AQA GCSE Chemistry

Topic 7: Organic chemistry

Carbon compounds as fuels and feedstock

Notes

(Content in bold is for Higher Tier only)

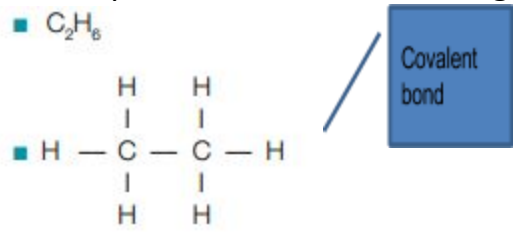
Crude oil, hydrocarbons and alkanes

Crude oil:

- Is a finite resource found in rocks
- Is the remains of an ancient biomass consisting mainly of plankton that was buried in mud
- Is a mixture of a very large number of compounds
    - Mixture: 2 or more elements that are not chemically combined
    - The chemical properties of each substance in the mixture are unchanged
- It is possible to separate the substances in the mixture by physical methods including distillation
- Most of the compounds in crude oil consist of molecules made up of hydrogen and carbon only (hydrocarbons). Most of these saturated hydrocarbons are alkanes.

Hydrocarbons:

- have the general formula: C_nH_{2n+2}
- Alkane molecules can be represented in the following forms:



- The first 4 alkanes are methane, ethane, propane and butane (MEPB: Monkeys Eat Peanut Butter)

Fractional distillation and petrochemicals

- The oil is heated in the fractionating column and the oil evaporates and condenses at a number of different temperatures.
- The many hydrocarbons in crude oil can be separated into fractions each of which contains molecules with a similar number of carbon atoms
- The fractionating column works continuously, heated crude oil is piped in at the bottom. The vaporised oil evaporates and rises up the column and the various fractions are constantly tapped off at the different levels where they condense.

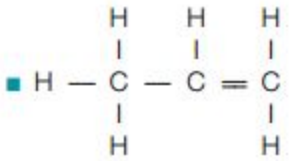
- The fractions can be processed to produce fuels and feedstock for the petrochemical industry.
    - Many of the fuels on which we depend for our modern lifestyle, such as petrol, diesel oil, kerosene, heavy fuel oil and liquefied petroleum gases, are produced from crude oil.
    - Many useful materials on which modern life depends are produced by the petrochemical industry, such as solvents, lubricants, polymers, and detergents.
    - The vast array of natural and synthetic carbon compounds occur due to the ability of carbon atoms to form families of similar compounds.

Properties of hydrocarbons

- Some properties of hydrocarbons depend on the size of their molecules. These properties influence their use as fuels.
- Shorter the molecules, the less viscous it is. (more runny)
- The longer the molecules, the more viscous it is.
- The shorter the molecules, the lower the temperature at which that fraction is vaporised or condensed – and the lower its boiling point.
- The shorter the molecules, the more flammable it is.
- Hydrocarbons are burnt so that they can be used as fuel, since the reaction produces energy.
    - hydrocarbon -> carbon dioxide + water
    - the hydrogen and carbon are oxidised in the reaction

Cracking and alkenes

- Hydrocarbons can be cracked to produce smaller, more useful molecules. This process involved heating the hydrocarbons to vaporise them.
- The processes are:
    - Passing them over a hot catalyst (catalytic cracking)
    - OR mixing them with steam and heated to a very high temperature so that thermal decomposition reactions can occur (steam cracking)
- alkenes:
    - The products of cracking include alkanes and unsaturated hydrocarbons called alkenes. Alkenes have the general formula C_nH_{2n} and have at least one double carbon-carbon bond.

- The first 2 alkenes are ethene and propene.
- Unsaturated carbons can be represented in the following forms:
  - C_3H_6
  - 
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- Alkenes react with bromine water, turning it from orange to colourless, alkanes do not (this is because an alkene's double bond makes them more reactive than alkanes)
- Alkenes are used for producing other chemicals (e.g. polymers)

- Some of the products made from cracking are useful as fuels, since they have shorter chains than the alkanes you started with, making them more flammable so a better fuel
- Equations for cracking:
  - you must make sure there are the same number of carbons and hydrogens on each side of the equation (the same as any other reaction)
  - remember you are going from a bigger molecule to usually 2 smaller molecules
  - e.g. if you had to add the other product to this reaction equation: $C_6H_{14} \rightarrow C_2H_4 + ?$, you simply calculate how many carbons and hydrogens are left over.
    carbons: 6-2=4
    hydrogens: 14-4=10
    therefore, ?= C_4H_{10}