6.2: Esters Procedure

Learning Objectives

- Gain a deeper understanding of the esterification process
- Practice naming esters
- Practice appropriate labratory safety techniques.

Safety

- Handle concentrated acids like sulfuric acid with extreme care. Use appropriate tools like pipettes and avoid direct contact.
- Work in a well-ventilated area or under a fume hood to avoid inhaling fumes from volatile chemicals.
- Always wear safety goggles
- Be cautious when using the Bunsen burner and hot water bath. Always use heat-resistant gloves when handling hot equipment or containers.
- Never leave the Bunsen burner unattended while it is lit.

Introduction

An ester is an organic compound that is formed when a carboxylic acid reacts with an alcohol while in the presence of a strong mineral acid such as sulfuric acid acting as a catalyst. When carboxylic acids are esterified by being combined with an alcohol to form an ester, many of the resulting esters have a very pleasant smell. That is why esters are often found in perfumes and essential oils. Synthetic esters produced in the laboratory are nearly the same molecules that give fruits their characteristic fragrance.

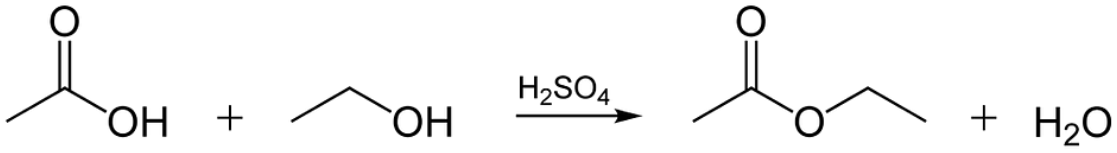

Figure 6.2.1. An Esterification reaction is a dehydration reaction

A carboxylic acid contains the -COOH functional group. In an ester, the hydrogen in this group is replaced by a hydrocarbon group of some kind. This could be an alkyl group like methyl or ethyl, or one containing a benzene ring like phenyl. A common ester is ethyl ethanoate. In this case, the hydrogen in the -COOH group has been replaced by an ethyl group. The formula for ethyl ethanoate is shown below:

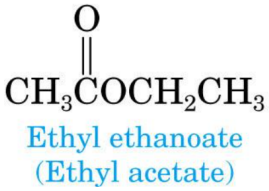

Figure 6.2.2. Ethyl ethanoate

Notice that the ester is named the opposite way from the order in which its formula is written. The “ethanoate” formula shown in blue comes from ethanoic acid. The “ethyl” comes from the ethyl group on the end.

Naming Esters: The common names for esters are derived from the organic acid and the alcohol from which they are derived. For example, when acetic acid reacts with ethyl alcohol, the resulting ester is commonly called ethyl acetate.

However, the International Union of Pure and Applied Chemistry (IUPAC) is responsible for formally naming chemical compounds, and per the IUPAC rules, acetic acid is called ethanoic acid. Thus, the ester formed is called ethyl ethanoate. IUPAC names for esters come from two words: first from the prefix of the alcohol and second from the name of the acid. Drop the ” –ic acid” from the IUPAC acid name and add “-ate.”

An ester from methanol or methyl alcohol and ethanoic acid (acetic acid) is named as follows:

1. From the alcohol comes the prefix “methyl”
2. From the ethanoic acid, drop “–ic acid” and add “–ate,” making it ethanoate
3. Thus, the full IUPAC name is: methyl ethanoate
4. The common name is: methyl acetate since acetic acid becomes acetate

Procedure

Part I

1. Use the Data Table on the report sheet for recording your observations for both Parts I and II.
2. Mark three small test tubes with the numbers 1 and 2. Record which number will relate to which ester as reflected in the Data Table.
3. Place the test tubes in a rack or well plate to securely hold them while you perform the experiment
4. Place 4 drops of acetic acid into test tubes #1 and #2.
5. Place 5 drops of isopentyl alcohol (also known as isoamyl alcohol) into test tube #1.
6. Place 5 drops of butanol into test tube #2.
7. Add 2 drops of sulfuric acid to each test tube.
8. Gently swirl, shake, and agitate each test tube to mix the acids and alcohols
9. Set up the burner stand and Bunsen burner as demonstrated by your instructor.
10. Half-fill the 100 mL glass beaker with very hot tap water and place it on the burner stand and heat until the water come to a rolling boil.
11. After the water has begun to vigorously boil, extinguish the Bunsen burner. The water will remain hot long enough for the esterification reaction to take place.
12. Use a hot-glove to transfer the beaker of hot water from the burner stand to your work area.
13. Place the three test tubes with the acid-alcohol mixtures into the beaker of hot water and let them stand in hot water for 5 minutes.
14. Use a clamp to remove the test tubes, one at a time, from the hot water bath. Suck water up into an empty pipet and then drop 20 drops of water from the pipet into each test tube’s contents. Agitate to mix. Then replace the test tubes into the test tube stand
15. Cautiously try to detect the odor of the products in each test tube by using your hand to waft the scent from the test tube toward your nose. Do this until you can detect and record an odor. Do not worry about having the “correct” odor for a particular ester. Descriptions of odors often vary with people, and some odors hard to describe.
16. Pour the contents of the test tubes into the labeled waste container. Wash the test tubes with the test tube brush, rinse with distilled water, and set to dry.

Part II

1. Mark 2 small test tubes with the numbers 3 and 4. Record which number will relate to which ester as reflected in the Data Table.
2. Place the test tubes in a rack or well plate to securely hold them while you perform the experiment
3. Using weigh-boat or weigh-paper on the digital scale, weigh 0.2 grams of salicylic acid and then transfer it into test tube #3. Repeat this for test tube #4.
4. Place 5 drops of methanol into test tube #3.
5. Place 5 drops of ethanol into test tube #4.
6. Add 2 drops of sulfuric acid to each test tube.
7. Repeat steps 8-17 of Part I for test tube #3 and #4.
