petroleum chemistry

Chemical engineering department

Al-Mustaqbal-college

First class

second semester

Lecture three

By

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2021-2022

Lecture one

Hydrocarbons

In organic chemistry, a hydrocarbon is an organic compounds consisting entirely of hydrogen and carbon.

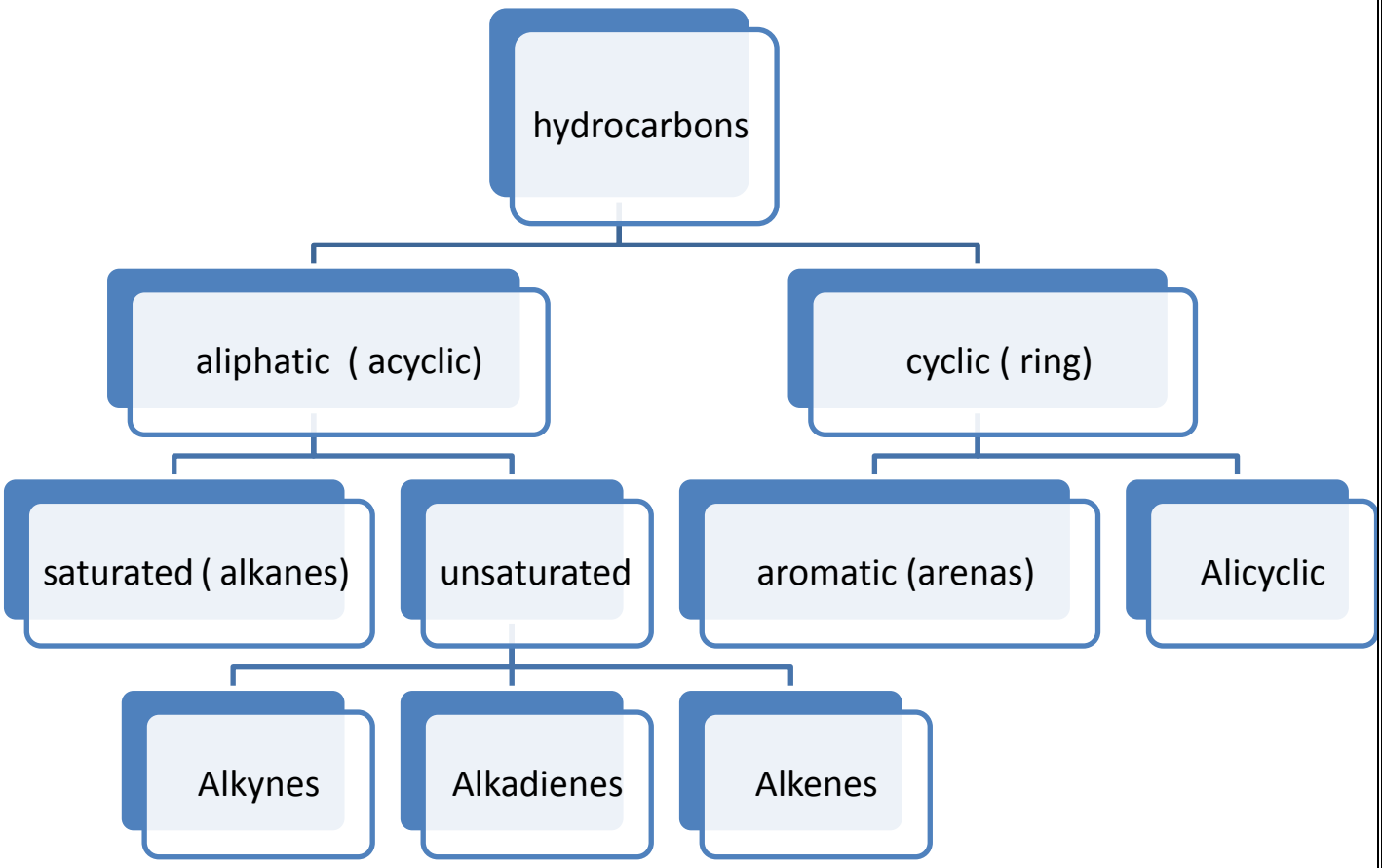

Fig.1: Classifications of hydrocarbons.

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Classifications of hydrocarbons :

1- Aliphatic
2- Aromatic
Or
1. Saturated hydrocarbons : alkanes
2. Unsaturated hydrocarbons: have one or more double or triple bonds between carbon atoms. Those with double bond are called alkenes Those with one double bond have the formula C_nH_{2n} (assuming non-cyclic structures). Those containing triple bonds are called alkynes with general formula C_nH_{2n-2}

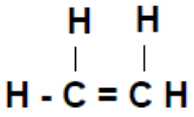
3.Cycloalkanes : are hydrocarbons containing one or more carbon rings to which hydrogen atoms are attached. The general formula for a saturated hydrocarbon containing one ring is **C_nH_{2n}.**

4- Aromatic hydrocarbons : known as arenas are hydrocarbons that have at least one aromatic ring.

For example :

$CH_3CH_2CH_2CH_3$

a saturated hydrocarbn



an unsaturated hydrocarbon

1-Aliphatic compound:

Aliphatic compound is a compound containing carbon and hydrogen joined together in straight chains, branched or non-aromatic rings. Aliphatic compounds can be saturated joined by single bonds (alkanes), or unsaturated, with double bonds (alkenes) or triple bonds (alkynes). Besides hydrogen other elements can be bound to the carbon chain, the most common being oxygen nitrogen sulphur and chlorine.

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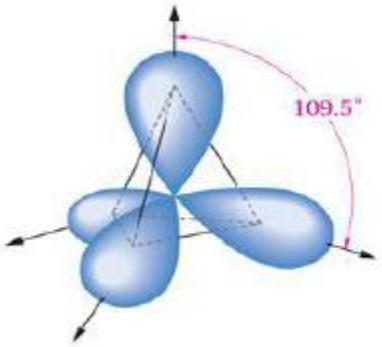
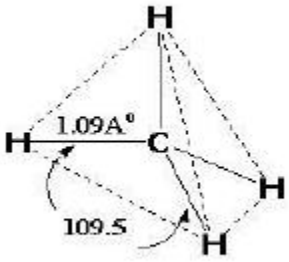
Alkanes

1- Alkanes are the simplest of the hydrocarbon species. The general formula for saturated hydrocarbons is C_nH_{2n+2} .
2- Alkanes are the hydrocarbons of aliphatic row.
3-Alkanes are hydrocarbons in which all the bonds are single covalent bonds (□-bonds).
4- Alkanes are called saturated hydrocarbons.

Structure of alkanes :

The simplest alkane is methane , **CH_4 .** Methane is perfectly tetrahedral with the 109.5° bond angles predicted for an sp3 hybrid carbon . The four hydrogen atoms are covalently bonded to central carbon atom, with bond lengths of 1.o9A.





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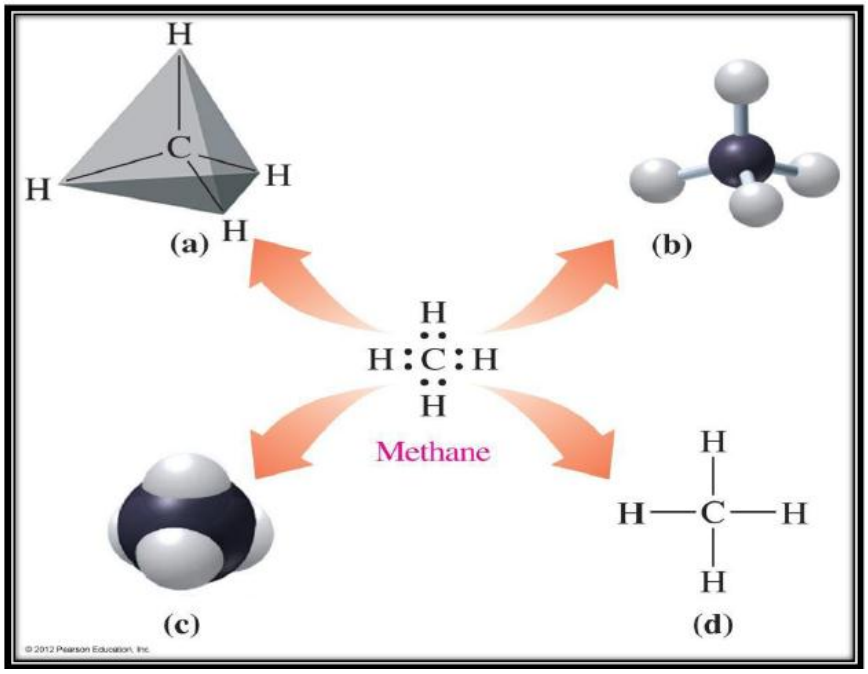
Molecular Representations :

Methane is represented using different models: (a) tetrahedron, (b) ball-and-stick model, (c) space-filling model, (d) expanded structural formula.



Alkanes are written with structural formulas that are :

1.Expanded formula to show each bond in the molecules
2.Condensed formula to show each carbon atom and its attached hydrogen atoms
3.Line-angle formula: is a form of the structural formula . A line represents a carbon-carbon bond and a vertex represents a carbon atom. A line ending in space represents a $–CH_3$ group.

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physical properties of alkane

1- Alkanes are non-polar compounds
2- It has a lower boiling point compared to other organic materials
3- -Alkanes from S1 to S4 are gases at high temperatures, while from S5 to S17 are liquid, while we find that alkanes with more than 18 carbon atoms are in the solid state.
4- It is insoluble in water, while it is soluble in non-polar solvents such as benzene, ether and carbon tetrachloride.
5- Alkanes are less dense than water, as liquid alkanes float on the surface of the water when you try to mix them.

Chemical properties of alkane

Alkanes are the least reactive type of organic compound. Alkanes are not absolutely unreactive. Two important reactions that they undergo are combustion, which is the reaction with oxygen and halogenation, which is the reaction with halogens.

1. Combustion

Like most organic compounds, alkanes react with enough oxygen to give carbon dioxide and water vapor in addition to an amount of energy.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + energy

$2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$ + energy

2. Halogenation

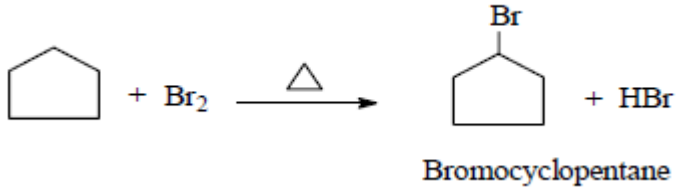
Alkanes (and cycloalkanes) react with chlorine and bromine in the presence of sunlight or by heating to give an alkyl halide, where one or more hydrogen atoms in the alkane are replaced by chlorine or bromine, as in the following examples :

$R\text{-}H + X_2 \rightarrow R\text{-}X + H\text{-}X$

- **Example 1 :**

$CH_3\text{-}CH_3 + Br_2 \rightarrow CH_3\text{-}CH_2\text{-}Br + HBr$

- **Example 2:**



Bromocyclopentane

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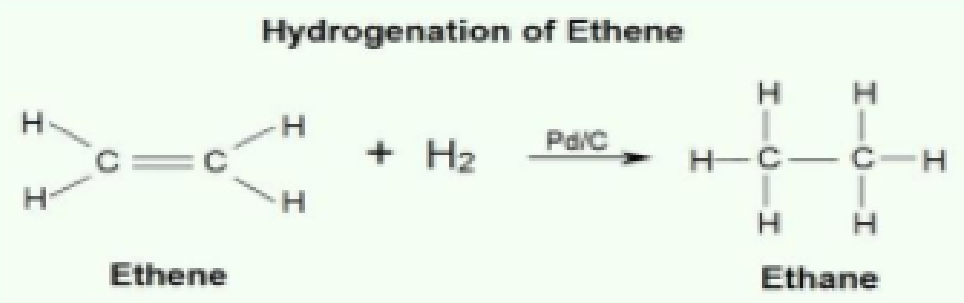
Preparation of Alkanes

1- Preparation of Alkanes from unsaturated hydrocarbon:

Alkane can be prepared from alkene and alkyne through the process of hydrogenation. In this process, dihydrogen gas is added to alkynes and alkenes in the present catalyst. This catalysts which are finely divided is like nickel, palladium or platinum to form alkanes. With the help of nickel as the catalyst, this reaction takes place at an elevated temperature, whereas the reaction takes place at room temperature with platinum as the catalyst.



2- Preparation of Alkanes from alkyl halides:

Alkane can be produced from alkyl halides predominantly by two ways:

1. Alkanes can be prepared from alkyl halides (except fluorides) through reduction with zinc and dilute hydrochloric acid.

$$CH_3\text{-}Cl + H_2 \rightarrow CH_4 + HCl$$

2. Wurtz reaction: In dry ethereal solution, on treating alkyl halides with sodium metal, production of alkanes is higher. By this reaction, we can achieve higher alkanes with an even number of carbon atoms.

$$CH_3\text{-}Br + 2Na + BrCH_3 \rightarrow CH_3\text{-}CH_3 + 2NaBr$$

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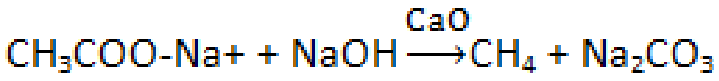
3- Preparation of alkanes from carboxylic acids:

Preparation of alkanes from carboxylic acids mainly happens via two means:

1. Alkanes can be prepared from carboxylic acid via the removal of carbon dioxide. This process is known as decarboxylation. It produces alkane with a carbon atom lesser than that present in the carboxylic acid.



2. Kolbe's electrolytic method: In this process, the alkane is produced through electrolysis of sodium or potassium salt of carboxylic acid.