Inputs & Use of Biodiesel

Lesson Plan

*Note: *This lesson should be preceded by or taught concurrently with the History and Production of Biodiesel lesson.*

Nebraska AFNR:
Standard 7: Students will recognize the historical, social, cultural, and potential applications of biotechnology.
- Benchmark 7.2: Investigate current and future application of biotechnology in agriculture.

Nebraska AFNR Environmental Science:
Standard 4: Students will differentiate non-renewable and renewable energy sources.
- Benchmark 4.3: Predict and present future energy use based on population growth.
- Benchmark 4.4: Determine alternative sources available for use.

Objectives:
- The student will understand the different material options for biodiesel production.
- The student will understand the past, current, and future uses of biodiesel.
- The student will understand and describe the different market segments for biodiesel in the U.S. and worldwide.

Materials:
Buzzer or bell for optional activity

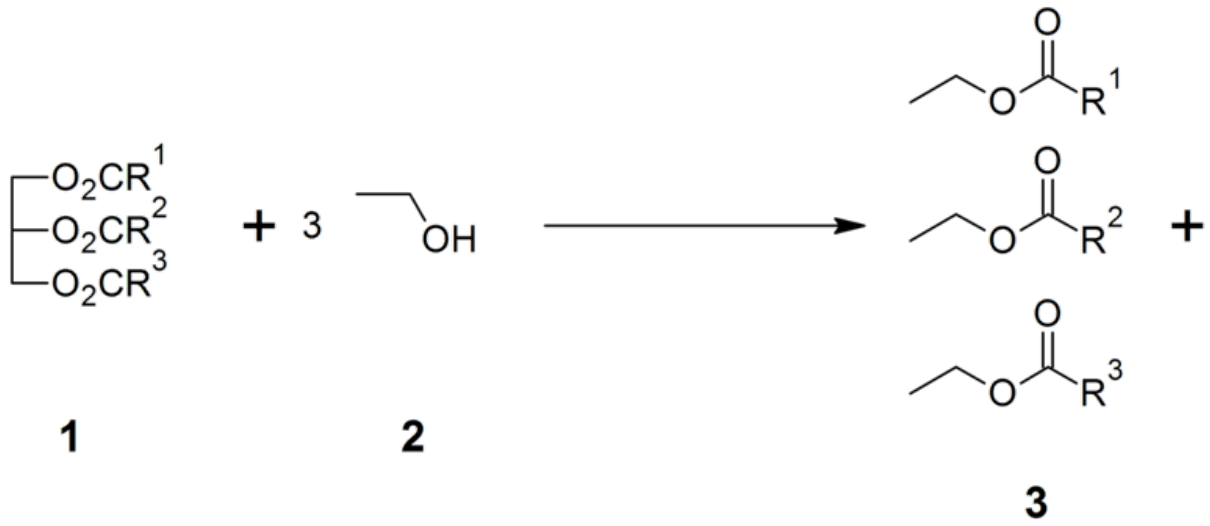
Additional Enrichment Resources or Source Files:
- Source for Myths & Facts for Biodiesel: http://www.associatedpetroleum.com/pdf/AE-BioDiesel-Myths-Facts.pdf
- http://bioenergycenter.org/besc/
- Additional lessons: http://www.learnbiofuels.org/high-school

Students will enter this lesson with varying backgrounds and knowledge pertaining to biodiesel. This lesson should be preceded by or taught concurrently with the History and Production of Biodiesel Lesson, or similar background content.

Input Materials for Biodiesel

Biodiesel, a member of the biofuel family, is a "renewable, clean-burning diesel replacement that is reducing U.S. dependence on foreign petroleum, creating jobs and improving the environment. Made from a diverse mix of feedstocks including recycled cooking oil, soybean oil, and animal fats, it is the first and only EPA-designated Advanced Biofuel in commercial-scale production across the country and the first to reach 1 billion gallons of annual production. Meeting strict technical fuel quality and engine performance specifications, it can be used in existing diesel engines without modification and is covered by all major engine manufacturers' warranties, most often in blends of up to 5 percent or 20 percent biodiesel. It is produced at plants in nearly every state in the country." (Source: biodiesel.org, 2016)

1. Biodiesel is produced through a chemical process call transesterification. Animal fats and plant oils are composed of triglycerides (1). When alcohol is added to the equation (2), the oils are separated into two distinct products - methyl esters (the chemical name for biodiesel) (3), and glycerin (4). Glycerin is a valuable by-product that can be used to make soap.



1 **2** **3**

2. Available feedstocks for biodiesel production are rapidly expanding through research, although soybeans remain a cornerstone of the industry. Have students research all the possible inputs for biodiesel production, including those currently in use and others still within the research realm. Discuss challenges and opportunities within each.

Market Segments

Biodiesel is not restricted to vehicle use. Have students take 2-3 minutes to individually brainstorm where biodiesel can be used. Optional: create a small competition within the class to see who can list the most uses of biodiesel. Use the teacher list below to compare.

Biodiesel market segments (from biodiesel.org, 2016): bioheat (home/business heat), fleet trucks, marine vehicles, school buses, farm equipment, transit vehicles, mining, electrical generation, on-highway (traditional vehicle use), general interest (national parks, specific companies, emergency crews, etc.)

Optional:

Biodiesel Myths & Facts

Can you sort myth from fact when it comes to biodiesel? Divide the class into 2 teams, each with a bell or buzzer of some sort. The teacher will read a statement, and the first team to "buzz" in with the correct answer of "myth" or fact" will receive a point. The team with the most points at the end of the game wins.

1. Biodiesel is an experimental fuel and has not been thoroughly tested.
    a. Answer: **Myth**. The fact is: Biodiesel is one of the most thoroughly tested alternative fuels on the market. A number of independent studies have been completed with the results showing biodiesel performs similar to petroleum diesel while benefiting the environment and human health compared to diesel. That research includes studies performed by the U.S. Department of Energy, the U.S. Department of Agriculture, Stanadyne Automotive Corp. (the largest diesel fuel injection equipment manufacturer in the U.S.), Lovelace Respiratory Research Institute, and Southwest Research Institute. Biodiesel is the first and only alternative fuel to have completed the rigorous Health Effects testing requirements of the Clean Air Act. Biodiesel has been proven to perform similarly to diesel in more 50 million successful road miles in virtually all types of diesel engines, countless off-road miles and countless marine hours. Currently more than 300 major fleets use the fuel.

2. Biodiesel performs as well as diesel.
    a. Answer: **Fact**. One of the major advantages of biodiesel is the fact that it can be used in existing engines and fuel injection equipment with little impact to operating performance. Biodiesel has a higher cetane number than U.S. diesel fuel. In more than 50 million miles of in-field demonstrations, B20 showed similar fuel consumption, horsepower, torque, and haulage rates as conventional diesel fuel. Biodiesel also has superior lubricity and it has the highest BTU content of any alternative fuel (falling in the range between #1 and #2 diesel fuel).

3. Biodiesel doesn't perform well in cold weather.
    a. Answer: **Myth**. The fact is: Biodiesel will gel in very cold temperatures, just as the common #2 diesel does. Although pure biodiesel has a higher cloud point than #2 diesel fuel, typical blends of 20% biodiesel are managed with the same fuel management techniques as #2 diesel. Blends of 5% biodiesel and less have virtually no impact on cold flow.

4. Biodiesel causes filters to plug.
    a. Answer: **Myth**. The fact is: Biodiesel can be operated in any diesel engine with little or no modification to the engine or the fuel system. Pure biodiesel (B100) has a solvent effect, which may release deposits accumulated on tank walls and pipes from previous diesel fuel use. With high blends of biodiesel, the release of deposits may clog filters initially and precautions should be taken to replace fuel filters until the petroleum build-up is eliminated. This issue is less prevalent with B20 blends, and there is no evidence that lower-blend levels such as B2 have caused filters to plug.

5. Biodiesel cost is accompanied by an increase in diesel quality.
    a. Answer: **Fact**. Using a 2% blend of biodiesel is estimated to increase the cost of diesel by 2 or 3 cents per gallon, including the fuel, transportation, storage and blending costs. Any increase in cost will be accompanied by an increase in diesel quality since low-blend levels of biodiesel greatly enhance the lubricity of diesel fuel.

6. Using biodiesel in existing diesel engines does not negate engine warranty coverage.
    a. Answer: **Fact**. The use of biodiesel in existing diesel engines does not void parts and materials workmanship warranties of any major US engine manufacturer.

7. Biodiesel does not have sufficient shelf life.
    a. Answer: **Myth**. The fact is: Most fuel today is used up long before six months, and many petroleum companies do not recommend storing petroleum diesel for more than six months. The current industry recommendation is that biodiesel be used within six months, or reanalyzed after six months to ensure the fuel meets ASTM specifications (D-6751). A longer shelf life is possible depending on the fuel composition and the use of storage enhancing additives.

8. The U.S. lacks the infrastructure to prevent shortages of the product.
    a. Answer: **Myth**. The fact is: There are presently more than 14 companies that have invested millions of dollars into the development of the biodiesel manufacturing plants actively marketing biodiesel. Based on existing dedicated biodiesel processing capacity and long-term production agreements, more than 200 million gallons of biodiesel capacity currently exists. Many facilities are capable of doubling their production capacity within 18 months.

9. There are government programs to support development of a biodiesel industry.
    a. Answer: **Fact**. The U.S. Department of Agriculture announced in January 2001 the implementation of the first program providing cost incentives for the production of 36 million gallons of biodiesel. Bills supporting the use of biodiesel and ethanol were also introduced to the U.S. Congress in 2003, including one that would set a renewable standard for fuel in the U.S. and one that would give biodiesel a partial fuel excise tax exemption. More than a dozen states have passed favorable biodiesel legislation.