PERIODIC TRENDS:
Making Soap from Biodiesel Waste

Georgia Performance Standards: SCSh1-9, SC4 a, b
National Science Standards: Content Standards A, B: structure of atoms, F: natural resources, environmental quality, G: nature of scientific knowledge

Objective: Students will make soaps using different alkali metal hydroxides. The students will then determine the trend of soap properties and related it to the trends in the group of alkali metals.

Essential Questions:

- How do you make lye soap?
- What is the effect of the alkali metal on the properties of the soap?
- What is the soap property trend as you go down the alkali metal group?

Background: One of the by-products of making biodiesel is glycerin (or glycerol). Glycerin can be used as a fuel to heat boilers in biodiesel plants or it can be cleaned up and sold to the pharmaceutical industry. Because so much glycerin is produced it does not have a great monetary value. It also takes a lot of money and energy to clean it up for pharmaceutical use. Therefore a lot of the time glycerin is just taken to the landfill. Some home-producers of biodiesel find it hard to deal with a lot of the glycerin waste so they turn it into something useful for their home – soap. The soap produced from the glycerin waste is an excellent degreaser and it can be used as hand and body soap or it can even replace shampoo. It is a natural product and therefore has an appeal for those people who prefer non-commercial, non-additive, natural products.

Procedure: 1. Obtain two thermometers, three 250 mL beakers, one 100 mL beaker and one 600 mL beaker
2. Label three 250 mL beakers: one as 'NaOH soap', one as 'KOH soap', and one as 'LiOH soap'.
3. Label the 100 mL beaker as 'lye solution' and the 600 mL beaker as 'glycerin'.

4. Measure out 300 mL of glycerin into the 600 mL beaker and set it aside for use later.
5. Pour 100 mL of glycerin from your 600 mL beaker into the beaker labeled 'NaOH soap.' Heat this glycerin to 65°C.
6. While your glycerin is warming up, measure out exactly 25 mL of distilled water using a graduated cylinder and pour it into the beaker labeled 'lye solution.'
7. Weigh out 3.85 grams of NaOH (record the *actual* mass you weigh) and add it to the water in the 'lye solution' beaker.
8. Heat the lye solution to 40°C while stirring. Be careful not to splash the solution on you.
9. When both your glycerin and lye solution are at the proper temperature, pour the lye solution into the warm glycerin (in the 'NaOH Soap' beaker). Stir and keep heated for 10 minutes.
10. Take the 'NaOH Soap' beaker off the heat and set aside to cool.

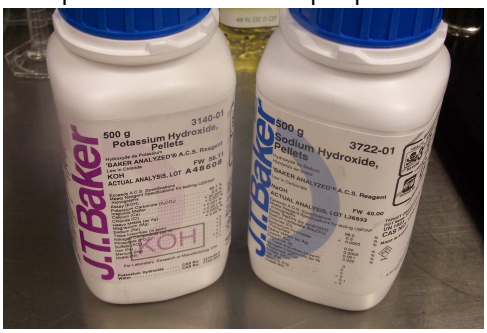
11. Repeat steps 5-10 using the same amount of KOH and 'KOH Soap' beakers. You may rinse out the 100 mL 'lye solution' beaker and reuse it.
12. Repeat steps 5-10 using the same amount of LiOH and 'RbOH Soap' beakers. You may rinse out the 100 mL 'lye solution' beaker and reuse it.
13. When all three soaps are cool, record your observations about the three different soaps.

Materials:

- Pure glycerin
- NaOH, KOH, and LiOH pellets
- Distilled water
- Three 250 mL beakers, one 600 mL beaker, and one 100 mL beaker per lab group
- Balances (preferably electronic)
- One 25 mL graduated cylinder per lab group

Assessment: Lab rubric

Questions: Answer the following questions in your lab report or on a separate sheet of paper.



1. What physical differences did you notice in the three soaps?
2. What happens to the size and ionization energy of the alkali metals as you go down the group? Why?
3. Make a statement about the trend of soap properties and relate it to the alkali metals.

4. Do your best to try and explain why you get the soap property trend that you see.

Lab Data Sheet – Making Soap

Actual Mass of NaOH used: _____g

Actual Mass of KOH used: _____g

Actual Mass of LiOH used: _____g

Observations of the lye and glycerin mixture while it is reacting:

NaOH:

KOH:

LiOH:

Observations of the finished soap product:

NaOH:

KOH:

LiOH:

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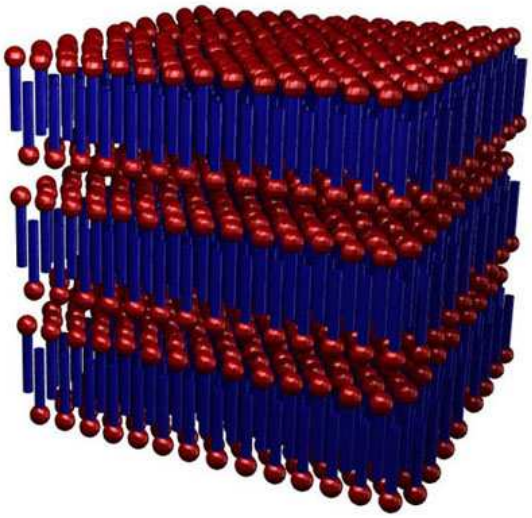
Instructor Notes

RbOH could also be used if it is available. You could add it to the list and make 4 soaps or you could use RbOH instead of LiOH.

From: http://barrett-group.mcgill.ca/teaching/liquid-crystal/LC05.htm
A picture of solid soap – the red 'heads' are the polar ends and the blue 'tails' are the nonpolar ends of the soap molecule.



The description with this picture on the website reads:
At extremely high concentrations (neat soap), the surfactants crystallize into a lamellar structure with elongated sheets separated by thin water layers. The structure is very reminiscent of the lipid bilayers seen in biological systems.

Since K^+ is more soluble in water than Na^+ is produces a liquid soap.

http://chemistry.about.com also has diagrams and information on the saponification reaction. However, most websites provide information on saponification of fats which is not the same as starting with glycerol.