Organic Compounds

Functional Group Identification

Many organic compounds contain an atom or group of atoms that substitute for hydrogen or carbon in a basic hydrocarbon. The atom or group of atoms is commonly referred to as **functional group**. Each imparts characteristic chemical properties to the substituted hydrocarbon.

The aim of this experiment is to study the chemical properties of several functional groups: alcohols, carboxylic acids, phenols, aldehydes and ketones.

Alcohols

They are hydrocarbons in which an (-OH) replaces a hydrogen atom. Alcohols are classified as primary (ethanol), secondary (isopropanol), and tertiary (tertiary butanol).

Oxidation:

All alcohols (except tertiary alcohols) are oxidized by potassium permanganate ($KMnO_4$) and potassium dichromate ($K_2Cr_2O_7$) to give aldehydes or ketones.

Procedure:

A. Oxidation by $KMnO_4$:

1) Place 10 drops of sample in 3 separate test tubes.
2) Add 5 drops of 2% $KMnO_4$ to each tube and heat and notice:
    a. In case of primary alcohol a brown precipitate will be formed. Primary alcohol will be oxidized to aldehyde then further into carboxylic acid.
    b. Secondary alcohol will be oxidized to ketone and a brown precipitate will be formed (MnO_2).
    c. No reaction with the tertiary alcohol.

B. Oxidation by $K_2Cr_2O_7$: 2-3g of $K_2Cr_2O_7$ is dissolved in few mls of water then continue the volume to 500 ml with conc. H_2SO_4 with cooling.

1) Place 10 drops of sample in 3 separate test tubes.
2) Add 5 drops of $K_2Cr_2O_7$ solution, heat and notice that:
    a. Primary alcohol: a green solution will be formed.
    b. Secondary alcohol: a green solution will be formed.
    c. Tertiary alcohol: no reaction.

$$\mathbf{R\text{-}CH_2\text{-}OH + K_2Cr_2O_7 \xrightarrow{H2SO4} R\text{-}CHO + CrO_3 + K_2SO_4}$$

Phenols

Are aromatic hydrocarbons consisting of a benzene ring attached to –OH group. They are more reactive than alkanes but less reactive than alkenes and alkynes.

They are soluble in 5% sodium hydroxide, but insoluble in 5% NaHCO3.

They react with a solution of bromine in carbon tetrachloride by substitution and an equivalent quantity of hydrogen bromide is evolved. they yield intense coloration (blue, green, red, or purple) when treated with a solution of ferric –chloride.

Ferric chloride test:

1) To small quantity of phenol add one drop of $FeCL_3$.
2) Complex coloration will be formed according to the type of phenol used.

Carboxylic Acids

Organic acids are prepared by the oxidation of primary alcohols or aldehydes with strong oxidizing agent e.g. $KMnO_4$.

Carboxylic acids are soluble in 5% sodium hydroxide and 5% of sodium bicarbonate ($NaHCO_3$) (The latter reaction is accompanied by the evolution of CO_2)

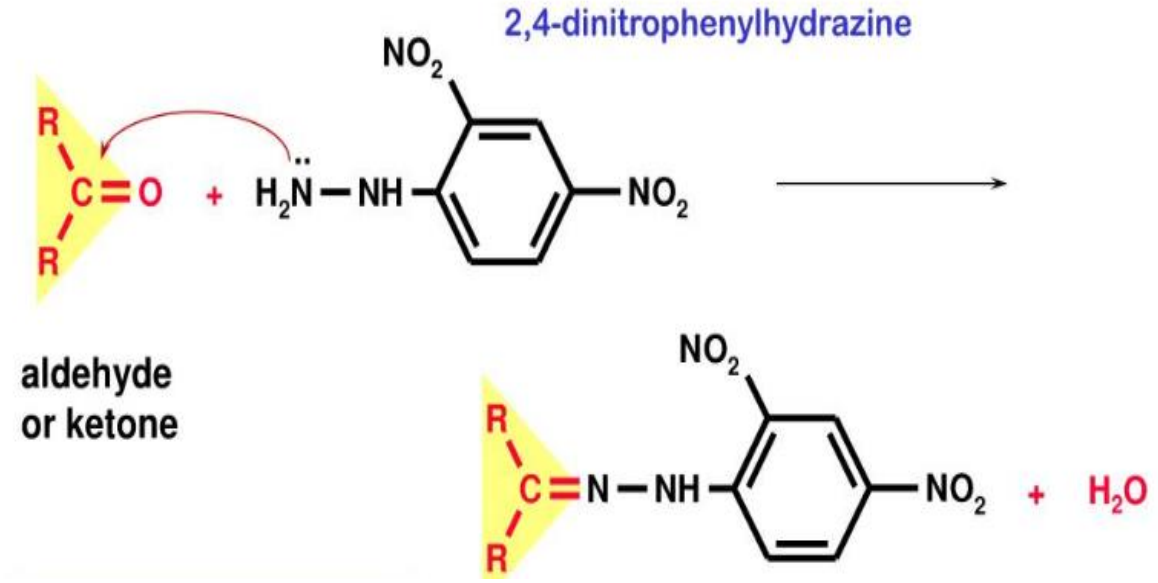
Carboxylic acids are non-reactive towards a solution of bromine in CCL_4. They give positive test with ferric chloride $FeCL_3$ solution.

Ferric chloride test:

3) To 10 drops of carboxylic acid add 3 drops of $FeCL_3$.
4) Observe the color change.

Aldehydes and Ketones

Both aldehydes and ketones contain the carbonyl group, hence a general test for carbonyl compounds will immediately characterize both classes of compounds. The preferred reagent is 2.4- dinitrophenyl hydrazine (DNP) which give insoluble phenyl hydrazone with carbonyl compounds.



Test for carbonyl group:

1) To 10 drops of the sample add 5 drops of 2.4- dinitrophenyl hydrazine.
2) Yellow-Orange precipitate will be formed.

Reagent: (2.4- dinitrophenyl hydrazine)

- Dissolve 0.25g of 2.4- dinitrophenyl hydrazine in 42 ml of conc. HCL and 50 ml of water, heat in water bath and complete the volume to 250 ml

Aldehydes can be oxidized to carboxylic acids using oxidizing agents such as Tollen's and Fehling's reagents.

Tollen's Reagent: (freshly prepared)

1) Add few drops of 10% NaOH to $AgNO_3$ (10%), a brown precipitate will be formed (Ag_2O).
2) Then add drop by drop dilute ammonia till all Ag_2O get dissolved

Procedure:

1) Add few drops drops of aldehyde sample to Tollen's reagent.
2) Warm in hot water bath for about (2-5) min.
3) A silver mirror is deposited on the walls of the tube.

$$\mathbf{R\text{-}CHO + 2\,[Ag(NH_3)_2]^+ + 3OH^- \longrightarrow R\text{-}COO^- + 2Ag\downarrow + 2H_2O + 4NH_3}$$

(silver mirror)