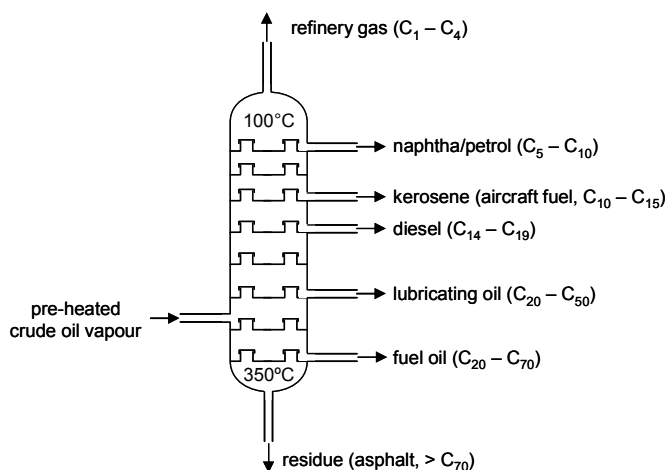
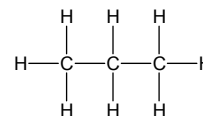


Topic C1.3: Fuels from crude oil

Summary

Crude oil is formed by the action of bacteria in the absence of oxygen on buried marine organisms over millions of years. It is a mixture of compounds, most of which are hydrocarbons (compounds of carbon and hydrogen **only**). The majority of these molecules are **saturated hydrocarbons** known as **alkanes** with the general formula C_nH_{2n+2} , which contain chains of carbon atoms with hydrogens attached to give each carbon a total of four bonds. The alkanes are named according to the number of carbon atoms in the chain, e.g. methane (CH_4), ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), pentane (C_5H_{12}), etc. The structure of alkanes is shown by that of propane below: Many properties of alkanes depend on the number of carbons in the chain. With increasing chain length – melting and boiling points increase, viscosity (stickiness) increases, flammability decreases and the sootiness of the flame increases.

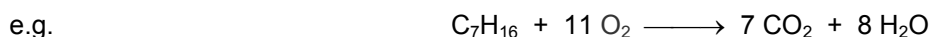


Because the components of crude oil have different boiling points, it may be separated into different fractions by fractional distillation. Industrially, this is achieved by passing crude oil vapour into a tall fractionating tower which is kept hotter at the bottom than the top. Compounds with high boiling points condense near the bottom of the tower whilst those with lower boiling points condense further up. At various levels, **fractions** may be extracted which contain a mixture of hydrocarbons with similar boiling points. Those obtained nearer the top of the tower make better fuels as they are more flammable and burn with cleaner flames.

Heavy crude oil contains a higher proportion of the long-chain molecules. Light crude oil contains a higher proportion of the short chain fractions. As

these are more useful as fuels they command a higher price and consequently light crude is more expensive than heavy crude.

When hydrocarbons burn in a good supply of oxygen they form carbon dioxide and water

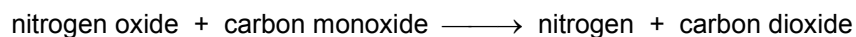


Carbon dioxide is a major contributor to the **greenhouse effect**. It allows sunlight to reach the earth but it prevents heat from escaping into space. Thus increasing levels of carbon dioxide in the atmosphere lead to **global warming**.

If the supply of oxygen is limited, some of the carbon in the fuel ends up as **soot** (elemental carbon), some as **carbon monoxide** (CO) and some of the fuel remains unburnt. The soot and unburnt fuel forms **particulates** which escape into the atmosphere and give rise to smog which reflects sunlight back into space. This is known as **global dimming**. Carbon monoxide is toxic as it prevents the blood from transporting oxygen to the brain. Such pollution is minimised by ensuring a good supply of air to the point of combustion.

Impurities in the fuel also burn and form by-products. Sulphur produces **sulphur dioxide** gas which irritates the respiratory tract and also dissolves in water droplets in the clouds giving rise to acid rain. Acidic gases from power stations may be absorbed (by alkalis) before they are discharged into the atmosphere. Diesel fuel these days is generally sold as low-sulphur diesel from which most of the sulphur impurity has been removed.

Oxides of nitrogen are also formed in engines due to the high temperatures causing a reaction between nitrogen and oxygen in the air. These also trigger asthma attacks and give rise to acid rain. Their emission from vehicles can be minimised by fitting a catalytic converter to catalyse the following reaction:



Crude oil is a **non-renewable** resource and, at current levels of use, will run out in fifty years or so. There are many alternatives to fuels derived from crude oil. These include:

- Biodiesel – obtained from plant oils such as oilseed rape
- Alcohol – obtained by fermentation of sugar-containing fruits/vegetables
- Electricity generated by renewable resources, e.g. wind, wave, solar power
- Electricity generated from incinerating waste – though this gives rise to other toxins
- Hydrogen – obtained from the electrolysis of water (combustion produces only water!)