CHAPTER TWENTY FOUR

ALKANOLS (ALCOHOLS), THE ORGANIC ACIDS AND ESTERS

Alcohols:

- They form a homologous series and have the general formula C_nH_{2n+1} or R – OH, where R is an alkyle group.
- The first two members of the series are methanol (CH_3OH) and ethanol (C_2H_5OH), simply known as alcohol.
- These two are respectively known as methyl alcohol and ethyl alcohol.
- Ethanol like the other alcohols, is a good solvent for substances that are not soluble in water.
- This implies that these substances are soluble in it.
- It is a volatile liquid which means that it evaporated quickly and for this reason, it is used in glues, paints, varnishes, printing ink and perfumes.
- It is also used as the raw material for making other substances, such as flavorings and surgical and photographic collodions.
- It is also used in making alcoholic beverages.
- Ethanol when mixed with methanol gives rise to methylated spirit.
- Ethanol when drank over a long period of time ruins the liver.
- All the alcohols contain the OH group, and it is this group which determines their properties or characteristics.

Physical properties:

- The simple alcohols such as methanol and ethanol are liquids at room temperature and pressure.
- Alcohols are colourless and volatile and they have a characteristic smell.
- They have high boiling points since they contain hydrogen bonding.
- They are soluble in water because of their ability to form hydrogen bonds with water molecules.
- They are polar compounds and their polarity is due to the presence of the OH group.

- Their boiling point increases as the number of carbon atoms increases.

The acidity of alcohol:

- Like water, alcohols are able to lose H^+ ions into solution, in order to make the solution acidic.

Basicity of alcohol:

- Alcohols are basic because of their ability to release OH^- ions into solution.

Manufacture of alcohol (ethanol):

(a) Ethanol from starch:

- Items such as potatoes, cereals, cassava and yam contain starch ($C_6H_{10}O_5$).
- The fermentation of any of these starch containing substances will lead to the production of alcohol (ethanol).

(b) Ethanol from sugar:

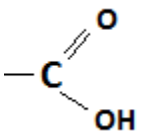
- Items such as palm wine, sugar cane, pineapple juice and orange juice contain a type of sugar called sucrose ($C_{12}H_{22}O_{11}$).
- By using the right chemical process, alcohol can be obtained from the sucrose.

Industrial source of alcohol:

- There are two methods used in the preparation of alcohol industrially, and these are:
  (1) By the hydration of alkenes obtained from petroleum cracking.
  (2) By the fermentation of carbohydrate.

The organic acids (carboxyclic acids):

- Carboxyclic acids are organic acids with –COOH functional group i.e;



- Their names end with oic acid.

- A monocarboxylic acid is a compound with only one COOH group in its structure, and those with two COOH groups are called dicarboxylic acids, e.g. ethanoic acid $(COOH)_2$.
- Their general molecular formula is $C_nH_{2n+1}COOH$.
- The first member of the carboxylic acid homologous series is methanoic acid, also known as formic acid (H.COOH or CH_2O_2).
- The second member is ethanoic acid, which is commonly known as acetic acid (CH_3COOH or $C_2H_4O_2$).
- They are usually called saturated, aliphatic, or fatty acids because many of their higher members are found in natural fat.
- Some of the common fatty acids and their sources are:

Name:	**Sources:**
Hexadecanoic acid (Palmitric acid)……..	Palm wine.
Methanoic acid……	Ants .
Ethanoic acid……..	Vinegar.
Citric acid……	Citrus fruits.
Lactic acids ……..	Sour milk.
Tartaric acid……..	Tartar.
Stearic acid ……..	Animal/ vegetable fat.
Oleic acid……	Butter fat, groundnut oil.

- Methanoic acid (CH_3cooH) and ethanoic acid like the other members of the series have several important uses.
- Methanoic acid is used as:

  (I) a reducing agent.

(II) a drying agent in the textile industry.

(III) a starting material in the preparation of medicines and other organic compounds.

- Ethanoic acid is used in the

(I) preparation of certain esters.

(II) preparation of rayon and aeroplane dope.

(III) in the manufacture of adhesives for wood, paper and glass.

(IV) preparation of vinegar for food preservation.

- As a result of the presence of hydrogen bonding, the boiling point of carboxylic acid is higher than expected.
- Carboxylic acids are highly soluble in water, because of the formation of hydrogen bonding between carboxylic acid and water molecules.

Physical properties:

- The lower members are liquids.
- Solubility increases down the group.

Weak acid:

- Carboxylic acids are weak acids, because they are not completely dissociated in solution.
- Their acidity is due to their ability to release H^+ ions in solution.

Ester formation:

- Carboxylic acid reacts with alcohol in the presence of a mineral acid, under boiling conditions to give rise to a compound which has a sweet smelling scent known as ester.

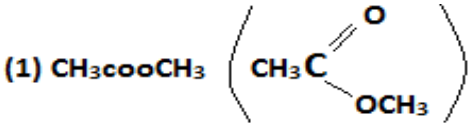
Uses:

- In the manufacture of vinegar, drug and dyes.

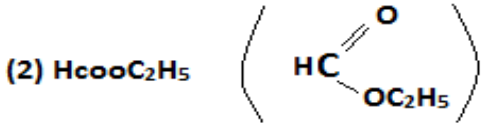
Esters:

- They are also referred to as alkyl alkanoates.
- They are pleasant smelling liquids or solids, which are formed when organic acids react with alkanols.

- They have the general molecular formula of $R_1CH_2cooH_2R$, where R_1 and R_2 may be the same or different hydrocarbon residues such as CH_3, C_2H_5 etc.
- For example, $CH_3cooC_2H_5$ is ethyl ethanoate, which is a pleasant smelling ester.
- Esters are of considerable importance in nature, and are sometimes recognized by their characteristic fruity odour.
- They are mainly responsible for the fragrance of flowers and the flavors of fruits.
- Fats and oils are esters formed from the reaction of the trihydric alcohol called glycerol and fatty acids such as hexadecanoic acid ($C_{15}H_{31}cooH$).
- The names of esters end with oate and examples are



methyl ethanoate



ethyl methanoate

Physical properties:

(1) Simple esters are colourless liquids. (2) They have pleasant or sweet smelling scent.

Preparation:

- As ester such as ethyl ethanoate, can be prepared in the laboratory by the reaction of ethanol and glacial ethanoic acid, using concentrated tetraoxosulphate (vi) acid as catalyst.
- The fractional distillation of the resulting reaction mixture, results in the recovery of the ester.

$$CH_3cooH_{(L)} + C_2H_5OH_{(L)} \longrightarrow CH_3cooC_2H_{5(L)} + H_2O_{(L)}$$

acid ethanol ester water

- The process in which esters are produced by the interaction of organic acid and alcohol is called esterification.

Esterification and neutralization:

- There is a formal similarity between esterification and neutralization.
- For in each case, acid is one of the reactants with water being one of the end products.

  Examples:

  (1) $CH_3cooH + C_2H_5OH \longrightarrow CH_3cooC_2H_5 + H_2O$
  acid ethanol ester water

  (2) $CH_3cooH + NaOH \longrightarrow CH_3cooNa + H_2O$
  acid base salt water

- However, these two processes differ fundamentally because of these reasons:
- Neutralization is an ionic reaction which occurs instantaneously, and proceeds practically to completion.
- But the esterification process is slow, non-ionic and reversible, which requires a catalyst and heat energy to proceed.
- Esterification is not a neutralization process, since alcohols are natural substances.

Fats and oils:

- Fats and oils are known as triglyceride.
- They are mainly the esters formed from the interaction of glycerol (propane – 1, 2, 3 – triol) and long chain fatty acids such as hexadecanoic acid.
- The glycerol contains an alkyl group and when this group is mainly unsaturated, the compound is known liquid glyceride or oil.
- On the other hand, when this group is mainly saturated, the compound is known as solid glyceride or fat.
- At room temperature, fat is solid and oil is liquid.
- Since the alkyl group of the oil is mainly unsaturated, then it contains either a double bond or a triple bond.
- By a process known as catalystic hydrogenation, oil may be converted to fat.
- In this process, the double bond or the triple bond in the alkyl group is converted into a single bond, leading to the formation of a solid glyceride or fat.

- This process is employed in the manufacture of margarine.
- Glycerol esters are called glycerides.
- Fats are mainly the glycerides of saturated fatty acids, whereas oils are the glycerides of a mixture of both saturated and unsaturated fatty acids.

  Examples of fats are Shea-butter, butterfat and tallow and that of oil are palm oil, palm kernel oil and coconut oil.