

Unit 6

HYDROCARBONS AND THEIR NATURAL SOURCES

6.1 Introduction to Organic Chemistry

Organic Compounds and Organic Chemistry

Organic compounds are a vast class of chemical compounds that primarily contain carbon and hydrogen atoms. These compounds are all around us—present in our food, medicine, cleaning products, and even in our bodies. For example:

- **Foodstuff:** Fruits, vegetables, sugar, fats, and starches.
- **Substances:** Pesticides, fuels, soaps, detergents, pharmaceuticals, and alcoholic beverages.
- **Natural Products:** Compounds made by living organisms, such as nicotine from tobacco, cathinone from khat, opium from poppies, and cocaine from coca leaves.

Organic Chemistry is the study of carbon-containing compounds. Despite the advances in chemistry, the term "organic" still applies to various natural and synthetic substances. For instance, organic vitamins and foods are derived from natural sources, but synthetic vitamins can also be equally effective.

Historical Context

Organic chemistry began with the decline of **Vitalism**, a theory suggesting that organic compounds could only come from living organisms. This theory was disproven in 1828 by Friedrich Wöhler, who synthesized urea from inorganic compounds. This breakthrough marked the beginning of organic chemistry as a scientific discipline. Since then, over 50 million organic compounds have been discovered, both from natural sources and through laboratory synthesis.

Why Carbon?

Carbon is unique due to its ability to form chains and rings through a property called **catenation**. This means carbon atoms can bond with each other and with other elements like hydrogen, oxygen, nitrogen, and sulfur to create a wide variety of compounds. This property allows the vast diversity of organic compounds.

6.1.1 History of Organic Chemistry

Organic chemistry evolved from the old concept of **Vitalism**, which posited that only living things could create organic compounds. Friedrich Wöhler's synthesis of urea from ammonium cyanate disproved this idea, proving that organic compounds could be synthesized from inorganic substances. This discovery led to the development of modern organic chemistry, which now includes the synthesis of a wide range of compounds beneficial to society.

Example Reaction: Ammonium cyanate \rightarrow Urea $\text{NH}_4\text{OCN} \xrightarrow{\text{Heat}} \text{CO}(\text{NH}_2)_2$

6.1.2 Structural Representations of Organic Molecules

Understanding the structure of organic molecules is crucial. Here are the different ways to represent organic compounds:

a. Complete Structural Formula

- Shows all bonds and atoms.
- Example: Methane (CH_4) can be represented as:
 - Lewis Structure:** $\text{H}-\text{C}-\text{H}$
 - Structural Formula:** $\text{H}-\text{C}-\text{H}$

b. Condensed Structural Formula

- Abbreviates the complete structural formula by omitting some bonds.
- Example: Hexane (C_6H_{14}) can be written as:
 - Condensed Formula:** $\text{CH}_3(\text{CH}_2)_4\text{CH}_3$

c. Bond-Line Representation

- Represents carbon and hydrogen atoms implicitly.
- Example: Hexane (C_6H_{14}) can be shown with zig-zag lines, indicating the carbon chain and hydrogen atoms.

d. Polygon Formula

- Used for cyclic compounds.
 - Example: Cyclohexane (C_6H_{12}) is shown as a hexagon where each vertex represents a carbon atom.
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6.1.3 Classes of Organic Compounds

Hydrocarbons are organic compounds made up of only carbon and hydrogen. They are categorized into:

- **Aliphatic Hydrocarbons:** Include alkanes, alkenes, and alkynes.
- **Aromatic Hydrocarbons:** Contain benzene rings and have a low hydrogen-to-carbon ratio.

Classification:

- **Saturated Hydrocarbons:** Have single bonds (alkanes).
- **Unsaturated Hydrocarbons:** Have double or triple bonds (alkenes, alkynes).

Examples:

- **Alkanes:** Methane (CH_4), Ethane (C_2H_6)
- **Alkenes:** Ethene (C_2H_4)
- **Alkynes:** Ethyne (C_2H_2)

Functional Groups are specific groups of atoms within molecules that determine the chemical behavior of those molecules. Examples include:

- **Alcohols:** $-\text{OH}$ group
- **Aldehydes:** $-\text{CHO}$ group
- **Carboxylic Acids:** $-\text{COOH}$ group

6.2.3 Nomenclature of Alkanes

Alkanes are hydrocarbons with only single bonds between carbon atoms. They can be named using common names or the IUPAC (International Union of Pure and Applied Chemistry) system.

1. Common Names of Alkanes

- **n- (Normal):** Used when all carbon atoms form a continuous chain.
 - Example: n-Butane, where all four carbon atoms are in a straight chain.
- **Iso-:** Indicates a branch off the main chain.
 - Example: Isobutane, where the main chain has three carbons and one branch.
- **Neo-:** Refers to a specific branched form.
 - Example: Neopentane, where there is a branching pattern on a five-carbon chain.

2. IUPAC Nomenclature

The IUPAC system provides a systematic way to name alkanes, both unbranched and branched.

a. Naming Unbranched Alkanes

1. **Straight-Chain Alkanes:** Name based on the number of carbons in a continuous chain.
 - o Methane (1 carbon)
 - o Ethane (2 carbons)
 - o Propane (3 carbons)
 - o Butane (4 carbons)
 - o Pentane (5 carbons)
2. **Suffix:** All names end with “-ane.”

b. Naming Branched-Chain Alkanes

1. **Identify the Longest Continuous Chain:** This determines the parent name.
 - o Example: For the structure with six carbon atoms in a chain, the parent name is hexane.
2. **Number the Longest Chain:** Start from the end closest to a substituent to give the substituents the lowest possible numbers.
 - o Example: In 2-methylhexane, the chain is numbered so that the methyl group gets the lowest number.
3. **Name Substituents:** Prefixes like methyl-, ethyl-, etc., denote substituent groups.
 - o Example: 4-Ethyl-2-methylhexane.
4. **List Substituents Alphabetically:** When there are multiple substituents, list them alphabetically.
 - o Example: 4-Ethyl-2,2-dimethylheptane.
5. **Use Prefixes for Multiple Substituents:** Use di-, tri-, tetra-, etc., to indicate the number of identical substituents.
 - o Example: 2,3-Dimethylbutane.
6. **Number Identical Substituents:** If two or more substituents are identical, each must have a number.
 - o Example: 2,2,4-Trimethylpentane.
7. **Complex Substituents:** If a substituent itself has branches, name it as if it were a separate molecule.
 - o Example: 2,3-Dimethyl-6-(2-methylpropyl)decane.

c. Alkyl Groups

When a hydrogen atom is removed from an alkane, an alkyl group is formed:

- **Methyl (Me-):** CH_3
- **Ethyl (Et-):** CH_2CH_3
- **Propyl (Pr-):** $\text{CH}_2\text{CH}_2\text{CH}_3$
- **Isopropyl (iPr-):** $(\text{CH}_3)_2\text{CH}-$
- **Butyl (Bu-):** $\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

The symbol **R** is used to represent any alkyl group in general formulas, such as R-H.

6.2.4. Isomerism in Alkanes

Isomers are compounds with the same molecular formula but different structures.

a. Structural Isomers

- **Definition:** Compounds with the same molecular formula but different connectivity of atoms.
 - Example: Butane (C_4H_{10}) can be linear or branched (isobutane).
- **Number of Isomers:** Increases with the number of carbon atoms. For 4 to 7 carbons, the number of isomers can be determined using the formula $2^{(n-4)} + 1$.

b. Physical Properties

Isomers have different physical properties, such as boiling points and densities, despite having the same molecular formula. For example:

- **Butane:** Boiling point -0.5°C
- **Isobutane:** Boiling point -11.7°C

6.2.5 Preparation of Alkanes

Introduction: Alkanes are hydrocarbons with single bonds between carbon atoms, and they are the main components of petroleum and natural gas. They can be prepared both industrially and in the laboratory using several methods.

1. Hydrogenation of Alkenes

- **Process:** Alkanes can be prepared by adding hydrogen (H_2) to alkenes (hydrocarbons with double bonds) using a metal catalyst such as nickel or platinum.
- **Reaction:** $\text{R-CH=CH}_2 + \text{H}_2 \xrightarrow{\text{Catalyst}} \text{R-CH}_2\text{-CH}_3$

2. Würtz Synthesis

- **Process:** This method involves the reaction of halogenated alkanes (alkyl halides) with sodium to form a new alkane.
- **Reaction:** $2R-X + 2Na \rightarrow R-R + 2NaX$
 - **R-X:** Halogenated alkane
 - **R-R:** Alkane
 - **NaX:** Sodium halide
- **Note:** Named after French chemist Charles-Adolphe Würtz.

3. Decarboxylation

- **Process:** Heating the sodium salt of a carboxylic acid with soda lime (a mixture of sodium hydroxide and calcium oxide) removes the carboxyl group, forming an alkane.
- **Reaction:** $RCOONa + NaOH \xrightarrow{CaO, \text{ heat}} R-H + Na_2CO_3$
 - **RCOONa:** Sodium salt of carboxylic acid
 - **R-H:** Alkane
 - **Na₂CO₃:** Sodium carbonate

Methane Formation:

- Methane is the primary component of natural gas, found in petroleum and formed by the decay of organic matter in marshy areas.
- **Biogas Production:** Made from cow dung, plant waste, and other organic materials. Biogas technology helps save fuels and reduce deforestation. The residue serves as fertilizer.

6.2.6 Chemical Properties of Alkanes

1. Combustion Reaction:

- **Description:** Alkanes burn in oxygen to produce carbon dioxide and water, releasing energy.
- **General Reaction:** $C_nH_{2n+2} + O_2 \rightarrow CO_2 + H_2O + \text{Energy}$
- **Example:** Methane burns as follows: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Energy}$

2. Substitution Reaction:

- **Description:** Involves replacing one or more hydrogen atoms in alkanes with halogen atoms. It is a photochemical reaction involving chlorine or bromine.
- **Steps:**
 1. **Chain Initiating:** Formation of free radicals by absorbing light.
 2. **Chain Propagating:** Reaction of free radicals with alkanes to form new radicals.
 3. **Chain Terminating:** Free radicals combine to form stable products.

3. Elimination Reaction:

- **Description:** Removal of smaller molecules from alkanes, leading to the formation of alkenes (compounds with double bonds).
- **Example:** $\text{C}_2\text{H}_6 \xrightarrow{600-800^\circ\text{C}} \text{C}_2\text{H}_4 + \text{H}_2$

6.2.7 Cycloalkanes (Alicyclic Hydrocarbons)

Description:

- Cycloalkanes are alkanes with carbon atoms arranged in a ring structure. They have the general formula $\text{C}_n \text{H}_{2n}$, which is two hydrogens fewer than the corresponding linear alkanes.
- **Examples:**
 - **Cyclopropane:** C_3H_6
 - **Cyclobutane:** C_4H_8
 - **Cyclopentane:** C_5H_{10}
 - **Cyclohexane:** C_6H_{12}

Properties:

- Similar to alkanes but with different physical and chemical properties due to the ring structure.

6.3 Unsaturated Hydrocarbons: Alkenes, Alkynes, and Aromatic Hydrocarbons

Unsaturated hydrocarbons contain carbon-carbon multiple bonds and are categorized into alkenes, alkynes, and aromatic hydrocarbons. This section focuses on alkenes, including their general characteristics, nomenclature, physical properties, isomerism, preparation, and chemical properties.

6.3.1 Alkenes (Olefins)

Definition: Alkenes are unsaturated hydrocarbons with at least one carbon-carbon double bond. They are also known as olefins. Their general formula is C_nH_{2n} , where n is a positive integer (e.g., 2, 3, 4, ...).

Homologous Series of Alkenes:

- **Ethene (C_2H_4):** The simplest alkene, used as a starting material for producing ethanol, ethylene oxide, and polyethylene. It is also a natural plant hormone involved in fruit ripening.
- **Propene (C_3H_6):** Used in making polypropylene and other chemicals like acetone and cumene.

Table of Physical Constants for Alkenes:

IUPAC Name Molecular Formula Condensed Formula M.P. (°C) B.P. (°C) Density (g/L)

Ethene	C ₂ H ₄	CH ₂ =CH ₂	-169	-102	0.61
Propene	C ₃ H ₆	CH ₂ =CHCH ₃	-185	-48	0.61
1-Butene	C ₄ H ₈	CH ₂ =CHCH ₂ CH ₃	-130	-6.5	0.63
1-Pentene	C ₅ H ₁₀	CH ₂ =CH(CH ₂) ₂ CH ₃	-130.5	30	0.64
1-Hexene	C ₆ H ₁₂	CH ₂ =CH(CH ₂) ₃ CH ₃	-138	63	0.67
1-Heptene	C ₇ H ₁₄	CH ₂ =CH(CH ₂) ₄ CH ₃	-119	93	0.69
1-Octene	C ₈ H ₁₆	CH ₂ =CH(CH ₂) ₅ CH ₃	-104	122	0.72
1-Nonene	C ₉ H ₁₈	CH ₂ =CH(CH ₂) ₆ CH ₃	-95	146	0.73
1-Decene	C ₁₀ H ₂₀	CH ₂ =CH(CH ₂) ₇ CH ₃	-87	171	0.74

Exercise 6.8:

- 1. Define alkene and explain how it differs from alkanes.**
 - Alkenes are hydrocarbons with one or more double bonds between carbon atoms (C=C), while alkanes are saturated hydrocarbons with single bonds only (C-C). The general formula for alkanes is C_nH_{2n+2}, which means alkenes have fewer hydrogen atoms compared to alkanes with the same number of carbons.
- 2. Describe the general characteristics of the homologous series of alkenes.**
 - Alkenes form a homologous series with a consistent structure, differing by a CH₂ unit. They have similar chemical properties, such as undergoing addition reactions at the double bond.
- 3. Derive the general formula for alkenes and compare it with that of alkanes.**
 - The general formula for alkenes is C_nH_{2n}. For alkanes, it is C_nH_{2n+2}. The difference lies in the number of hydrogen atoms: alkenes have 2 fewer hydrogens than alkanes with the same number of carbon atoms.
- 4. Discuss the relationship between the number of carbon atoms and the melting point, boiling point, and density.**
 - As the number of carbon atoms increases, melting and boiling points generally rise due to stronger intermolecular forces. Density also tends to increase with molecular weight.

5. **Write the molecular formula of the first 10 members of the alkene homologous series.**
 - Ethene (C_2H_4)
 - Propene (C_3H_6)
 - 1-Butene (C_4H_8)
 - 1-Pentene (C_5H_{10})
 - 1-Hexene (C_6H_{12})
 - 1-Heptene (C_7H_{14})
 - 1-Octene (C_8H_{16})
 - 1-Nonene (C_9H_{18})
 - 1-Decene ($C_{10}H_{20}$)
6. **Draw their condensed structures and bond-line representations.**
 - For example:
 - Ethene: $CH_2=CH_2$
 - Propene: $CH_2=CHCH_3$
 - 1-Butene: $CH_2=CHCH_2CH_3$
 - And so on.

Nomenclature of Alkenes:

1. **Parent Chain Name:** Identify the longest carbon chain with the double bond. Change the ending of the corresponding alkane from -ane to -ene.
2. **Numbering:** Number the chain to give the double bond the lowest possible number.
3. **Substituents:** Name and number any substituent groups.

Examples:

- **Ethylene (Ethene):** C_2H_4
- **Propylene (Propene):** C_3H_6
- **Isobutylene (2-Methylpropene):** C_4H_8

Physical Properties of Alkenes:

- **Polarity:** Alkenes are generally nonpolar molecules.
- **Solubility:** Alkenes are not soluble in water but soluble in organic solvents like carbon tetrachloride.
- **Trends:** As molecular weight increases, melting and boiling points increase. The density also generally increases.

Isomerism in Alkenes:

1. **Chain Isomerism:** Different carbon chain arrangements (e.g., 1-Pentene vs. 2-Methyl-1-butene).
2. **Position Isomerism:** Different positions of the double bond (e.g., 1-Butene vs. 2-Butene).

3. **Geometrical Isomerism:** Different spatial arrangements around the double bond (cis vs. trans).

Preparation of Alkenes:

1. **Cracking:** Obtained from petroleum refining.
2. **Dehydration of Alcohols:** Removing water using concentrated sulfuric acid or alumina.
3. **Dehydrohalogenation:** Removing hydrogen and halogen from alkyl halides using a base.

Chemical Properties of Alkenes:

1. **Combustion:** Alkenes burn with a luminous flame to produce CO_2 and H_2O .
2. **Addition Reactions:**
 - o **Halogenation:** Adding halogens (e.g., Br_2) across the double bond.
 - o **Hydrogenation:** Adding hydrogen to form alkanes.
 - o **Hydrohalogenation:** Adding hydrogen halides (e.g., HBr) to form alkyl halides.
 - o **Hydration:** Adding water to form alcohols.
 - o **Oxidation:** Using alkaline KMnO_4 to form diols.
 - o **Polymerization:** Joining monomers to form polymers.

Uses of Ethene (Ethylene):

- Production of ethanol, ethylene oxide, and polymers like polyethylene and PVC.
- Used as an antifreeze and for fruit ripening.

Cycloalkenes:

- **Definition:** Cyclic hydrocarbons with one double bond. General formula: $\text{C}_n\text{H}_{2n-2}$.
- **Naming:** Prefix "cyclo" to the alkene name with the same number of carbons.
 - o **Example:** Cyclohexene, Cyclopentene.

6.3.2 Alkynes and Their Physical Properties

Alkynes Overview: Alkynes are a group of unsaturated hydrocarbons characterized by the presence of at least one carbon-carbon triple bond ($\text{C}\equiv\text{C}$) in their structure. They have the general formula $\text{C}_n\text{H}_{2n-2}$, where $n \geq 2$. The simplest alkyne is ethyne, also known as acetylene. The names of alkynes end with "-yne."

Nomenclature:

- **Unbranched Alkynes:** Named by replacing the "-ane" ending of the corresponding alkane with "-yne." The chain is numbered to give the carbon atoms of the triple bond the lowest possible numbers.
 - **Example:** Ethyne (C_2H_2), Propyne (C_3H_4), 1-Butyne (C_4H_6).
- **Branched Alkynes:** Named similarly to alkenes, with the position of the triple bond and any substituents indicated by numbers.
 - **Example:** 2-Pentyne, 4-Ethyl-4,5-dimethyl-2-heptyne.

Isomerism in Alkynes: Alkynes exhibit chain and position isomerism but not geometrical (cis-trans) isomerism.

- **Chain Isomerism:** Different arrangements of the carbon chain.
 - **Example:** 1-Butyne and 2-Butyne.
- **Position Isomerism:** Different positions of the triple bond.
 - **Example:** 3-Methyl-1-butyne and 1-Pentyne.

Physical Properties:

- Alkynes are typically colorless gases or liquids.
- They have lower melting and boiling points compared to alkenes and alkanes with the same number of carbon atoms due to weaker van der Waals forces.

Table 6.5: Physical Constants of Alkynes

Formula	Condensed Structure	IUPAC Name	Melting Point (°C)	Boiling Point (°C)
C_2H_2	$CH\equiv CH$	Ethyne	-82	-75
C_3H_4	$CH\equiv C-CH_3$	Propyne	-105.5	-23
C_4H_6	$CH\equiv C-CH_2-CH_3$	1-Butyne	-122	9
C_5H_8	$CH\equiv C-(CH_2)_2-CH_3$	1-Pentyne	-98	40
C_6H_{10}	$CH\equiv C-(CH_2)_3-CH_3$	1-Hexyne	-124	72
C_7H_{12}	$CH\equiv C-(CH_2)_4-CH_3$	1-Heptyne	-80	100
C_8H_{14}	$CH\equiv C-(CH_2)_5-CH_3$	1-Octyne	-70	126
C_9H_{16}	$CH\equiv C-(CH_2)_6-CH_3$	1-Nonyne	-65	151
$C_{10}H_{18}$	$CH\equiv C-(CH_2)_7-CH_3$	1-Decyne	-36	182

Preparation of Alkynes:

1. **Dehydrohalogenation:** Of vicinal (adjacent) dihalides using a base (e.g., NaOH, KOH).
2. **Alkylation:** Sodium acetylide reacts with primary alkyl halides.
3. **Reaction of Calcium Carbide with Water:** $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$

Chemical Properties:

1. **Combustion Reaction:** Alkynes burn with a smoky luminous flame.
$$C_nH_{2n-2} + (3n-1)O_2 \rightarrow nCO_2 + (n-1)H_2O + \text{Heat}$$
2. **Addition Reactions:**
 - o **Hydrogenation:** Converts alkynes to alkanes in the presence of a catalyst.
 - o **Halogenation:** Forms dihaloalkenes and tetrahaloalkanes.
 - o **Hydrogen Halides Addition:** Produces monohaloalkenes and dihaloalkanes.
 - o **Trimerization of Acetylene:** Forms benzene at high temperatures.

Uses of Acetylene (Ethyne):

- **Fuel:** Used in oxy-acetylene torches for cutting and welding due to its high flame temperature (~3000°C).
- **Chemical Production:** Produces acrylonitrile, vinyl chloride, and other chemicals used in textiles, PVC, and other applications.

Comparison of Ethane, Ethene, and Ethyne:

Property	Ethane	Ethene	Ethyne
Nature of Flame	Non-luminous	Luminous	Smoky luminous
Effect on Br ₂ in CCl ₄	No effect	Decolorizes	Decolorizes
Effect on Alkaline KMnO ₄	No effect	Decolorizes	Decolorizes

6.4 Aromatic Hydrocarbons: Benzene

1. Introduction to Benzene:

- **What is Benzene?** Benzene is the simplest aromatic hydrocarbon with the molecular formula C₆H₆. It consists of a six-membered ring of carbon atoms with alternating double bonds.
- **Historical Context:** The first structure of benzene was proposed by August Kekulé in 1872. He suggested that benzene had alternating single and double bonds. However, this was later revised to the concept of resonance, where the actual structure is a hybrid of two equivalent Kekulé structures.
- **Structure and Stability:** In the resonance hybrid model, benzene is represented with a ring of six carbon atoms with equal-length bonds, which are neither single nor double. This results in greater stability compared to alkenes.

2. Nomenclature of Substituted Benzenes:

- **Monosubstituted Benzenes:**
 - **Naming:** The benzene ring with one substituent is named by prefixing the substituent to "benzene." For example:
 - **Methylbenzene** (Toluene)
 - **Ethylbenzene**
 - **Bromobenzene**
 - **Nitrobenzene**
 - **Phenol** (Hydroxybenzene)
 - **Aniline** (Aminobenzene)
- **Disubstituted Benzenes:**
 - **Isomerism:** When two substituents are present, the possible isomers are ortho (1,2-), meta (1,3-), and para (1,4-).
 - **Examples:**
 - **1,3-Dimethylbenzene** (m-Xylene)
 - **4-Bromotoluene**
 - **1-Chloro-2-ethylbenzene**

3. Physical Properties of Benzene:

- **Characteristics:**
 - Benzene is a colorless, flammable liquid with a characteristic smell.
 - It is less dense than water and is insoluble in water but soluble in non-polar solvents like ether and carbon tetrachloride.
 - Benzene is a carcinogen and its exposure is harmful.

4. Chemical Properties of Benzene:

- **Reactions:**
 - **Combustion Reaction:** Benzene burns with a smoky flame, producing carbon dioxide (CO₂) and water (H₂O).
$$2\text{C}_6\text{H}_6 + 15\text{O}_2 \rightarrow 12\text{CO}_2 + 6\text{H}_2\text{O} + \text{Heat}$$
 - **Substitution Reactions:** Benzene undergoes substitution reactions rather than addition reactions:
 - **Halogenation:** Benzene reacts with bromine or chlorine in the presence of catalysts (FeCl₃ or AlCl₃) to form halobenzene.
 - **Nitration:** Benzene reacts with nitric acid (HNO₃) and sulfuric acid (H₂SO₄) to form nitrobenzene. $\text{C}_6\text{H}_6 + \text{HNO}_3 \rightarrow \text{C}_6\text{H}_5\text{NO}_2 + \text{H}_2\text{O}$
 - **Sulphonation:** Benzene reacts with sulfuric acid (H₂SO₄) to form benzenesulphonic acid. $\text{C}_6\text{H}_6 + \text{H}_2\text{SO}_4 \rightarrow \text{C}_6\text{H}_5\text{SO}_3\text{H} + \text{H}_2\text{O}$
- **Addition Reaction:** Benzene does not typically undergo addition reactions under normal conditions..

6. Natural Sources of Hydrocarbons:

- **Sources:**
 - **Natural Gas:** Mainly methane, used as fuel.
 - **Petroleum (Crude Oil):** A complex mixture of hydrocarbons refined into various fractions like gasoline, kerosene, and diesel.
 - **Coal:** Contains aromatic hydrocarbons and is processed to produce coal tar and coke.
- **Refining Process:**
 - **Fractional Distillation:** Separates crude oil into fractions based on boiling points, which are then used for different purposes.