Biodiesel Experiment

Use this link to see images of the experiment:
http://www.dynamicscience.com.au/tester/solutions1/chemistry/organic/biodsl1prac.htm

Biofuels are solids, liquids and gases made from dead biological materials that can be burnt for energy. The burning of these fuels does release CO_2 into the atmosphere. However as they release CO_2 that they have previously absorbed from the atmosphere, they are considered to be carbon neutral. Biofuels can be produced from plants or biological waste. Biological waste can be burnt or acted on by bacteria, crops can be specifically grown to produce biofuels such as ethanol. The most common fuel crops produce either ethanol, as in the case of corn and sugar, or biodiesel, which is used primarily for transport. During this practical we will produce biodiesel from vegetable oil.

Materials:

- 150mL of oil **(oil is a slip hazard! Alert your teacher or lab tech if any is spilt on the ground!)**
- hotplate
- 100mL beaker
- 1.05g potassium hydroxide (KOH) **(caution potassium hydroxide is extremely caustic)**
- 250mL conical flask
- thermometer
- 30mL methanol **(caution methanol is flammable and toxic)**
- stirring rod
- 500ml schott bottle
- 2 funnels
- retort stand
- 1 separating funnels

SAFETY: Lab coats, safety glasses and gloves must be worn at all times during this experiment! Extraction fans must also be used.

Method:

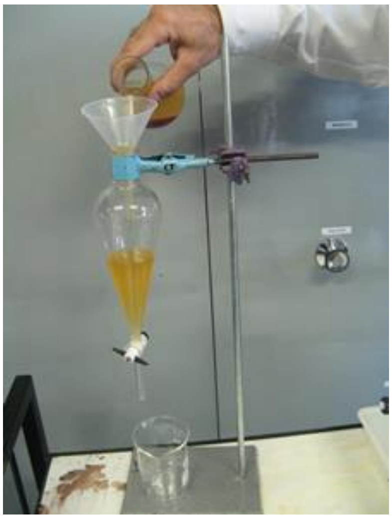
1. Add 30 mL of methanol to a 100 ml beaker

2. Weigh 1.05g of KOH and place it in the beaker with methanol. Stir until the KOH is completely dissolved (this will take a few minutes).

3. Place 150mL of vegetable oil in a 250mL flask and heat on the hotplate to about 55^{o}C. Turn off your hot plate.

4. Away from your hot plate, use a funnel to help you pour the oil into a 500ml schott bottle

5. Carefully pour the methanol and potassium hydroxide solution into the schott bottle with the oil and tightly close the lid. (Please alert your teacher or lab tech immediately if you spill any methanol/potassium hydroxide solution!)



6. Vigorously shake your schott bottle for at least 5 minutes. When the reaction is complete the methanol layer disappears.

7. Pour the contents of the flask into separating funnel and let stand for at least 30 minutes.

8. The mixture separates into layers. The glycerol from the vegetable oil sinks to the bottom while the biodiesel floats on top.

   Pour out the glycerol.

   Collect the biodiesel (you will be using this for a second experiment next week)

Questions

1. The fatty acids in the vegetable oil are present in the form of triglycerides. What are triglycerides?

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2. Where does the glycerol come from?

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3. What type of reaction is the breakdown of triglycerides?

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4. What is transesterification?

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5. Explain why the biodiesel melts at a lower temperature than the vegetable oil?

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6. Why is it important that biodiesel have a low melting temperature?

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7. Biodiesel is intended to replace petrodiesel as a fuel in diesel engines. Why should we not just use the natural vegetable oil (rather than convert to biodiesel)?

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8. A vegetable oil was added to an aqueous solution of KOH and methanol. The mixture was shaken for at least 5 minutes and then transferred to a separating funnel and allowed to settle. After several minutes two layers were visible.
   a. What is the top layer composed of?

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   b. What is the bottom layer composed of?

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   c. Explain how these two layers form and the properties that each layer has.

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Part B: Properties of Biodiesel

(a) Density

1. Weigh a 10 mL measuring cylinder
2. Add 10 mL of the biodiesel to the measuring cylinder
3. Reweigh the measuring cylinder and the biodiesel

(a) Density

1. *Table of mass results*

Item	Mass in grams
mass of empty measuring cylinder	
mass of measuring cylinder plus 10 mL biodiesel	
mass of 10 mL of biodiesel	

2. (i) Determine the density of biodiesel in g mL^{-1}

(b) Effect of temperature on flow rates

1. Fill one test tube with Biodiesel nearly filled up to about 1.0 cm from the top
2. Fill another test tube to the same level with petrodiesel (*do this step in a fume cupboard*).
3. Securely place a rubber stopper in each test tube.
4. Measure the temperature of the room and invert each test tube, recording the time it takes for the air bubble to reach the top of the test tube in your results table.
5. Place each test tube into an ice/water bath and allow the temperature to equilibrate (around 10 mins), then repeat step 4 at the lower temperature (record the temperature of the ice/water bath).
6. Place each test tube into a beaker of warm water (around 35˚C) and allow the temperature to equilibrate. Measure the temperature of the water, then repeat step 4.

(b) Effect of temperature on flow rates

Table of time taken (sec) for bubble to reach top of test tube when inverted for biodiesel and petrodiesel at various temperatures.

<table>
<tr><th>Temperature (˚C)</th><th>Biodiesel</th><th>Petrodiesel</th></tr>
<tr><td rowspan="2">Ice/Water bath</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="2">Room temperature</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="2">Warm water</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Questions

1. Given that the Australian Standard for the density of petrodiesel to be in the range of 0.820 to 0.850 g mL^{-1}, how does the density of the Biodiesel compare to that of petrodiesel?

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2. How did the flow rate of biodiesel change with temperature and how did this compare with that observed for petrodiesel?

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3. Petrodiesel contains about 75% saturated hydrocarbons (i.e. alkanes) ranging from C_{10} to C_{15}, with an average of 12 carbons in the hydrocarbon chain. Draw the structure of the alkane with 12 carbons in the chain and also indicate what type of intermolecular forces exists between molecules of petrodiesel.

4. Given that the biodiesel you have produced is a fatty acid ester molecule (structure given in the introduction), discuss the similarities and/or differences of the intermolecular forces, polarity and melting points between petrodiesel and biodiesel.

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5. If a substance is hygroscopic it absorbs water over a period of time as the water molecules are attracted to that substance. In reference to their structures, would diesel or biodiesel be more hygroscopic and how would this affect the efficiency of the fuel when burned?

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