PW 4: Preparation of a soap

1. Introduction

Soap has a rich history that reflects cultural practices and technological advancements over the centuries. In recent years, there has been a revival of interest in traditional and natural soap-making, with a focus on sustainable and eco-friendly practices.

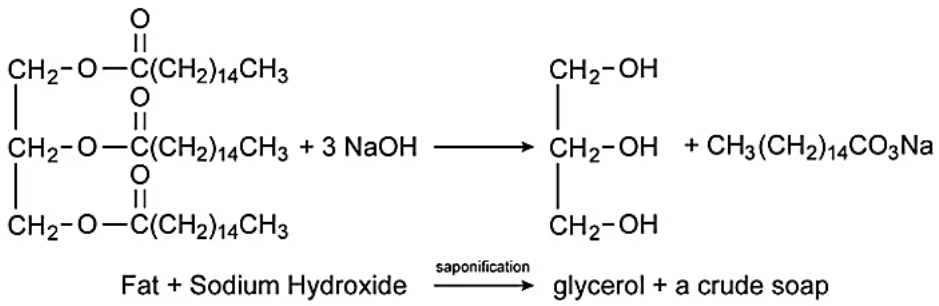
Saponification is the chemical process by which fats or oils are converted into soap and glycerin through the reaction with an alkali, typically sodium hydroxide (lye) or potassium hydroxide. It represents one of the oldest reactions in organic chemistry. During saponification, the triglycerides react with the alkali, resulting in soap and glycerin. The general reaction can be summarized as follows:

Fat/Oil + Base → Soap + Glycerin

Two main types of soap are known: bar Soap: Usually made with sodium hydroxide and liquid Soap: typically made with potassium hydroxide.

A classic example of a saponification reaction involves the reaction of a triglyceride (fat or oil) with sodium hydroxide (lye). Here's a simplified version of the reaction:

- Triglyceride: this can be any fat or oil, such as olive oil or coconut oil. For illustration, we'll use "tristearin" (a triglyceride derived from stearic acid).
- Sodium Hydroxide (NaOH): The alkali used in the reaction.
  For tristearin, the reaction can be represented as:



The resulted soap molecules have a hydrophilic (water-attracting) head and a hydrophobic (water-repelling) tail, which allows them to interact with both water and oils, making them effective at cleaning.

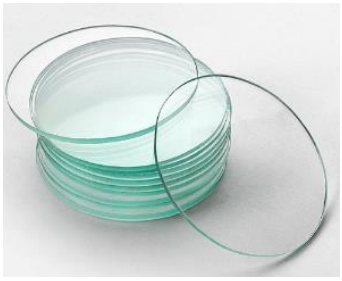
2. Objectives of the manipulation

- ✓ Synthesize soap in the laboratory;
- ✓ Become familiar with saponification reaction;

- ✓ Highlighting some properties of soap: foaming.

3. Equipment and chemicals

Equipment	Chemicals
 **Graduated cylinder**	Vegetable oil
 **Double necked flask**	Sodium hydroxide (NaOH)
 **Heating magnetic stirrer**	95% ethanol
 **250 mL beakers**	Saturated sodium chloride

 **Magnetic bar**	Distilled water
 **Büchner**	Iced water
 **Pumice stone**	
 **Watch glass**	
 **pH paper**	

4. Operating mode

Before starting, check if the glassware is clean and dry.
Confirm that the tank-heater is set to a temperature that does not exceed 90°C.

- ✓ Place 20 mL of sodium hydroxide (with C=8mol/l) in 250 mL flask;
- ✓ Add 20 mL of 95% ethanol and stir until the sodium hydroxide is dissolved;
- ✓ Add 10 mL of vegetable oil;
- ✓ Add a few grains of pumice stone;
- ✓ Heat the flask content for 30 minutes **without exceeding 90°C;**

- ✓ At the end of heating, pour the contents of the flask into a beaker containing a saturated solution of sodium chloride. **Note: (20 g of NaCl in 100 mL of water)**.

Observation: The formation of a yellowish solid layer, this layer floats on the surface of the salt water (NaCl saturated solution): it's the soap that precipitates.

- ✓ Filter the content using a large-diameter Büchner funnel; wash the soap successively with ice-cold water and measure the pH of the filtrate;
- ✓ Place the soap in a mold and let it dry.

Measure of foaming properties of soap:

- ✓ Cut a small piece of the obtained soap and introduce it into test tube;
- ✓ Add approximately 3mL of distilled water and shake.

Note: It is not recommended to use the obtained soap for hand washing; indeed, it still contains a lot of sodium hydroxide and is therefore caustic.

5. Questions

- What is saponification?
- Write the general equation for the saponification reaction and name all reagents and products.
- Provide the reaction mechanism.
- To which class of chemical compounds do fatty substances belong?
- What substance can be used instead of sodium hydroxide (lye)?
- Why was ethanol added to the reaction mixture of fat and base?
- How could we measure the foaming properties of soap?
- Explain how soaps emulsify oils and fats
- Calculate the yield of the reaction.