

Name: _____

Date: _____

AQA A-LEVEL CHEMISTRY

Alkanes as Fuels: Pollutants, Impacts and Removal

Learn Pack

This pack is designed to be completed alongside the video to help you build a secure understanding of this topic before moving on to revision and exam practice.

WATCH THE LESSON



Alkanes as Fuels

Every day we burn masses of alkanes to provide the energy we need to power our homes or drive our cars. And although alkanes are incredibly good fuels, their use has some serious consequences.

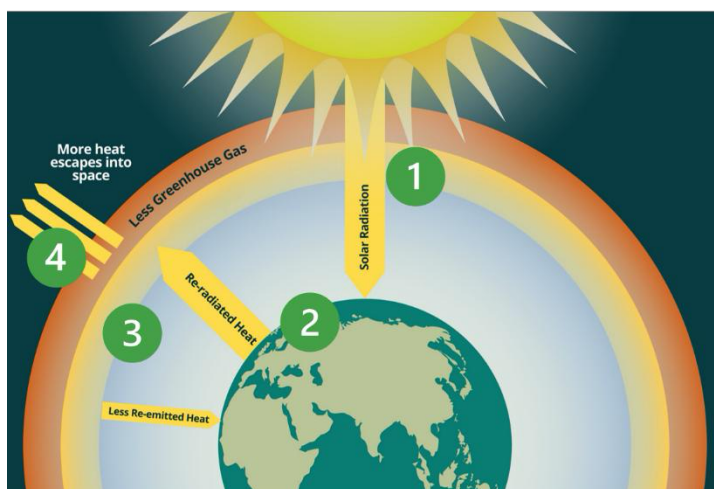
Carbon Dioxide

During complete combustion carbon
dioxide and water are

formed as products. Carbon dioxide is a greenhouse gas and therefore if the concentration of carbon dioxide in the atmosphere increases it contributes towards global warming.

Describe the greenhouse effect:

1. The sun emits short wave radiation that passes through Earth's atmosphere.
2. The radiation is absorbed by the Earth before being re-emitted as longer wave infra-red radiation.
3. Greenhouse gases in the atmosphere absorb some of the infra-red radiation.
4. The remainder of the radiation escapes into space.



Explain why the greenhouse effect is necessary:

Without it none of the Sun's energy would be trapped meaning Earth's temperature would be far too low for life to exist.

Explain the consequences of increasing carbon dioxide concentration in the atmosphere:

More infra-red radiation is absorbed and so less escapes back out into space.
This causes the temperature of the atmosphere to increase – global warming.

Lesson Objectives:

- Know that combustion engines produce a number of pollutants including NO_x , CO, carbon and unburned hydrocarbons.
- Understand the environmental and health impacts of these pollutants. And how they can be removed using catalytic converters.
- Know that the combustion of fuels containing sulphur impurities produces sulphur dioxide which can be removed by flue gas desulphurisation.

Carbon dioxide is a greenhouse gas because it can absorb the energy carried by infra-red radiation. Carbon dioxide molecules are made up of one carbon atom covalently bonded to two oxygen atoms by double bonds. Due to the difference in electronegativity, these bonds are polar and this allows infra-red energy to be absorbed by causing the bonds to vibrate. This can happen because the bonds vibrate at the same frequency as the infra-red radiation.

Carbon Monoxide

Carbon monoxide gas is formed by the incomplete combustion of alkanes. Carbon monoxide is a poisonous, colourless and odourless gas.

Describe the effect of carbon monoxide on the body:

When inhaled carbon monoxide enters your blood stream and binds very strongly to haemoglobin. This reduces the oxygen carrying capability of your red blood cells.

Carbon Particulates

Carbon particulates are solid particles of carbon formed during incomplete combustion of fuels. Carbon particulates have two negative consequences:

1. Breathing problems and exacerbating asthma.
2. Global dimming.

Unburned Hydrocarbons

Unburned hydrocarbons are hydrocarbon fuel molecules that leave an engine without combusting at all. They are greenhouse gases and can therefore contribute towards global warming.

Nitrogen Oxides

Temperatures inside of a combustion engine can become very high, these high temperatures can cause oxygen and nitrogen from the air to react and form nitrogen oxides (NO_x).

Give the equations for:

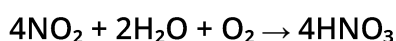
1. The formation of nitric oxide:



2. The formation of nitrogen dioxide:



Nitrogen dioxide is a toxic gas, and along with other nitrogen oxides can contribute towards acid rain. When nitrogen dioxide reacts with water and oxygen in the atmosphere, nitric acid can be formed:



The nitric acid that is formed in this way can then fall as acid rain, which can:

1. Damage plants.
2. Harm aquatic ecosystems and marine life.
3. Damage buildings.

Nitrogen oxides can also cause respiratory problems as they can irritate the airways and damage lung tissues.

Sulphur Impurities

Explain how sulphur impurities lead to the formation of sulphur dioxide and the problems they cause:

When fuels containing sulphur impurities are burned the sulphur reacts with oxygen to form sulphur dioxide. Sulphur dioxide is a toxic gas that can go on to form acid rain.

Catalytic Converters

Catalytic converters are fitted to exhaust systems to reduce the emissions of harmful pollutant gases. They contain a metal catalyst, usually platinum, palladium or rhodium, coated on a honeycomb structure.

Explain the benefits of coating the metals on a honeycomb structure:

Increases the surface area which increases the rate of reaction, making it more efficient whilst also using less of the expensive metals.

Write equations to show how each of the following pollutants are removed by catalytic converters.

1. Carbon monoxide:



2. Nitrogen oxides:



3. Unburned hydrocarbons:



Flue Gas Desulphurisation

In large-scale industrial combustion, such as at power stations, the gases produced during combustion are released as flue gases. Before these gases are released into the atmosphere, they can be treated to remove sulphur dioxide in a process known as flue gas desulphurisation.

Explain how sulphur dioxide is removed during this process:

The flue gases are passed through a slurry that contains a base such as calcium oxide or calcium carbonate. The acidic sulphur dioxide is then neutralised by the base.

Practise Questions – Fact Recall

1. Give three pollutants produced by vehicle exhausts.

Carbon monoxide, carbon particulates, nitrogen oxides, carbon dioxide, unburned hydrocarbons.

2. Explain how acid rain is caused by burning fuels that contain sulphur impurities.

The sulphur impurity reacts with oxygen when the fuel is burned forming sulphur dioxide which can go on to cause acid rain.

3. Give the equation for the removal of carbon monoxide from exhaust gases.



4. Name a metal used as a catalyst inside the catalytic converter.

Platinum, palladium or rhodium

5. What is the environmental consequence of carbon particulate emission?

Global dimming.

Practise Questions – Application

1. Platinum, palladium and rhodium are metals used inside catalytic converters. A very thin layer of the metals is used on a honeycomb ceramic support. Explain why a thin layer is used in this way.

Increases the surface area which increases the rate of reaction, making it more efficient whilst also using less of the expensive metals.

What next?

The next step in the Learn, Revise, Practise Method is Revise, where you'll strengthen your memory through retrieval practice exercises before then moving on to Practise where you start applying your knowledge to exam questions.