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Chemistry Topic 9 Crude oil and fuels

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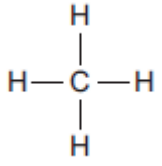
Section 1: Key terms

Crude oil	A **mixture** of **hydrocarbons** formed over **millions of years** from dead **plankton** subjected to **high pressure & temperature**.
Hydrocarbon	A molecule containing **hydrogen** and **carbon** atoms **only**.
Alkane	A **hydrocarbon** containing only **single bonds**. Follows the formula C_nH_{2n+2}.
Fractional distillation	The method of **separating hydrocarbons** based on their **boiling point**.
Fraction	A fraction contains **similar length hydrocarbons** with a **small range of boiling points**.
Intermolecular force	**Weak forces of attraction** that exist between **molecules**.
Boiling point	The temperature at which a **liquid** turns into a **gas**.
Viscosity	The ability of a substance to **flow**.
Volatility	The tendency to turn into a gas
Flammability	How easily a substance **burns** or **ignites**.
Combustion	A **reaction** between a **fuel** and **oxygen** that produces **heat**.
Complete combustion	Combustion in **plenty of oxygen**. Complete combustion of a hydrocarbon will produce **carbon dioxide** and **water**.
Incomplete combustion	Combustion in **inadequate oxygen**. Incomplete combustion of a hydrocarbon produces **water** and **carbon monoxide or carbon particulates**.
Alkene	A **hydrocarbon** containing at least one **double bond**. They follow the formula C_nH_{2n}. Used to make **polymers**.
Bromine water	A chemical that is **brown/orange** in colour. If added to an **alkene** it reacts and changes to **colourless**. Alkanes do not react hence do not produce a change in colour.
Cracking	The process by which less-useful **long-chain hydrocarbons** are **split** to produce an **alkane** and an **alkene**.
Catalyst	A chemical that **speeds up the rate of reaction** without being used up itself.

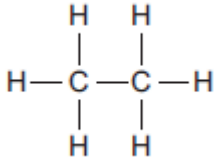
Section 2: Alkanes

Most of the hydrocarbons in crude oil are alkanes. The general formula of an alkane is C_nH_{2n+2} The alkanes are **saturated hydrocarbons** with all the **carbon-carbon bonds** being **single covalent bonds**.

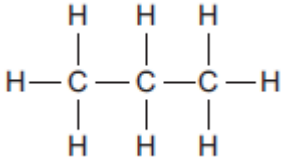
Prefix	Number of carbon atoms
Meth-	1
Eth-	2
Prop-	3
But-	4



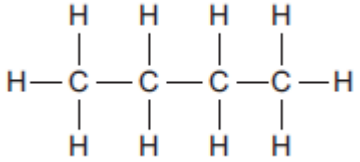
Methane CH_4



Ethane C_2H_6



Propane C_3H_8



Butane C_4H_{10}

Section 3: The properties of the alkanes

Boiling points	Alkanes have **low boiling points** (the first four alkanes are gases at room temp.) Between these simple molecules are **weak intermolecular forces** of attraction which **don't require much energy** to overcome.
Viscosity	Longer chain alkanes are **more viscous** because they have **stronger intermolecular forces** and stick together more making them thicker liquids.
Volatility	**Shorter chain** alkanes are **more volatile** than larger chain alkanes because they **have weaker forces of attraction** between their molecules than longer chain
Flammability	Flammability **decreases** with **chain length** because more oxygen is needed for combustion (burning) so they don't burn as well.

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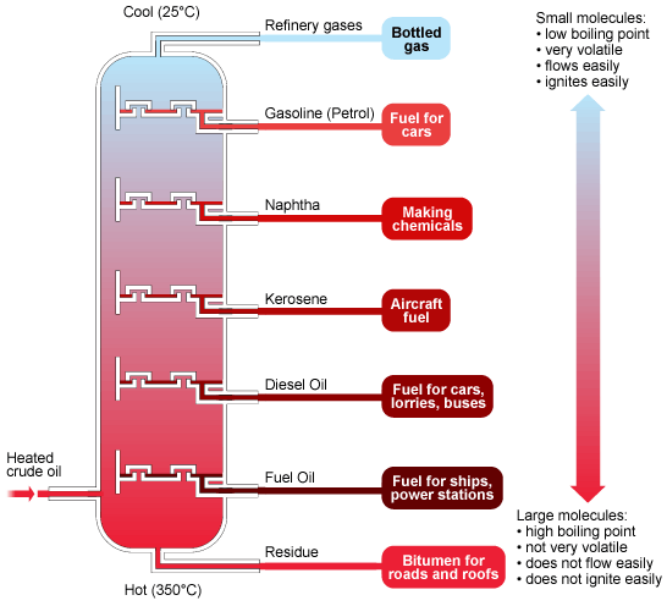
Section 4: Fractional distillation of oil

Crude oil is separated into hydrocarbons with similar boiling points. Each hydrocarbon fraction contains molecules with similar numbers of carbons.

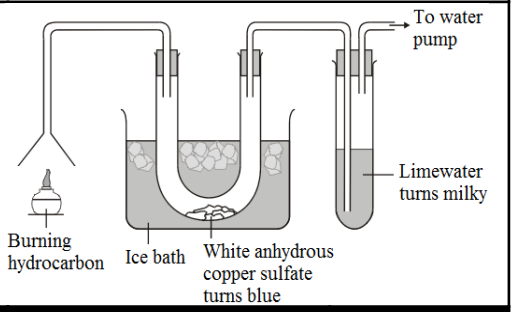
- The crude oil is **heated** to about 370°C and fed into bottom of a fractionating column.
- The fractionating column is hottest at the bottom & coolest at the top.
- Most fractions **evaporate** and become **vapours**. The residue (heavier long chain molecules) doesn't boil & flows to the bottom of the column.
- Hot vapours (shorter chain molecules) **rise** up the column & **cool down**.
- When the vapours **cool** to their **boiling point** they **condense** and flow out of the column.
- Those with **lower boiling points rise further** before cooling down.
- Refinery gases do not cool down to their boiling point so **remain as gases**.
- Large chain fractions are cracked producing smaller more useful fuels.



Section 5: Burning hydrocarbon fuels

Obtained from the **fractional distillation and cracking** of crude oil.
The combustion of hydrocarbon **fuels releases energy**.
During combustion, the carbon and hydrogen in the fuels are **oxidised.**
Complete combustion – alkanes will burn in oxygen to produce carbon dioxide and water. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
Incomplete combustion – when there is **not enough oxygen**, **carbon monoxide and carbon particulates** also form.

You can **test the products** given off when a **hydrocarbon burns** using the apparatus opposite. As well as using anhydrous copper sulfate, you can also use **blue cobalt chloride paper** which turns **pink** when water is present.



Section 6: Cracking

Cracking – breaks long chain hydrocarbons into more useful shorter chain hydrocarbons. Cracking can be done by either catalytic cracking or steam cracking. Cracking can also be described as a **thermal decomposition**.

Method	Process	Temperature
Catalytic Cracking	passed over a hot zeolite catalyst	**500°C.**
Steam Cracking	mixed with steam and heated to a very high temperature.	**850°C.**

e.g. Cracking of Decane. $C_{10}H_{22} \rightarrow C_5H_{12} + C_3H_6 + C_2H_4$