

# Organic chemistry and petrochemicals

## Organic chemistry

- All organic compounds contain carbon
- They usually contain hydrogen and may contain other elements as well
- A group of organic molecules with similar properties is called a homologous series
- All alcohols have an  $-OH$  group and all carboxylic acids have a  $-COOH$  group
- We call this group a functional group
- A functional group is an atom or groups of atoms that gives a compound particular properties
- Carboxylic acids behave in a different way from alcohols but each carboxylic acid has very similar properties

Homologous series	Name ending	Functional Group	Example
Alkane	-ane		Ethane
Alkene	-ene		Ethene
Alcohol	-ol		Ethanol
Carboxylic acid	-oic acid		Ethanoic acid

We can give each homologous series a general formula which applies to all members of the homologous series.

Alkanes have the general formula:  $C_nH_{2n+2}$

Alkenes have the general formula:  $C_nH_{2n}$

Where  $n$  is the number of carbons

- The members of a homologous series have very similar chemical properties because they have the same functional group

- The physical properties in a homologous series change in a regular way as the number of carbon atoms increase

### Hydrocarbons

- A hydrocarbon is a compound which only contains carbon and hydrogen atoms

### Alkyl groups

Prefix	Number of carbon atoms	Name and molecular formula	Full structural formula
Meth-	1	Methane,	
Eth-	2	Ethane,	
Prop-	3	Propane,	
But-	4	Butane,	
Pent-	5	Pentane,	
Hex-	6	Hexane,	

- When we remove a hydrogen atom from an alkane chain we have a group called an alkyl group
- Alkyl groups are named after the hydrocarbons by changing the -ane ending of the hydrocarbon to -yl
- The general formula for an alkyl group is:  $C_nH_{2n+1}$

### Fuels

- The fossil fuels: coal, petroleum and natural gas all contain hydrocarbons.
- We cannot use petroleum as a fuel because it is a sticky black liquid that is difficult to set alight
- When it does burn it produces clouds of poisonous black smoke

- Petroleum is a mixture of many types of hydrocarbons having different lengths of carbon chain
- Some of the chains are branched and there may even be compounds with rings of carbon atoms
- Fractional distillation is used to separate the hydrocarbon molecules in petroleum into groups that have similar boiling points
- These groups of molecules are called fractions
- Each contains hydrocarbons having a certain range of carbon atoms
- Apart from refinery gases, all these fractions are liquids
- Many of these fractions are used as fuels:

Fraction	Number of carbon atoms	Type of fuel
Refinery gas	1-4	Methane, propane, butane for gas cylinders
Gasoline (petrol)	5-10	Petrol for cars
Kerosene	10-16	For aircraft
Diesel	16-20	Diesel for cars and larger vehicles
Fuel oil	20-30	For ships and home heating

There is a variety of fuels we can use:

- Wood- we use wood for heating and cooking. Some scientists are working to produce liquid fuel from very young trees
- Biofuels- some plants such as oilseed rape and corn produce plant oils that can be modified for use in diesel engines. Other plants such as sugar cane and beet can be used to produce ethanol by the process of fermentation. Ethanol can be used as a fuel in cars
- Solid waste- this can be burnt in some small power stations. But great care has to be taken that the poisonous chemicals formed in the furnace at high temperatures are not released into the atmosphere
- Methane (natural gas) - as well as being found underground, methane is also produced by decomposition of materials in rubbish sites. In some places, the gas can be piped out from the rubbish site and used for heating
- Hydrogen- a good fuel because it releases a lot of energy per gram and is non-polluting. However, it is usually made by using energy from other fuels

What makes a good fuel?

- How much heat does it give out? Most hydrocarbon fuels give out a similar amount of energy per gram but hydrogen produces a lot more energy per gram
- Is it polluting? Coal is very polluting, oil is less polluting and natural gas does not produce much pollution. But all these fuels produce the greenhouse gas, carbon dioxide when burnt
- Is it easy to use? Solid fuels such as coal and wood are not as easy to use as liquid fuels
- Is it readily available? Many people are worried that the supply of petroleum and natural gas will run out over the next 100 years
- Is it cheap? The price depends on many things: how easy it is to extract and transport, availability and politics
- Is it easy and safe to transport? Many fuels are flammable so care has to be taken when transporting them and using them

## Petroleum

- The hydrocarbon fractions are separated by fractional distillation
- The petroleum is first heated so that all the hydrocarbons present are present as gases
- The petroleum is then fed into a tower called a fractionating column
- The column is kept hot at the bottom but is cooler at the top
- So there is a range of temperatures in the column
- Near the bottom, the hydrocarbons with higher boiling points condense
- Hydrocarbons with lower boiling points are still gases
- These move further up the column
- As they move up the column, each hydrocarbon condenses at the point where the temperature is the column falls just below the point of the hydrocarbon
- Hydrocarbons of similar boiling points are collected as fractions
- Some of the hydrocarbons do not condense
- They come off as gases at the top of the column
- These are refinery gases such as methane, ethane, propane and butane
- In many oil refineries these are removed from the petroleum before fractionation