Chemistry | Organic Chemistry

Tests for Hydroxyl Group

General Aim

Identification of aliphatic alcohols through the chemical detection of hydroxyl groups.

Method

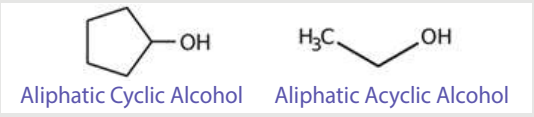
Detection of the presence of hydroxyl groups in aliphatic alcohols using special chemical tests.

Learning Objectives (ILOs)

- Define and determine aliphatic alcohols theoretically through their chemical structure.
- Classify organic compounds containing hydroxyl groups into aliphatic and aromatic.
- Compare between alcohols and other functional groups in terms of chemical structures, properties and reactions.
- Identify aliphatic alcohols experimentally.
- Select the appropriate reagents to differentiate between alcohols and other organic compounds.

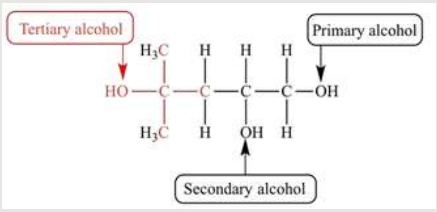
Theoretical Background/Context

- Aliphatic alcohols are non-aromatic hydrocarbons possessing at least one hydroxyl group within their structure. They can be either cyclic or acyclic compounds. Alcohols are considered to be neutral compounds.



Aliphatic Cyclic Alcohol Aliphatic Acyclic Alcohol

- Alcohols are also classified to primary, secondary and tertiary alcohols according to the number of carbon atoms attached to the carbon atom linked to the hydroxyl group.



First: Preparation of Aliphatic Alcohols

- Alcohols can be prepared through some chemical routes such as reduction of the corresponding aldehydes and ketones using some reducing agents such as lithium aluminum hydride or sodium borohydride. They can be also obtained from hydration of the corresponding alkenes. Some primary alcohols can be synthesized through the nucleophilic substitution of corresponding alkyl halides using potassium or sodium hydroxides.
- Alcohols can be also obtained through some biological routes such as ethanol and butanol through fermentation processes in presence of glucose. Glucose is obtained from starch hydrolysis in the presence of yeast.

Theoretical Background/Context (Cont')

Second: General Properties of Aliphatic Alcohols

- Aliphatic alcohols are polar compounds and can form hydrogen bonds easily. Simple alcohols such as methanol, ethanol and propanol are highly miscible in water. Longer ones such as butanol are moderately miscible with water. In general, alcohols are more soluble than their corresponding alkanes in water due to formation of hydrogen bonds with water molecules.
- Alcohols have higher boiling points than that of their corresponding alkanes or ethers owing to the ability of alcohols to form hydrogen bonds.

Third: Occurrence of Aliphatic Alcohols in Nature

Aliphatic alcohols such as ethanol are dominant in nature as a byproduct of fermentation processes.

Forth: Uses of Aliphatic Alcohols

- Many aliphatic alcohols have been used in different industrial and pharmaceutical applications. For instance, methanol is used as fuel and in production of formaldehyde.
- Ethanol is also used in beverages industries, and as a solvent in preparation of some pharmaceutical products such as elixirs. In addition, it has been used as fuel. Ethanol is also used as a sanitizer and antibacterial in gels and wipes.
- Longer alcohols and fatty alcohols have been used in the industries of plasticizers and detergents.

Principle of Work

- In this experiment, aliphatic alcohols are tested through detecting their hydroxyl groups using chemical tests. In addition, these tests can be used to differentiate between alcohols and other organic classes, especially those containing hydroxyl groups. This is done through using specific reagents.

Acetyl Chloride Test: In this test, acetyl chloride is added to a sample containing alcohol. The acetyl chloride reacts with the alcohol producing esters and hydrochloric gas. The hydrochloric acid gas is then detected using ammonium hydroxide where white fumes of ammonium chloride are formed as shown in the following reactions. Ammonia gas then can be detected using hydrochloric acid as they react together forming white fumes of ammonium chloride as shown in the following chemical reactions.

$$C_2H_5OH + CH_3COCl \rightarrow CH_3COOC_2H_5 + HCl \uparrow$$

$$HCl + NH_4OH \rightarrow H_2O + NH_4Cl \uparrow$$