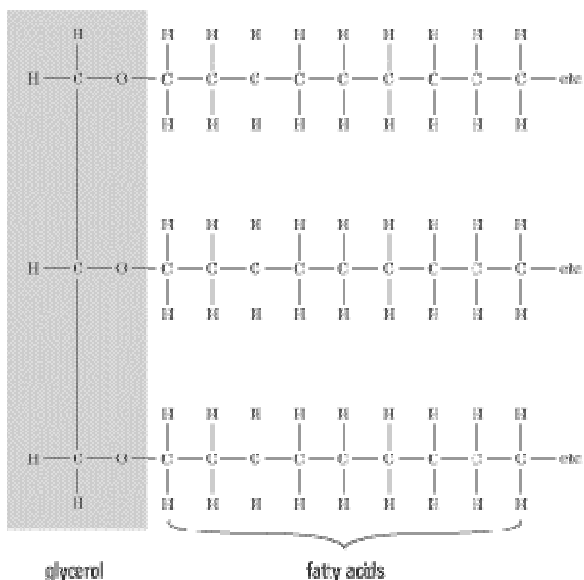
Objective:

Essential Questions:

Background: The reaction involving biodiesel involves both organic and inorganic molecules. Organic molecules are mainly made up of carbon and hydrogen and are called *hydrocarbons*. Molecules that are not primarily carbon and hydrogen are considered inorganic. Organic molecules usually have covalent bonds (since they are made of mostly nonmetals) and inorganic molecules can either be ionic or covalent.

Hydrocarbons can be tiny molecules or they can be very long, heavy molecules. In some cases, organic hydrocarbons can contain long chains of carbons that can be 16-22 carbons bonded together.

With biodiesel, you take a fat or oil and you react it with an alcohol. Fats and oils are typically called triglycerides. Triglycerides look like:

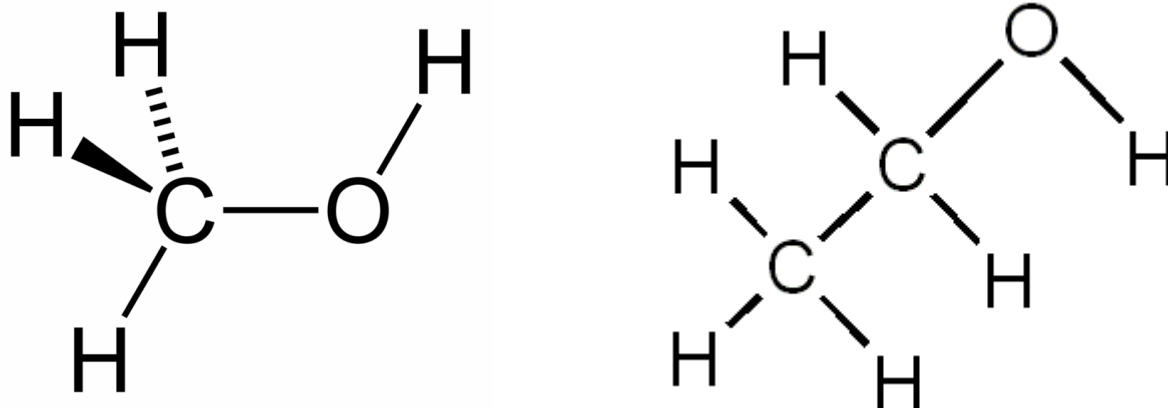


There are three fatty acids attached to a glycerol backbone. The fatty acids can all be the same or they can be up to three different acids on the same backbone.

We say that a fatty acid is saturated if it contains all single bonds. The fatty acid is unsaturated if it has any double or triple bonds.

Picture from: <http://img.sparknotes.com/content/testprep/bookings/sat2/biology/0002/fat.gif>

The triglyceride is reacted with an alcohol, usually methanol. An alcohol is an organic molecule that contains an -OH, oxygen bonded to hydrogen. The -OH is attached to a carbon. Ethanol can also be used. Ethanol has two carbon atoms while methanol has one.



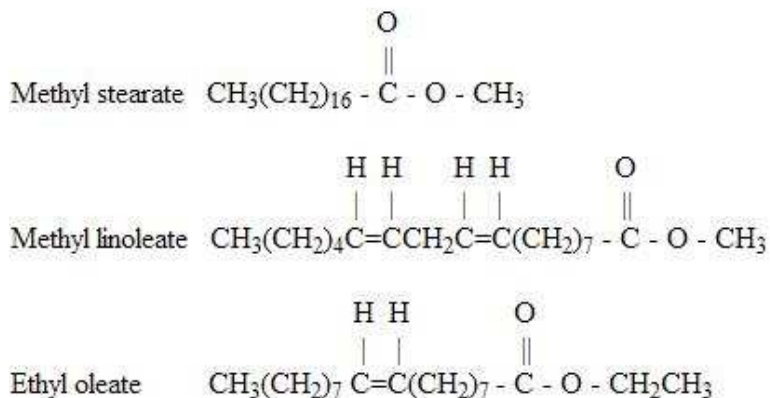
Pictures from:

<http://upload.wikimedia.org/wikipedia/commons/9/95/Ethanol.png>

<http://upload.wikimedia.org/wikipedia/commons/thumb/a/a2/Methanol-2D.png/710px-Methanol-2D.png>

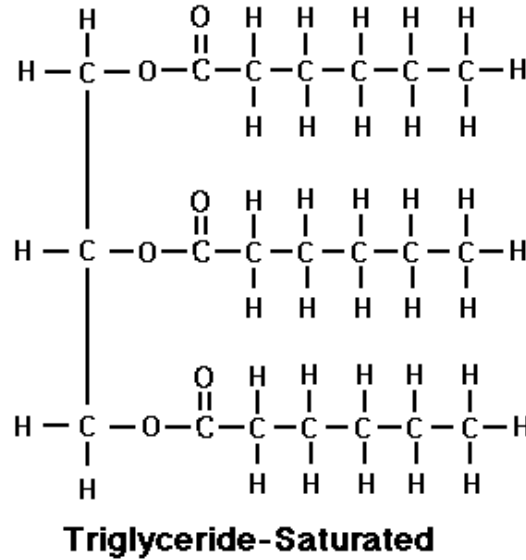
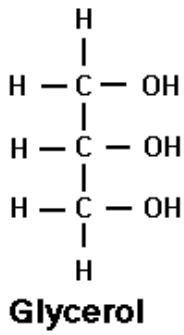
The catalyst used in the reaction is either sodium hydroxide or potassium hydroxide.

The products of the reaction are glycerol and esters. If methanol is used, methyl esters are produced. If ethanol is used, ethyl esters are produced. An ester is an organic molecule that contains a carbon double-bonded to an oxygen atom and also single-bonded to second oxygen atom. Examples of esters:



You can see that the esters have the two oxygen atoms in them.

These esters are formed from breaking the fatty acids off the glycerol backbone of the triglyceride. Therefore the esters are about 1/3 the size of the triglyceride.



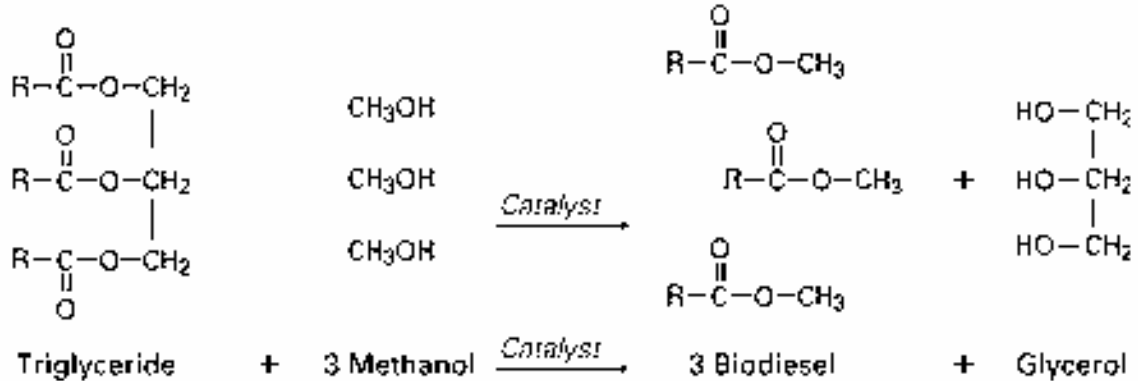
Picture from:

<http://www3.me.iastate.edu/biodiesel/Pages/bonds.JPG>

Once the fatty acids are broken off the triglyceride, the glycerol backbone is left.

Picture from: <http://www.raw-milk-facts.com/images/GlycerolTrigly.gif>

The biodiesel reaction (transesterification) looks like this:



The 'R' s that are attached is just a shorthand way of saying that there are long chains of carbon and hydrogen atoms attached.

Picture from: <http://imartinez.etsin.upm.es/bk3/c15/Biodiesel.bmp>

Materials: None from the teacher – materials must be gathered by the students

Procedure: You will need to make a mounted model of the biodiesel reaction. You can use whatever materials that you like. The model must be professional-looking in nature. Bonus points if you make parts of the model easily detachable to show the mechanism of the reaction!

The models of the molecules must show the three-dimensional shape of the molecules (do not just think in two-dimensions). You should use different colors to indicate the different atoms and you should be consistent with those colors for the entire model.

With each molecule's model, you should explain: where there are covalent or ionic bonds, if the molecule is polar or non-polar, and the basic geometry of each section of the molecule.

As you are making the model, think about how these molecules react with each other and if they dissolve in one another in order to react. Additional research might be necessary on your part to complete the project. For the triglyceride, choose whatever fatty acids you like.

Assessment: rubric

Building A Structure : Molecules of Biodiesel

Teacher Name: _____

Student Name: _____

CATEGORY	10	7.5	5	2.5
Scientific Knowledge	Explanations indicate a clear and accurate understanding of scientific principles underlying the construction and modifications.	Explanations indicate a relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations indicate a mediocre understanding of scientific principles underlying the construction and modifications.	Explanations do not illustrate much understanding of scientific principles underlying the construction and modifications.
Construction - Materials	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.
Construction - Care Taken	Great care taken in construction process so that the structure is neat, attractive and follows plans accurately.	Construction was careful and accurate for the most part, but 1-2 details could have been refined for a more attractive product.	Construction accurately followed the plans, but 3-4 details could have been refined for a more attractive product.	Construction appears careless or haphazard. Many details need refinement for a strong or attractive product.
Plan	Plan is neat with clear measurements and labeling for all components.	Plan is neat with clear measurements and labeling for most components.	Plan provides clear measurements and labeling for most components.	Plan does not show measurements clearly or is otherwise inadequately labeled.
Information Gathering	Accurate information taken from several sources in a systematic manner.	Accurate information taken from a couple of sources in a systematic manner.	Accurate information taken from a couple of sources but not systematically.	Information taken from only one source and/or information not accurate.

BONDING AND POLARITY:

Instructor Notes

It will most likely be necessary to go over the background information thoroughly with the students providing them with a small introduction to organic chemistry.