

Chapter 18

Introduction to Hydrocarbons

Hydrocarbons are **organic compounds** made up of only **carbon (C)** and **hydrogen (H)** atoms. These form the basis of **organic chemistry**, a vast field studying compounds mainly composed of carbon.

What Are Hydrocarbons?

Hydrocarbons are compounds formed **exclusively of carbon and hydrogen atoms**. They are the simplest type of **organic compounds** and are mainly found in **fuels, natural gas, crude oil**, etc.

Organic Compounds

Organic compounds are chemical compounds that contain **carbon atoms** bonded with other elements, especially **hydrogen**, often along with **oxygen, nitrogen, sulfur, phosphorus**, etc.

Main Features of Organic Compounds:

- Contain **carbon-hydrogen bonds**
- Usually form **covalent bonds**
- Show **isomerism**
- Exhibit **combustibility**
- Have **low melting and boiling points** compared to inorganic compounds

Examples of Organic Compounds:

- Methane (CH_4)
- Ethanol ($\text{C}_2\text{H}_5\text{OH}$)
- Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)
- Acetic acid (CH_3COOH)

Types of Hydrocarbons

1. Saturated Hydrocarbons (Alkanes)

These hydrocarbons contain only **single bonds** between carbon atoms.

General formula: $\text{C}_n\text{H}_{2n+2}$

Examples: Methane (CH_4), Ethane (C_2H_6), Propane (C_3H_8)

- ◆ All carbon atoms are **sp^3 hybridized**
- ◆ Called **alkanes**

2. Unsaturated Hydrocarbons

These hydrocarbons have one or more **double or triple bonds** between carbon atoms.

i. Alkenes

- Contain **one or more double bonds**
- General formula: C_nH_{2n}
- Example: Ethene (C_2H_4), Propene (C_3H_6)

ii. Alkynes

- Contain **one or more triple bonds**
- General formula: C_nH_{2n-2}
- Example: Ethyne (C_2H_2), Propyne (C_3H_4)

Homologous Series

A **homologous series** is a group of organic compounds having:

- Same **functional group**
- Same **general formula**
- Similar **chemical properties**
- Each successive member differs by a **CH_2 unit**

Features of Homologous Series:

- Constant difference in **molecular mass** (14 u)
- Gradual change in **physical properties**
- Similar **chemical properties**

Examples:

- Alkanes: CH_4 , C_2H_6 , C_3H_8 ,...
- Alkenes: C_2H_4 , C_3H_6 , C_4H_8 ,...

Alkyl Radical

When one hydrogen atom is removed from an alkane, it forms an **alkyl group** ($R-$).

Example:

- $CH_4 \rightarrow CH_3-$ (methyl group)

Features:

- Represented as **$R-$**
- Reactive part of the molecule
- Often appears in **organic reactions**

Functional Group

A **functional group** is an atom or group of atoms that determines the **chemical behavior** of organic compounds.

Examples:

Functional Group	Name	Example
-OH	Alcohol	Ethanol
-COOH	Carboxylic acid	Acetic acid
-CHO	Aldehyde	Formaldehyde
-NH ₂	Amine	Methylamine

Features:

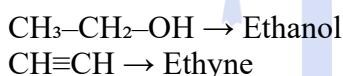
- Responsible for **chemical reactions**
- Attached to carbon chains
- Determine **compound classification**

Nomenclature of Hydrocarbons

Basic IUPAC rules:

1. Identify **longest carbon chain**
2. Number the chain from end nearest to **substituent or functional group**
3. Use prefixes (meth-, eth-, prop-, etc.)
4. Add **suffix** based on functional group (-ane, -ene, -yne)

Example:



Some Important Hydrocarbons and Their Compounds

i. Methane (CH₄)

- Simplest hydrocarbon
- Main component of **natural gas**

Uses:

- Domestic fuel
- Production of hydrogen gas
- In chemical industries

ii. Ethane (C₂H₆)

- Second alkane in homologous series
- Colorless, odorless gas

Uses:

- Used as fuel
- Source of ethene in cracking process

iii. Propane (C_3H_8)

- Common fuel in **LPG (Liquefied Petroleum Gas)**

Uses:

- Cooking gas
- Heating and refrigeration

iv. Butane (C_4H_{10})

- Also found in **LPG**

Uses:

- Fuel in lighters
- Portable gas cylinders

Alcohols

Alcohols are organic compounds with one or more **-OH (hydroxyl)** functional groups.

Properties of Alcohols:

- Soluble in water (short-chain)
- Form hydrogen bonds
- Flammable
- React with acids to form esters

Types of Alcohols

a. Monohydric Alcohols

Have **one -OH group**.

i. Methanol (CH_3OH)

Uses:

- As solvent
- In antifreeze
- Fuel and industrial chemicals

ii. Ethanol (C_2H_5OH)

Uses:

- Alcoholic beverages
- Disinfectant
- Fuel (bioethanol)
- Solvent

b. Dihydric Alcohol

Contain two **-OH groups**.

Example: Ethylene glycol (HO-CH2-CH2-OH)

Use: In antifreeze, polyester production

c. Trihydric Alcohol

Contain three **-OH groups**.

Glycerol (C3H5(OH)3)

Properties of Glycerol:

- Colorless, sweet-tasting, viscous liquid
- Highly hygroscopic
- Soluble in water

Uses of Glycerol:

- In making **cosmetics** and lotions
- Used in **pharmaceuticals**
- As antifreeze
- In **explosives** (nitroglycerin)

Interesting Facts:

- **Ethanol** is renewable and used as an eco-friendly fuel.
- **Methanol** is toxic; even small amounts can cause blindness.
- **Glycerol** is used in making **softeners** and **toothpaste**.
- The prefixes meth-, eth-, prop-, but- denote **1, 2, 3, 4 carbon atoms** respectively.

Quick Recap Table

Term	Key Concept
Hydrocarbon	Compounds of C and H
Saturated	Only single bonds (alkanes)
Unsaturated	Double/triple bonds (alkenes/alkynes)
Alcohol	Contains -OH group
Homologous series	Group of compounds with -CH ₂ - difference
Alkyl group	Hydrocarbon group missing one H
Methanol	Toxic, used in industrial solvents
Ethanol	Found in beverages, used as fuel
Glycerol	Trihydric alcohol, used in cosmetics