CARBON AND ITS COMPOUNDS

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Summary

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- Study of the compounds of carbon is organic chemistry. They form the basis of living organisms and the things around us.
- An unique property of carbon is 'catenation'. It is the property of forming bonds with the atoms of the same element. The catenation property of carbon is the basis of organic chemistry.
- Carbon is tetravalent in nature and forms the single, double and triple covalent bonds to combine with elements hydrogen, oxygen, sulphur, nitrogen and chlorine to form various types of compounds
- Isomers are compounds having same molecular formula but different structural formula. Carbon compounds display isomerism.
- An atom or a group of atoms that determine the characteristic properties of a carbon compound is called Functional group
- Functional groups such as alcohols, aldehydes, ketones, ethers, carboxylic acids give characteristic properties to these compounds
- Compounds containing only carbon and hydrogen, as their elements are known as Hydrocarbons. Hydrocarbons are a parent group of carbon compounds with many sub functional groups.
- Carbon compounds are known to exist as linear chains, branched chains and cyclic rings
- Nomenclature is the system of assigning a proper name to a particular organic compound on the basis of certain rules
- Combustion, oxidation, addition and substitution reactions are the important reactions of carbon compounds
- Carbon compounds are major sources of our fuels
- Ethanol and ethanoic acid are two important compounds used in our daily life
- Ethyl alcohol (commonly referred to as alcohol), may serve as source of energy in small quantities. But in large amounts it affects the nervous system. Methyl alcohol is poisonous and can cause blindness and be fatal.
- Soaps are sodium or potassium salts of long chain fatty (carboxylic) acids containing both hydrophobic and hydrophilic groups that emulsifies dirt to remove it.

Acetic acid is one of the commonest organic acids and has been known for quite a long time in the form of vinegar. It is also present free in a number of fruit juices. In the combined state it occurs in many oils and essential oils.

Formula: CH_3COOH, IUPAC Name: Ethanoic acid

Acetic acid is a colour less, corrosive liquid with a pungent smell at ordinary temperatures. But below 290K, it solidifies to an icy mass called glacial acetic acid. It boils at 391K and its specific gravity is 1.08 at 273K. It is miscible with water, alcohol and ether in all ratios. It is a good solvent for phosphorus, sulphur, iodine and inorganic compounds.

Since acetic acid contains an alkyl group and an acid moiety (each of the two parts into which a thing is divided), it exhibits the properties of both these groups.

Reactions of Alkyl Group - Halogenation

In acetic acid, halogen atoms successively replace the three hydrogen atoms of the alkyl group.

$$\underset{\text{Acetic acid}}{CH_3COOH} + Cl_2 \longrightarrow \underset{\text{monochloro acetic acid}}{CH_2ClCOOH} + HCl$$

$$CH_2ClCOOH + Cl_2 \longrightarrow \underset{\text{Dichloro acetic acid}}{CHCl_2COOH} + HCl$$

$$CHCl_2COOH + Cl_2 \longrightarrow \underset{\text{Trichloro acetic acid}}{CCl_3COOH} + HCl$$

Reactions Involving Replaceable Hydrogen Atom

Acetic acid ionizes in polar media to give hydrogen ion that is responsible for its acidic behaviour.

$$CH_3COOH \rightleftharpoons CH_3COO^{(-)} + H^{(+)}$$

Accordingly, acetic acid can react with alkalis and alkali metal carbonates and also with metals.

With Alkalis, Carbonates and Bicarbonates

Acetic acid turns blue litmus to red, neutralizes alkalis to form salt and water. It also decomposes carbonates and bicarbonates to liberate carbon dioxide indicated by effervescence.

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

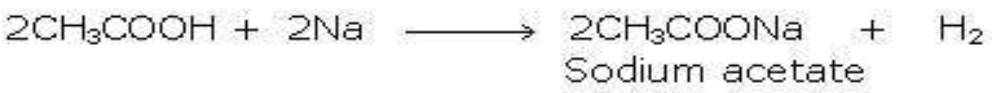
$$2CH_3COOH + Na_2CO_3 \longrightarrow \underset{\text{Sodium acetate}}{2CH_3COONa} + H_2O + CO_2\uparrow$$

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COO^-Na^+ + H_2O + CO_2\uparrow$$

Bicarbonate test is used as an identification test for the presence of carboxylic group in a compound.

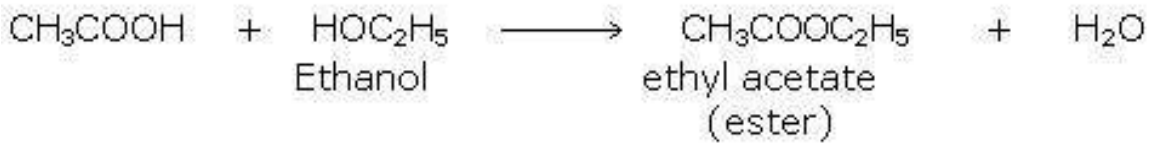
With Metals

Acetic acid reacts with strongly electropositive metals like sodium and zinc to give the respective acetate and liberate hydrogen.



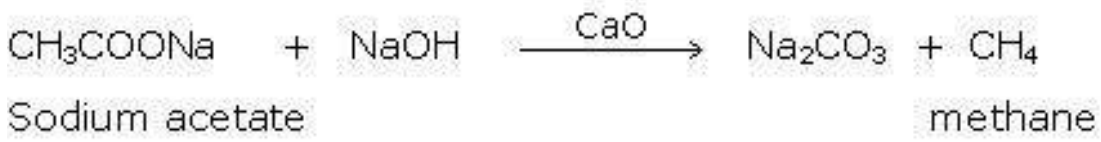
With Alcohols

Acetic acid reacts with alcohols in the presence of dehydrating agents like anhydrous zinc chloride or concentrated sulphuric acid to form esters.



Reactions Involving Carboxyl Group as a Whole

Dry distillation of the anhydrous alkali salts of acetic acid with soda-lime yields methane.



Reduction

Though acetic acid is resistant to reduction, prolonged heating under pressure with concentrated hydriodic acid and red phosphorus gives ethane.

This is also possible by heating the acid with hydrogen at high temperature and under pressure in the presence of a nickel catalyst.

$$CH_3COOH + 3H_2 \xrightarrow{Ni} C_2H_6 + 2H_2O$$

In the presence of lithium aluminium hydride, acetic acid can be reduced to ethanol. Hydrogenation in the presence of ruthenium or copper-chromium oxide catalyst gives the same result.

$$CH_3COOH + 3H_2 \xrightarrow{LiAlH_4} CH_3CH_2OH$$

Oxidation

On prolonged heating with a strong oxidizing agent, acetic acid is oxidized to carbon dioxide and water.

$$CH_3COOH \xrightarrow{[O]} 2CO_2 + 2H_2O$$

Uses

- Ethanoic aid is used in the manufacture of dyes, perfumes and rayons.
- Manufacture of rubber from latex and casein from milk. It is used for coagulation.
- In the form of salts in medicine and paints.
- In the form of acetates of aluminium and chromium is used as mordants.
- In dilute form is used as vinegar and in the concentrated form as a solvent.
- In form of organic esters as perfumes.