Alkanes & Crude Oil

Saturated (all single bonds)	General formula: $\mathbf{C_nH_{2n+2}}$	Used mainly as **fuels**

Combustion

Alkanes (or any hydrocarbon) can be **completely combusted** (reacted with **excess** O_2) → CO_2 and H_2O e.g.

$$\mathbf{CH_4 + O_2 \rightarrow CO_2 + H_2O}$$

Incomplete combustion (not enough O_2) gives a mixture of products. It is difficult to predict exactly what products will be obtained. Usually a mixture of **carbon monoxide (CO)** and **carbon** is obtained.

Pollutants

Nitrogen oxides are produced in car engines. The 'spark' provides enough energy for the following reaction to occur:

$$\mathbf{N_2 + O_2 \rightarrow 2NO}$$

Carbon monoxide produced in the incomplete combustion reaction is also a pollutant.

Catalytic convertors are used in cars to convert NO and CO into harmless gases. Rh, Ir or Pt are used as the catalysts:

$$\mathbf{2CO + 2NO \rightarrow 2CO_2 + N_2}$$

Sulphur can be present in hydrocarbons. During combustion reactions it is possible that some $\mathbf{SO_2}$ is produced which is another pollutant (think acid rain from GCSE).

As we saw in the group 2 topic, SO_2 can be removed from flue gases by reacting with something alkaline like CaO or $CaCO_3$ as SO_2 is acidic.

✓ the word 'flue' refers to power plants and the long chimney that the gases escape from.

Fractional Distillation

You don't need to know nearly as much about this as you did at GCSE. It's more just a general overview of the process.

Petroleum is a mixture of alkane hydrocarbons, which are separated using **fractional distillation**. See oxidation of alcohols tutorial for more on distillation.

The method works by heating up **crude oil**, which is separated into various length **'fractions'** due to **differences in boiling point**.

the longer the hydrocarbon chain = the higher the boiling point

This goes back to the intermolecular forces topic. A longer chain means **more van der waals** forces and therefore a higher boiling point.

In the fractionating column, the smaller hydrocarbons rise furthest towards the top and all the heavy long chain molecules with higher boiling points condense at the bottom.

Cracking

The long chain hydrocarbons obtained from fractional distillation have various uses; the main one being fuels.

The long chains can be broken up further into shorter length chains and potentially more useful compounds can be obtained. This is where the process of **cracking** is used.

the **carbon-carbon bonds** in hydrocarbon chains are broken

Generally a mixture of **alkanes AND alkenes** are obtained.

There are two main ways to do this:

Thermal cracking

High temperatures (400-900 °C) and high pressures are used → mainly **alkene** products.

Catalytic cracking

High temperatures (450 °C), a **zeolite catalyst** and low pressure are used → **branched** and **cyclic alkanes** plus **aromatic** products.

✓ the branched alkanes and aromatic compounds are added to **petrol** to help it burn more **smoothly**.

Equations

This is very easy. Just make some alkanes and alkenes and make sure the equation balances. For example:

$$C_{10}H_{22} \rightarrow C_6H_{14} + C_4H_8$$

Or you could get an equation with more than one alkene:

$$\mathbf{C_{16}H_{34} \rightarrow C_4H_{10} + C_7H_{14} + C_5H_{10}}$$