Lesson 3

Soap Making

Time: 1 45 minute class period if starting with glycerin soap base. It will take at least 2 class periods if making soap from lye and fat plus 3 wks to dry and balance pH.

HCPS III Benchmarks

SC.6.6.5 Explain how matter can change physical, chemical forms but total amount of matter remains constant
SC.6.6.6 Describe and compare the physical and chemical properties of different substances
SC.6.2.1 Explain how technology has an impact on society and science
SC.6.2.2 Explain how needs of society have influenced development and use of technologies
SC.8.2.1 Describe the significant relationships among society, science, and technology and how one impacts the other

NSES standards

Personal Health
Populations, resources, and environments
Science and technology in society
Science as Human endeavor
Nature of science
History of science
Properties and chances of properties in matter

Learning Objectives

1. Students will identify the different plant components that make up glycerin, lye, and other additives in their soap

2. Students will describe the physical and chemical properties of the starting materials and their final soap product

History of Soap making

The first known written mention of soap is found in Sumerian Clay Tablets dated at 2500 BC found in the Tigris/Euphrates area. During the excavation of Pompeii a soap factory was also discovered by archaeologists that was destroyed by volcanic eruption of Mt. Vesuvius in 79 A.D. Legend has it that soap comes from Mt. Sapo in Rome where animals were sacrificed on the top of this mountain. Rainwater mixed with the animals' fats and wood ashes down to the Tiber River where a soapy mixture was discovered that cleaned clothing and skin.

Advancements in soap making were made when a process was patented by a French chemist named Nicholas Leblanc that turned salt into an alkali (base). In colonial America, coals from hardwoods were placed in ash boxes lined with rocks and covered with hay.

Rainwater was then poured over the ashes which wash out lye, in this case potassium hydroxide KOH). The lye was collected and poured into melted animal fat and stirred and heated for several hours over a fire. This is how soap was made for home use. The ash with the lye removed was then added to vegetable crops and is an excellent soil amendment. Today companies make several different types of soaps with different properties that are suited for bathing, laundry, and cleaning.

Two sided soaps made with shell molds

Materials

Microwave-safe glass measuring cup with spout
Plastic wrap
Microwave
Stir stick
Mold – (try Seashells, glass cylinders, clay pots, and wood boxes work well too)
Glycerin soap base
Oil- for lubricating the mold, unless using a Teflon or silicone non-stick mold
Plant dyes (minimize amount of carrier liquid for best results)
Fragrance plants (lavender, sage, rosemary, thyme, basil, peppermint, vanilla, papaya juice, citrus zest, ginger, tumeric, shampoo ginger, coconut shavings)
Optional (add dried herbs, oatmeal, honey, aloe vera gel, or fine sand or ground pumice if you want a scrubbing soap)

Step 1. Put ½ cup glycerin soap base into the measuring cup, cover with plastic wrap and microwave for 1 minute. If the soap base is not liquefied, microwave for one minute at a time until ready to pour.

Step 2. add fragrance oils/plants and dyes

Step 3. pour into lubricated mold and set into refrigerator to cool. Soap should be solid in 3 hrs. If there is trouble removing the soap from the mold, place in the freezer for a half an hour. Careful! Liquid soap stays hot for a while.

Step 4. Test the soap. How does it smell? How does it look? Does it work? Would you do anything different next time?

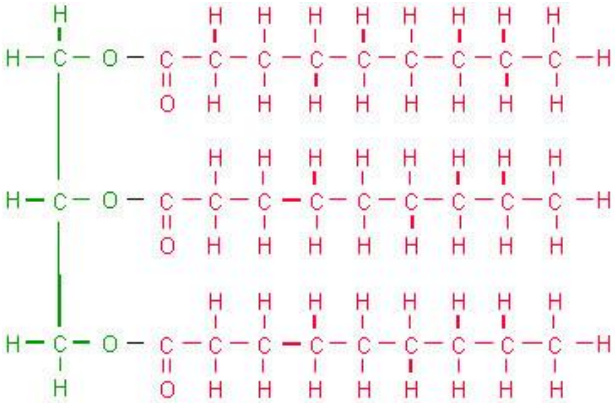
Product Knowledge

Do you know what soap is? Although the chemistry can get complex, the simple answer is a combination of fats or oils (acids) with lye (base) that produces a substance that cleans. From a chemists point of view soap is the salt of a fatty acid. The process of separating the parts of the fats and oils into glycerin

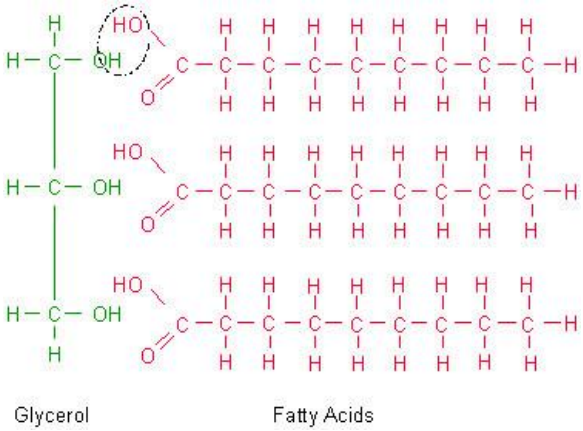
and fatty acids with lye is called saponification. Home made soap or glycerin soap is very different than most store-bought and commercial soaps. Both types will clean, but glycerin based soaps are much better because glycerin is a natural moisturizer.

In commercial soap the glycerin is removed and sold separately to manufacture cosmetics, explosives, and food products yielding a higher profit margin for soap makers. The commercial soap makers then add chemicals and detergents back into the soap to act as substitute moisturizers and cleaners. The result is a product that dries the skin and strips it of the natural oils. People with skin sensitivities should use glycerin based soaps since they are milder and do not remove desired oils in the epithelial tissue (skin) as detergents do. It is glycerin (a humectant) in soaps that creates moisturizing (emollient) effects.

Structure of a triglyceride



Hydrolyzed triglyceride (aka saponified oil)



Science behind soap making

KOH or NaOH, both referred to as **lye**, are strong **bases** because they accept protons or H^+. **What is the difference between glycerol (glycerin), fatty acids, and triglycerides?** Most natural fats are complex mixtures of triglycerides. **Triglycerides** are composed of a **glycerol** backbone to which three fatty acids have been bound. All **fatty acids** contain a long **hydrocarbon** chain (the fat part) and a terminal carboxyl group COOH (the part that is acid). Fatty acids rarely occur in this "free" form, however. The **acid** part is usually bound to glycerol in the form of a triglyceride. A total of three fatty acids can bind to one glycerol molecule (see Figure 1).

Fatty acids may be saturated, monounsaturated or polyunsaturated and can vary not only in the number of double bonds present, but also in the length of the carbon chain.

Making Soap from Coconut oil and Lye (Sodium hydroxide) **Recommended only For advanced students**

Materials

30 grams of coconut oil

16 grams of 50% Sodium hydroxide (19.1M)

150 ml glass/pyrex beaker

400 ml glass/pyrex beaker

Rubber gloves

Eyewear

Thermometer

Scale

Glass stirring rod

Teflon coated mini-muffin pan (for mold)

Spatula

PH tester

Essential oil (plant extract), ex peppermint, orange/citrus, cedar, sage, plumeria, almond, sandalwood, magnolia, orange blossom, lavender, coconut, etc.

Procedure

1. Weigh out 30.0 grams of coconut oil and place in a 150 mL beaker.

2. Place this beaker in a 400 mL beaker that is ½ full of water and immersed in a water bath set at 39^0C. The oil melts when the bath is between 37–41 degrees Celsius. For good quality of the product, it is very important that the mixture not get too hot.

3. Once the coconut oil melts completely add the 16.0 grams of NaOH. Have a glass stirring rod available to stir the solution as it thickens.

4. Stir the mixture every 5 minutes. The mixture will start looking opaque and start to thicken between 30 min. to an hour.

5. When the mixture has the consistency of pudding, take it out of the water bath. Add 2-3 drops of oil-based fragrance, if desired, and stir.

6. Pour the mixture into a Teflon-coated mini-muffin pan as a mold. This recipe fills up two cups of the muffin pan (one for each partner). Leave it in the pan overnight for the soap to harden on the surface.

7. The next day, with rubber gloves on remove the soap, inverting it into a suitable plastic dish. Be **careful** not to touch any of the wet surfaces thus exposed, since they are wet with the strong NaOH solution. This type of soap

needs to mature to lose its alkalinity (pH12 when new). Use only after at least 3 weeks of "curing", or when pH level is 8 or lower. Always test pH of the soap before hand.

Suggested vocabulary

Hydrolysis – a chemical process that splits a molecule with the addition of water

Hydrophilic – water loving, attracted to water

Hydrophobic – repelled by water, ex oil

Saponification – conversion of a triglyceride to the salt of a fatty acid plus glycerin via the addition of lye

Lye – potassium hydroxide (KOH) or sodium hydroxide (NaOH), both strong bases

Acid – donates a proton, or positive charge (H+)

Base – accepts a proton or a positive charge (OH-)

Triglyceride – most fats and oils, 3 fatty acids bound to a glycerol

Fatty acid – a hydrocarbon with a COOH (carboxyl group) at the end

Glycerol – backbone of most fats, C3 H8 O3

Hydrocarbon – carbon backbone bound to hydrogen

For further resources:

http://candleandsoap.about.com/od/soapmakingsafety/tp/Making-Lye-from-Wood-Ashes.htm

Reference

Cavitch, Susan Miller. The Natural Soap Book: Making Herbal and Vegetable Based Soaps. Storey Publishing, North Adams, MA, 1995

Davis, Jeudi. Teacher Recommended and Developed and/or Requested Demonstrations, Labs and Laboratory Resources. The Highschool Laboratory. Accessed 7/1/2011 from **http://www.hschem.org/Laboratory/labs.htm**

US patent #3,179,596; Apr. 20, 1965

Name _____
Date _____

Soap Making Observation Log

How did your soap turn out?

What plants did you add to make your soap?

What was the reason for each ingredient that you added (color, appearance, texture, smell, health, etc.)?

Try your soap out. How does it clean?

Does your skin feel moisturized after or does it dry your skin out?

What did you use for a mold?

Challenge questions

Why would you want soaps with different properties?

What are the different kinds of soaps that you have used?

How might you make soaps with different properties?

How do you think Draino (contains NaOH) works to unclog drains clogged with oils?

Do you know what any of the detergents that may be added in regular soap?