Unit -6 First part
Properties , Importance, Classification of Organic Compound

Properties of Organic Compounds

Organic compounds having following characteristics :

(1) Sources : Organic compounds are mostly obtained from living kingdom *i.e.*, from animal and vegetable kingdom. Where as inorganic compounds are obtained from minerals obtained from earth crust, land, water and air etc.

(2) Presence of elements in the compound : Carbon and hydrogen are the essential elements of these compounds. Besides these elements, they have O, S, N and P. They are all combustible elements.

(3) Similarities in the properties : They have the similarities in their properties. Almost all organic compounds get decomposed at red-hot heating.

(4) Complexity of molecules : Generally, the structures of these compounds are very complex. Hence, they are high molecular weight compounds. *e.g.*, the molecular weight of proteins is from 10000 to lakhs. Inorganic compounds do not have such complexity.

(5) Catenation property : Carbon atoms have the capacity to form a chain by combining with each other, this is called **catenation property.** This property is specially found in C, Si, S and P atoms. Carbon atoms combine to each other to form **open chain and closed chain** compounds. Due to the catenation property the number of known organic compounds has been increased up to 20 lakhs while the number of inorganic compounds is only about 90000 to 2 lakhs. Carbon atom has the more catenation property because the bond energy of carbon atom is more. The binding energies of some elements are given as :

Element	C-C	Si-Si	N-N	P-P	O-O	S-S
Binding Energies (K.Calories)	85	54	39	50	35	54

The catenation property decreases with the decrease in the binding energy.

(6) Solubility : Organic compounds are insoluble in water but soluble in organic solvents like ether, alcohol and benzene etc. While the inorganic compounds behave contrary to it.

(7) Isomerism : It is the special characteristic of organic compounds in which two or more compounds are represented by the same molecular formula. When two or more compounds having the same molecular formula but different structural formula, physical and chemical properties, are called **isomers** and the phenomenon is called **isomerism** *e.g.*,. The following two isomers are represented by the same molecular formula (C_2H_6O) :

(a) C_2H_5OH (ethyl alcohol)

(b) $CH_3—O—CH_3$ (dimethyl ether)

Sources of Organic Compounds

The main sources of organic compounds are :

(a) Plants and animals : A number of compounds are obtained from plants and animals directly *e.g.*, proteins, fats, vitamins, oils and carbohydrates etc.

(b) Coal : When coal undergoes destructive distillation, coke is formed. About 200 organic compounds are obtained from the coke.

(c) Natural gas and petroleum : A number of organic compounds are formed from petroleum industry, *e.g.*, solvents, rubber, plastics and explosives etc.

(d) Fermentation : The fermentation of some complex organic compounds is done in the presence of enzymes *e.g.*, alcohol, glycerol, vitamin and acetic acid etc.

Composition of Organic Compounds

Except carbon atom these compounds also contain H, O and N elements. The compounds which are formed by the combination of carbon and hydrogen are called hydrocarbons. *e.g.,* methane and ethane etc. besides this, C, H and O are also found in sugar, oil and starch also. The compounds which are obtained from animal kingdom have C, H, O and N elements *e.g.,* protein and urea etc.

Importance of Organic Compounds

Organic chemistry has its importance in our daily life. Our food, clothes, shoes, medicines and other things are obtained from organic compounds. Some of the substances obtained from organic compounds have been given as below :

(1) **Food :** Proteins, fat and oils, vitamins, gelatin, carbohydrates and starch etc.

(2) **Medicines :** Sulpha drugs, streptomycine, penicillin, asperin, paracetamol, disprin, darolac and Ceryle etc.

(3) **Clothes :** Silk, jute, Nylon, daeron, polyester and terylene etc.

(4) **Mordants :** Congored, indigo and malachite green etc.

(5) **Explosives :** Dynamite, tri nitrotoluene (T.N.T.) and nitroglycerine etc.

(6) **Scent :** Camphor, cytral and ionone etc.

(7) Insecticide and pesticides : Dichloro diphenyl trichloro ethane (D.D.T.) and benzene hexa chloride (B.H.C.) etc.

(8) Other materials : Pigments, paper, soap, detergents, rubber and plastics etc.

Main Characteristics of Carbon Atom

Main characteristics of carbon atoms are as follows :

(1) Tetra valency of carbon : The atomic number of carbon is six. Its tetra valency is proved on the basis of its ground state and excited state :

$C_6 \longrightarrow 2, 4$ or $1s^2, 2s^2 2p^2$ (Ground state configuration)

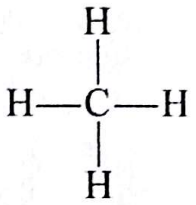
$C_6 \longrightarrow 1s^2, 2s^1\ 2px^1\ 2py^1\ 2pz^1$ (Excited state electronic configuration)

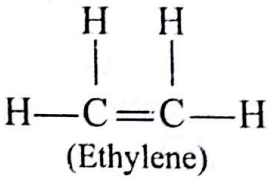
In this, way each carbonatom forms four covalent bonds. Hence, it forms, four single bonds or two double bonds or one covalent and three triple bonds.

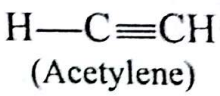
e.g., CH_4, C_2H_4 and C_2H_2 etc.

(2) Equivalence of four valencies of carbon : The four valencies of carbon are similar and their position is in the symmetrical form.

(3) Bonding capacity of carbon atom : Carbon atoms have the capacity to combine with each other and form the bonds. It is called **catenation property.** Due to this nature carbon atom forms single bond, double bond and triple bond. They may be represented as :

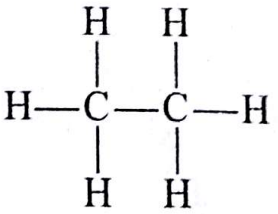

(Methane)

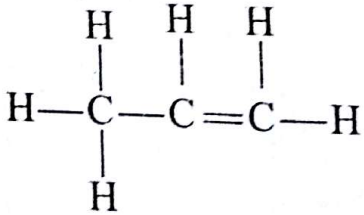

(Ethylene)

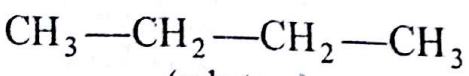

(Acetylene)

They form the two types of chains :

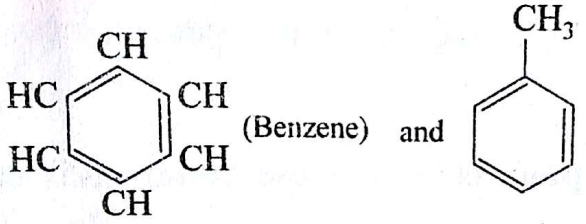
(a) Open chain compound : In these compounds carbon-carbon atoms are linked in the form of open chain compounds *e.g.*, :


(Eethane)


(Propene-1)


(*n*-butane) etc.

(b) **Closed chain compounds :** In these compounds carbon-carbon atoms are linked with each other in the form of closed chain *e.g.*, :



(Benzene) and

(toluene) etc.

(4) Arrangement of carbon valencies : The form valencies of carbon are not situated in the same plane. According to Lebel and Vant Hoff. "The carbon atom is present in the centre of a regular tetrahedral structure and the form valencies of carbon are directed towards the form corners of a regular tetrahedron and the angle between the two valencies is 109°28".

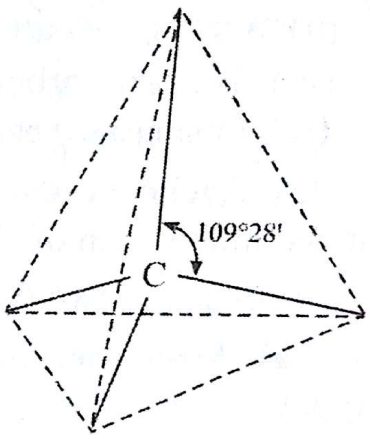


Fig. 6.1 Arrangement of Valencies

Classification of Organic Compounds

When Wohler (1820) synthesised urea in the laboratory and discarded **"Vital force theory"** of Berzelius, after it great revolution has come in the field of organic chemistry. At present about 24-25 lakh organic compounds are known. Hence, to create interest in the study of organic compounds they are classified as :

(1) Open chain or aliphatic compounds : In these compounds carbon-carbon atoms are linked with each other in the form of open chain. This type of chain may be of branched or unbranched. The carbon-carbon atoms are linked in the open chain in fats and fatty acids. Hence, Hoffmann gave the name 'aliphatic' to these hydrocarbons *e.g.*,.

$$CH_3—CH_2—CH_2—CH_2—CH_3$$

(*n*-pentane) (un-branched)

$$CH_3—CH_2—CH_2—\underset{\displaystyle CH_3}{\underset{|}{CH}}—CH_2—CH_3$$

(3-methyl hexane) (branched)

They are classified as :

(a) Hydrocarbons : They are made up of only carbon and hydrogen *e.g.*, CH_4 (methane), C_2H_4 (ethylene) and C_2H_2 (Acetylene) etc.

Methane is ancestor of all the hydrocarbons. Scientists thought that methane is the base of life.

In September 2014, Mars Orbital Mission (MOM) sent on the Mars planet to know about presence of methane.

(b) Hydrocarbon derivaties : Those hydrocarbons in which one or more hydrogen atoms are replaced by any other functional group are called as **hydrocarbon derivaties.**

e.g., Ethyl alcohol (C_2H_5OH) and methyl chloride (CH_3Cl) etc.

The carbon atoms, in organic compounds present in carbon chains are of four types :

(i) Primary carbon atom

(ii) Secondary carbonation

(iii) Tertiary carbon atom

(iv) Quaternary carbon atom

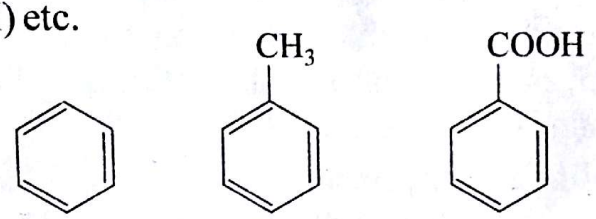
(2) Cyclic or closed chain compounds : In these compounds carbon atoms are linked in the form of closed chain.

They are of two types :

(a) Aromatic compounds : They have some specific properties. They are of two types :

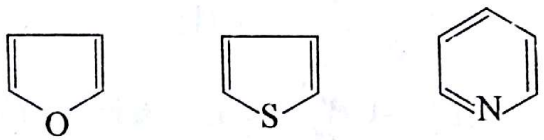
The word aromatic is taken from a greek word **"aroma"** means specific odour or smell. They are of two types :

(i) Carbocyclic or homocyclic aromatic compounds : Those compounds in which the closed chain is composed of carbon and hydrogen atoms only hence they are called aromatic or carbocylic compounds. *e.g.*, benzene (C_6H_6), toluene ($C_6H_5CH_3$) and benzoic acid (C_6H_5COOH) etc.



(Benzene) (Toluene) (Benzoic Acid)

(ii) Heterocyclic compounds : Those compounds in which N, S and O atoms are also present in the carbon chain besides carbon and hydrogen atoms are called heterocyclic compounds.

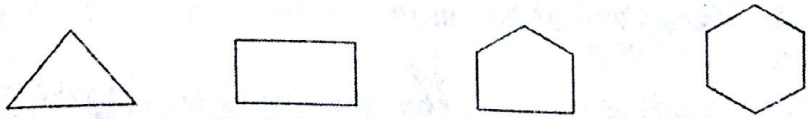


(Furan) (Thiophene) (Pyridine)

(b) Alicyclic compounds : Those cyclic compounds which have the properties similar to the aliphatic compounds are called alicyclic compounds.

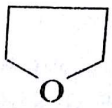
(Ali = Aliphatic + cyclic). They are two types :

(i) Homocyclic compounds : They have only carbon and hydrogen atoms in their cycle *e.g.*, cyclopropane and cyclo butane etc.

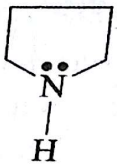


(Cyclo propane) (Cyclo butane) (Cyclo pentane) (Cyclo hexane)

(ii) **Heterocyclic compounds :** These compounds have *N, S and O* atoms other than carbon and hydrogen atoms in their cycle. *e.g.,*



(Tetrahydro Foram)



(Pyrolodine)

(Tetrahydro Furan) (Pyrrolidine)

Hydrocarbons : These compounds are made up of only carbon and hydrogen atoms. These are the parent hydrocarbons of all the organic compounds. They are of the following two types :

(a) Saturated hydrocarbons : Those organic compounds in which carbon-carbon atoms are linked with each other with the single bond are called **saturated hydrocarbons.** *e.g.*, methane (CH_4) and ethane (C_2H_6) etc. Chemically they are very less reactive and only give substitution reactions. So they are called **"paraffins"** (para + affinis).

(b) Unsaturated hydrocarbons : Those compounds in which carbon-carbon atoms are linked with each other through double triple bonds are called unsaturated hydrocarbons. *e.g.*, ethylene ($CH_2 = CH_2$) and acetylene ($CH \equiv CH$) etc. They are also called as olefins and olefines respectively. They give particularly addition reactions.

Homologous series : The series in which organic compounds having similar structure and similar chemical properties are arranged in ascending order of number of carbon atoms is called homologous series. Each member of a homologous series has similarity in chemical properties and chemical composition.

Each member of homologous series is called 'homologue'. The main characteristics of homologous series are as follows :

(1) All the members of the series have the same functional group. *e.g.,* Alcohol series has —OH (hydroxyl) group.

(2) All the members of the series are represented by the same functional group. *e.g.,* The members of alkene series are represented by the general formula C_nH_{2n}.

(3) There is a difference of $—CH_2$ in between the two consecutive members of the series.

(4) All the members of the series have the similarities in their chemical properties.

(5) All the members of the series may be prepared by the same general methods.

(6) The properties of all the members of the series changed with increase in the molecular weight.

(7) There is a difference of 14 a.m.u. in the molecular weights of two consecutive members of the series.

(8) The melting points, boiling points and densities of the two consecutive members are changed with change in the molecular weights.

e.g., (1) Alkene series :

General formula : C_nH_{2n}

Members : C_2H_4, C_3H_6 and C_4H_8 etc.

(2) Aldehyde series :

General formula : $C_nH_{2n+1}\cdot CHO$

Member : CH_3CHO, CH_3CH_2CHO etc.