

# 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 ( $\text{CH}_4$ )
- Ethanol ( $\text{C}_2\text{H}_5\text{OH}$ )
- Glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ )
- Acetic acid ( $\text{CH}_3\text{COOH}$ )

## 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 ( $\text{CH}_4$ ), Ethane ( $\text{C}_2\text{H}_6$ ), Propane ( $\text{C}_3\text{H}_8$ )

- ♦ All carbon atoms are  **$\text{sp}^3$  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 <sub>2</sub>	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:

$\text{CH}_3\text{--CH}_2\text{--OH} \rightarrow \text{Ethanol}$

$\text{CH}\equiv\text{CH} \rightarrow \text{Ethyne}$

## Some Important Hydrocarbons and Their Compounds

### i. Methane (CH<sub>4</sub>)

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

#### Uses:

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

### ii. Ethane (C<sub>2</sub>H<sub>6</sub>)

- 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 ( $\text{HO}-\text{CH}_2-\text{CH}_2-\text{OH}$ )

**Use:** In antifreeze, polyester production

## c. Trihydric Alcohol

Contain **three –OH groups**.

## Glycerol ( $\text{C}_3\text{H}_5(\text{OH})_3$ )

### 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 $-\text{CH}_2-$ 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