Lab Investigation: Biodiesel

Resource: Lab Sheet

Fueling up with Biodiesel

How does renewable fuel stack up to petroleum diesel?
Procedure adapted and reprinted with permission from Energy Foundations for High School Chemistry,

Procedure

1. Set up test apparatus.
   a. Bend up the pull-tab of an empty, clean aluminum soft drink can.
   b. Slide a glass stir rod through the top hole of the pull tab.
   c. Hold the glass stir rod horizontally and set it on a ring attached to a ring stand so the aluminum can is suspended underneath it.
   d. Raise or lower the ring stand so the bottom of the can is about 2cm above the wick of the metal sample cup (tea candle).
2. Prepare the sample of biodiesel.
   a. Take a tea light candle in a metal cup. Remove the candle from the cup.
   b. Remove the metal circle and its attached wick from the bottom of the candle.
   c. Set the candle aside. Place the metal circle and its attached wick back in the metal cup, so the wick stands upright.
   d. Place 5ml of biodiesel sample in the metal cup using a dropper or plastic pipette.
3. Record initial observations.
   a. Measure and record the initial weight of the biodiesel with the cup and wick.
   b. Record observations of the sample's color, odor, viscosity, etc.
4. Weigh 100 g of cold water, recording the weight to the nearest gram. Pour the water into the soft drink can. Measure and record the initial temperature of the water to the nearest degree Celsius.
5. Ignite the biodiesel sample using the wick. Once it is ignited, immediately move the metal cup underneath the soft drink can.
6. As the water in the can heats, stir it gently. Allow the biodiesel sample to burn for ~5 min.
7. Extinguish the flame by placing a watch glass over the metal cup.
8. Measure and record the highest temperature reached by the heated water to the nearest degree Celsius.
9. Allow the metal cup and sample to cool. Measure and record the final weight of the biodiesel sample with the cup and wick to the nearest 0.1 g.
10. Repeat steps 2-9 with a sample of petroleum diesel.
11. Safely return or dispose of fuel samples according to your teacher's directions.

Lab Investigation: Biodiesel

Data Collection: What did we do?

	Biodiesel	Petroleum Diesel
Initial Mass of Sample and Cup (g)		
Mass of Water Sample (approximately 100g)		
Initial Temperature of Water (degrees Celsius)		
Highest Temperature of Water (degrees Celsius)		
Final Mass of Sample and Cup (g)		

Data Analysis: What can we learn?

1. Using the temperature and weight data from heating the water in the can, calculate how much thermal energy was used to heat the water. The specific heat capacity of water is 4.18 J/(g • °C), meaning it takes 4.18 J to raise the temperature of 1 g of water by 1 °C.

2. Calculate the heat of combustion in kJ/g for the sample of biodiesel you burned. The heat of combustion is the quantity of thermal energy given off when a certain amount of a substance burns. Assume that all of the energy released by the burning biodiesel is absorbed by the water.

3. Petroleum diesel (from crude oil) produces 43 kJ/g of thermal energy when burned. Compare this to the thermal energy your biodiesel and ethanol samples produced when it was burned.

4. Compare your calculated heat of combustion with those calculated by the rest of the class. What is the class mean?

Reflection: What does this mean?

1. Would you recommend biodiesel as an alternative to petroleum diesel? Why or why not?

2. What considerations should be made when shifting cropland used for producing food crops to land for producing crops for biodiesel?

3. What do you foresee as the future of biodiesel?

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Lab Answer Key:

Data Analysis: What can we learn?

1. Using the temperature and weight data from heating the water in the can, calculate how much thermal energy was used to heat the water. The specific heat capacity of water is 4.18 J/(g • °C), meaning it takes 4.18 J to raise the temperature of 1 g of water by 1 °C.

   Answers will vary. A sample calculation is: Data:

   Mass of biodiesel burned: 3.4 g (difference between biodiesel sample, metal cup, and wick before and after burning)

   Mass of water: 1.00 x 102 g water
   Initial water temperature: 5 °C
   Final water temperature: 67 °tC
   E = mCΔT = (1.00 × 102 g)(4.18 J/(g • °C))(67 °C – 5 °C) = 26×103 J

2. Calculate the heat of combustion in kJ/g for the sample of biodiesel you burned. The heat of combustion is the quantity of thermal energy given off when a certain amount of a substance burns. Assume that all of the energy released by the burning biodiesel is absorbed by the water.

   Answers will vary. The method of gathering data for the heat of combustion is somewhat inefficient. A sample calculation, using the data from Analyzing Evidence question 1, 26×103 J, or 26 kJ, is given off by the burning biodiesel. The heat of combustion = 26 kJ / 3.4 g = 7.6 kJ/g

3. Petroleum diesel (from crude oil) produces 43 kJ/g of thermal energy when burned. Compare this to the thermal energy your biodiesel and ethanol samples produced when it was burned.

   Gram for gram, biodiesel produces less energy.

4. Compare your calculated heat of combustion with those calculated by the rest of the class. What is the class mean?

   Answers will vary, depending on class data.