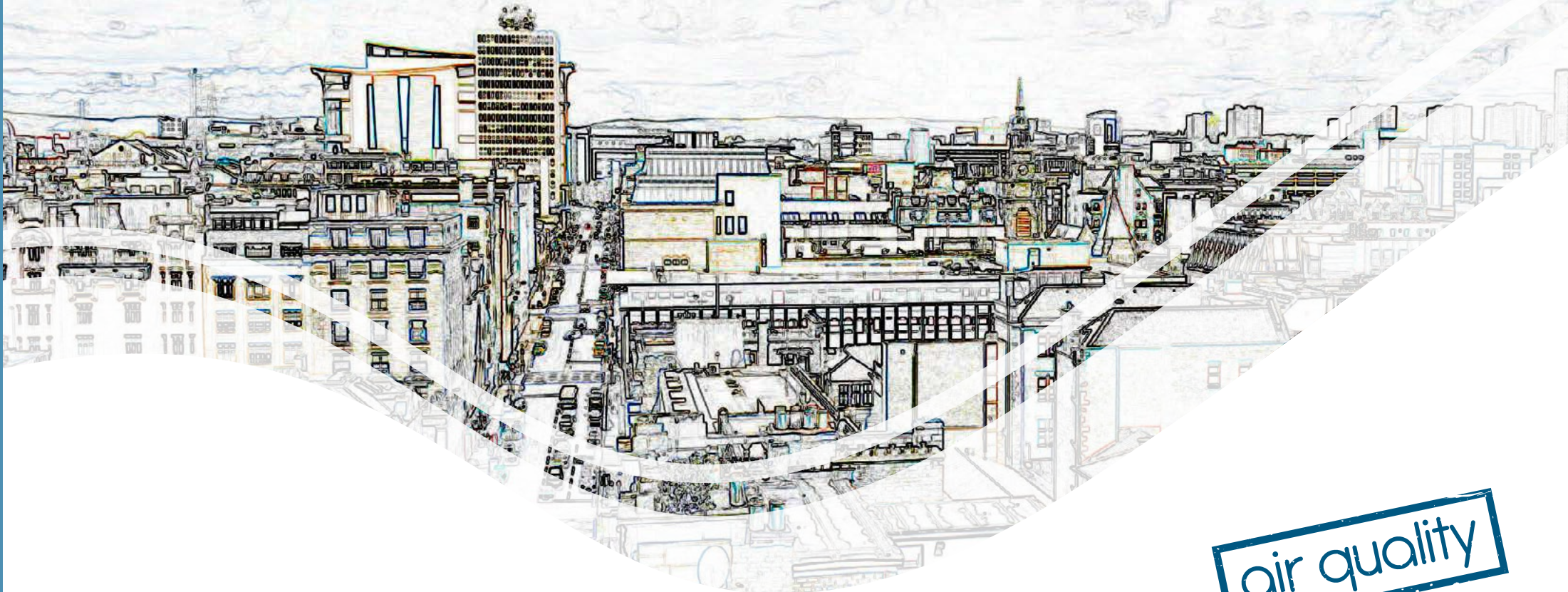


making the case
for the environment

The chemistry of air pollution



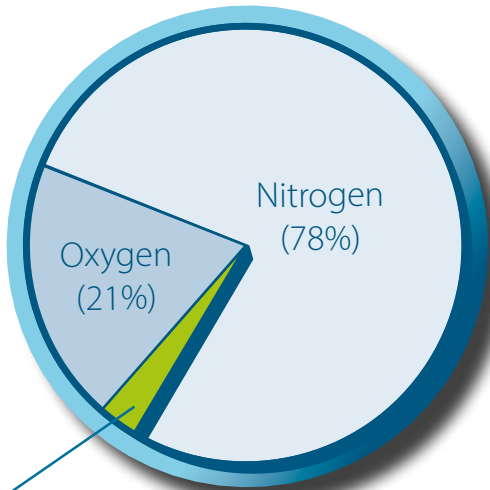
air quality

Contents



Air is very important as it provides oxygen and other gases that are essential to all life on Earth.

It consists of a mixture of invisible gases that surround the planet.



Other gases
(Less than 2%)

CO_2
0.04% Carbon dioxide

N
78% Nitrogen

Ar
0.93% Argon

O_2
21% Oxygen

O_3
0.00007% Ozone

NO_2
0.000002% Nitrogen dioxide

CO
trace
Carbon monoxide

H_2O
Water vapour

NH_3
trace Ammonia

Plus small amounts of other trace gases, such as carbon dioxide and methane.

Clean air is vital to sustain the delicate balance of life on Earth.

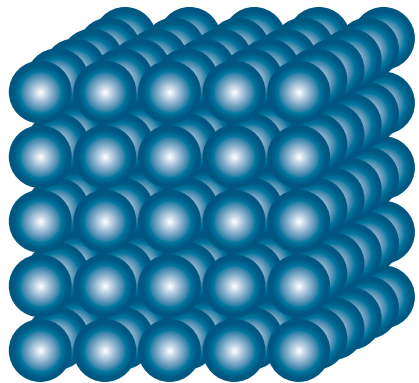
However the quality of air can be affected by air pollution.

Air pollution occurs when certain gases and particles build up in the atmosphere to such levels that they can cause harm to our health, causing breathing and respiratory problems, and even resulting in premature death, as well as damaging the environment around us.

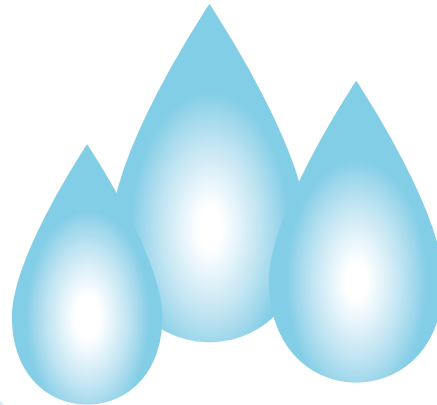
These gases and particles (known as pollutants) tend to come from man-made sources, including the burning of fossil fuels such as coal, oil, petrol or diesel, but can also come from natural sources such as volcanic eruptions and forest fires.

Pollutants can be in the form of:

solid particles



liquid droplets



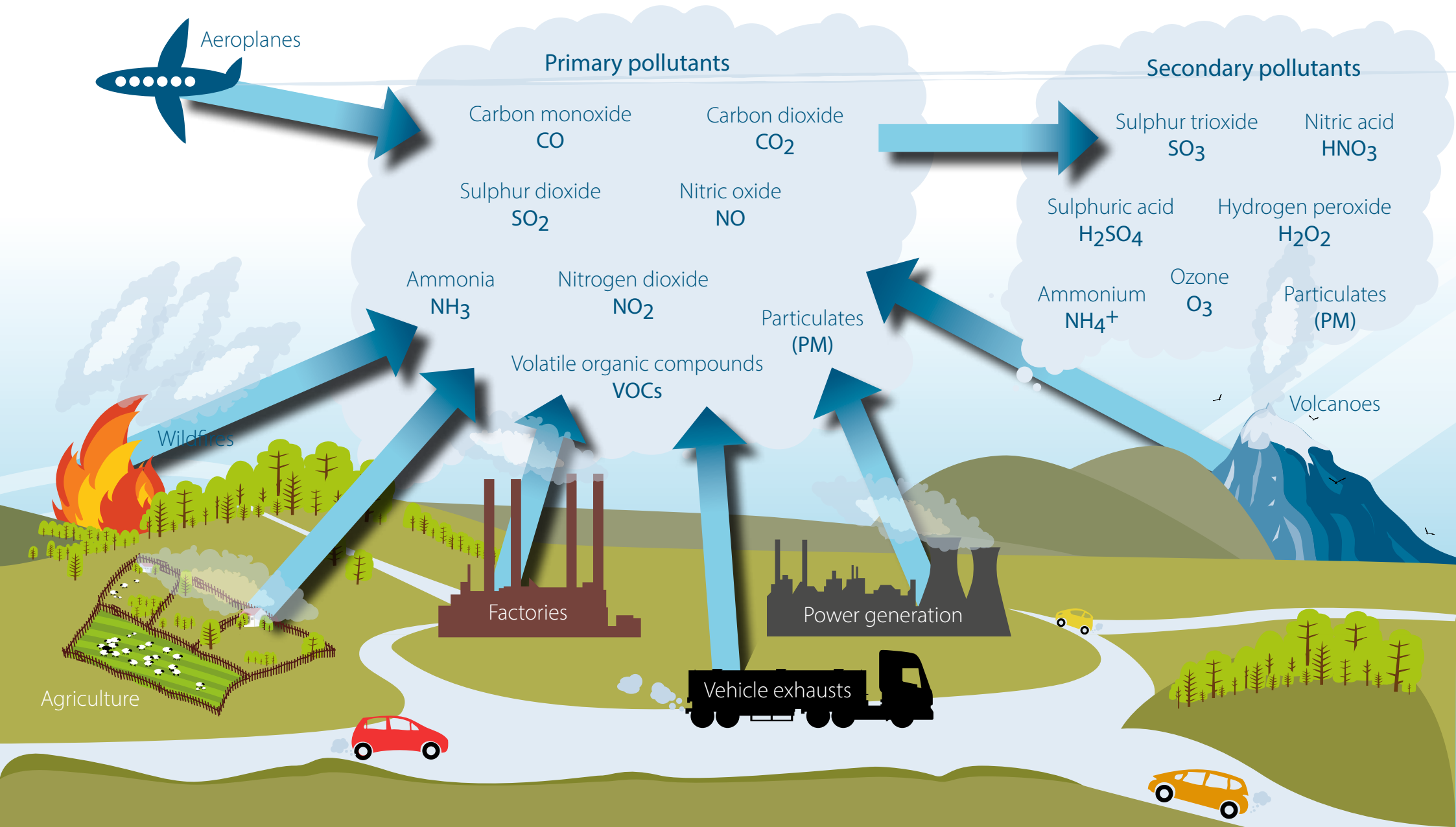
gases



Air pollutants can be classified as:

A **primary pollutant** is one that is emitted directly from a

Secondary pollutants are formed when primary pollutants interact with each other in the atmosphere.

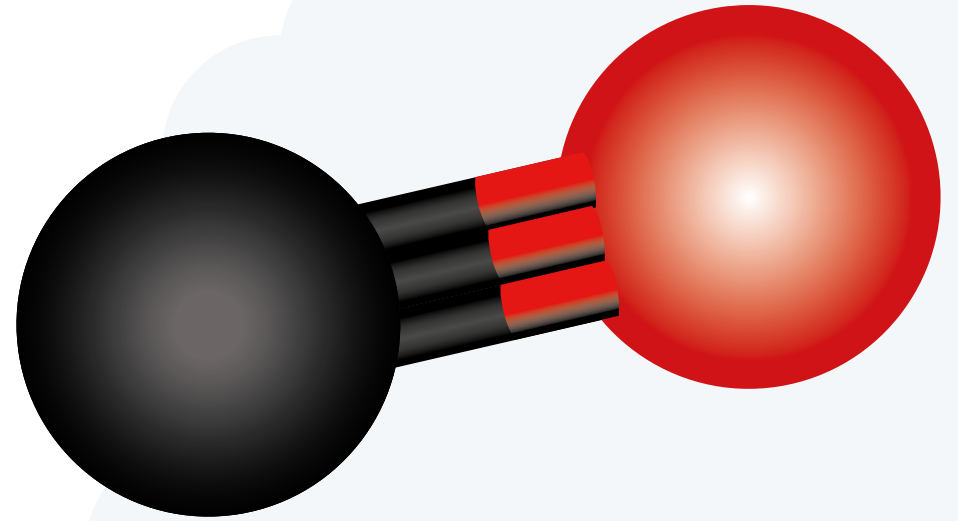


The main primary pollutants are





Carbon monoxide



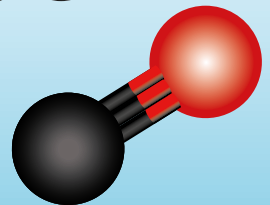
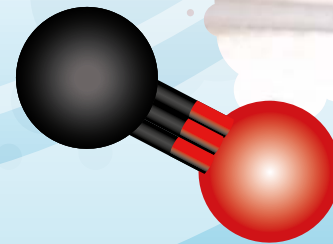
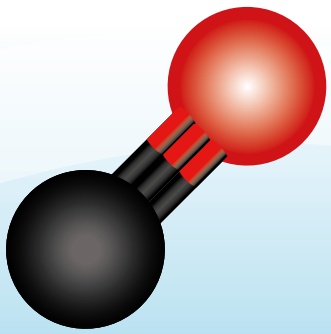
Carbon monoxide (CO) is a colourless, odourless, and very poisonous gas.

It is formed as a by-product of incomplete combustion processes involving carbon based energy sources, such as the burning of petrol, coal or wood.

During the process, if there is not enough oxygen available to create carbon dioxide as a by-product, then carbon monoxide is created instead.

The biggest sources of carbon monoxide comes from vehicles, especially when they are moving slowly or when the engine is idle.

Carbon monoxide is dangerous to humans, once inhaled it competes with oxygen by attaching on to haemoglobin in red blood cells and starving vital organs such as the brain, nervous system tissues and the heart of oxygen, reducing their ability to work properly.



NO₂

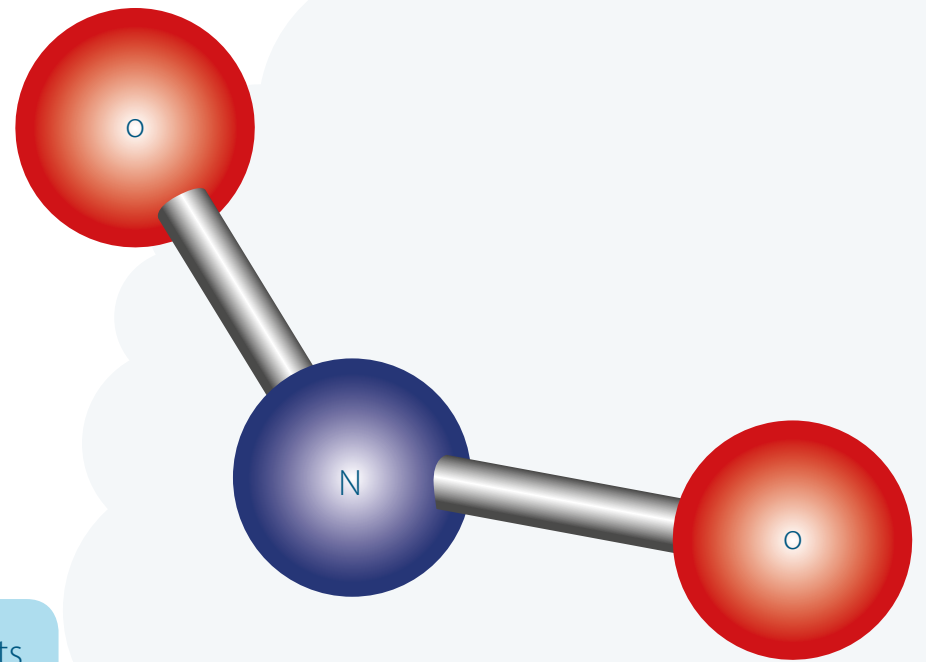
Nitrogen dioxide

Nitrogen oxides (NO_x) are a group of gases made up of varying amounts of oxygen and nitrogen molecules. One of the most common nitrogen oxides is nitrogen dioxide (NO₂) which is a reddish, brown gas that has an unpleasant smell and is poisonous in high concentrations.

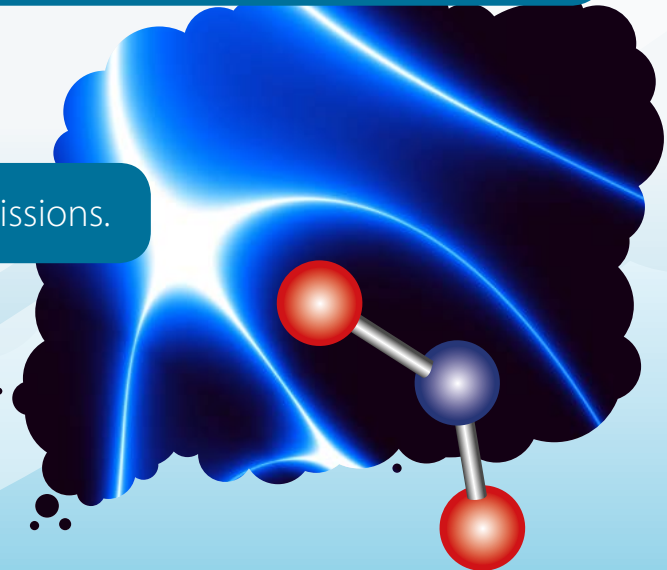
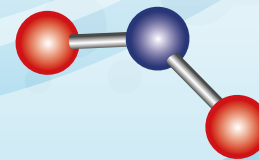
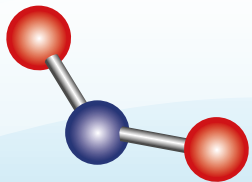
They are formed when fossil fuels are burned at high temperatures, but can also be formed naturally by lightning strikes.

Most of the nitrogen dioxide in urban areas comes from exhaust emissions.

It can increase the likelihood of respiratory problems, as it inflames the lining of the lungs, and can reduce immunity to lung infections. This can cause problems such as wheezing, coughing, colds, flu and bronchitis.

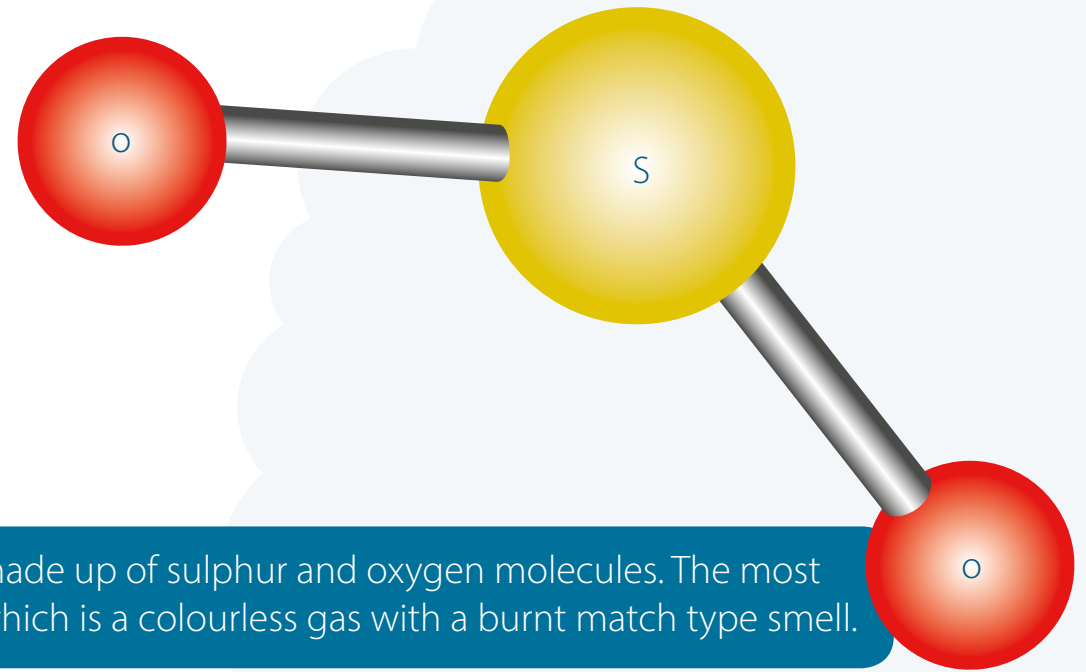


These can form secondary pollutants and can result in environmental problems such as acidification and nitrogen enrichment.



SO₂

Sulphur dioxide



Sulphur oxides (SO_x) are a group of compounds made up of sulphur and oxygen molecules. The most common sulphur oxide is sulphur dioxide (SO₂), which is a colourless gas with a burnt match type smell.

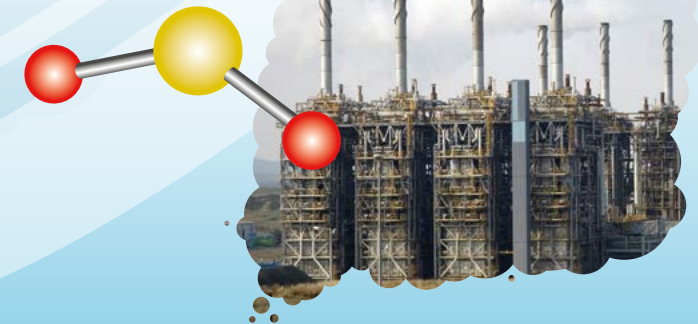
These can form secondary pollutants and can result in environmental problems such as acidification.

They are formed during the burning of fuels containing sulphur, such as coal and oil, and metal-containing ores (including aluminium, copper, zinc, lead and iron).

Most of the sulphur dioxide in our air is caused by the burning of coal and oil for energy generation and industrial activities.

It is also produced from natural sources such as active volcanoes and hot springs.

Sulphur dioxide can cause breathing difficulties if inhaled into the body. It is also toxic to plants and can cause acid rain when it reacts with moisture in the air.



PM

Particulates

Particulates or particulate matter (PM) are tiny pieces of solid matter or liquids in the air, and can consist of hundreds of different chemicals, including carbon, sulphur, nitrogen and metal compounds.

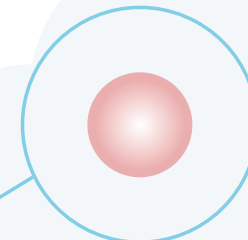
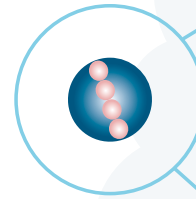
They originate from many different sources, including construction sites, vehicle exhausts, industrial sites, unpaved roads, and come in many shapes and sizes. Some are large enough to be seen with the naked eye, whereas others can only be seen through powerful microscopes.

Larger particles (larger than 10 micrometers) are generally filtered out of the body via the nose and throat.

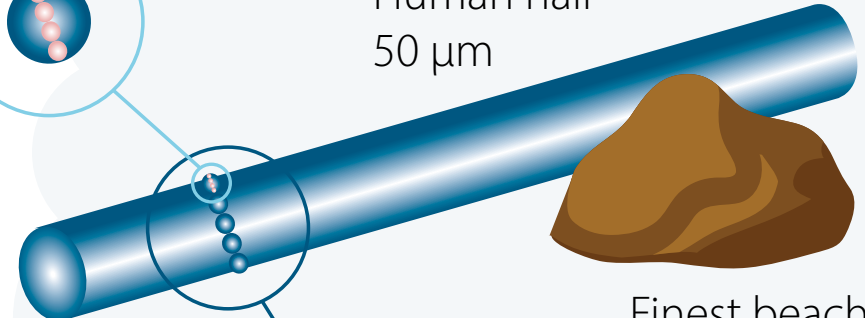
Particles that are 10 micrometers or smaller can be inhaled into the deepest parts of the lungs.

Fine particles are smaller than 2.5 micrometers and are small enough to pass from the lungs into the blood supply.

PM_{2.5} particles
<2.5 µm each



Human hair
50 µm



Finest beach sand
90 µm

PM₁₀ particles
<10 µm each



NH₃

Ammonia

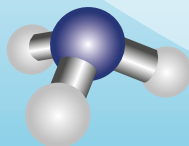
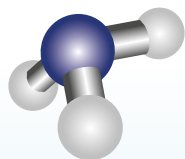
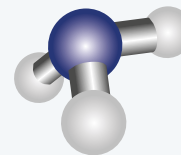
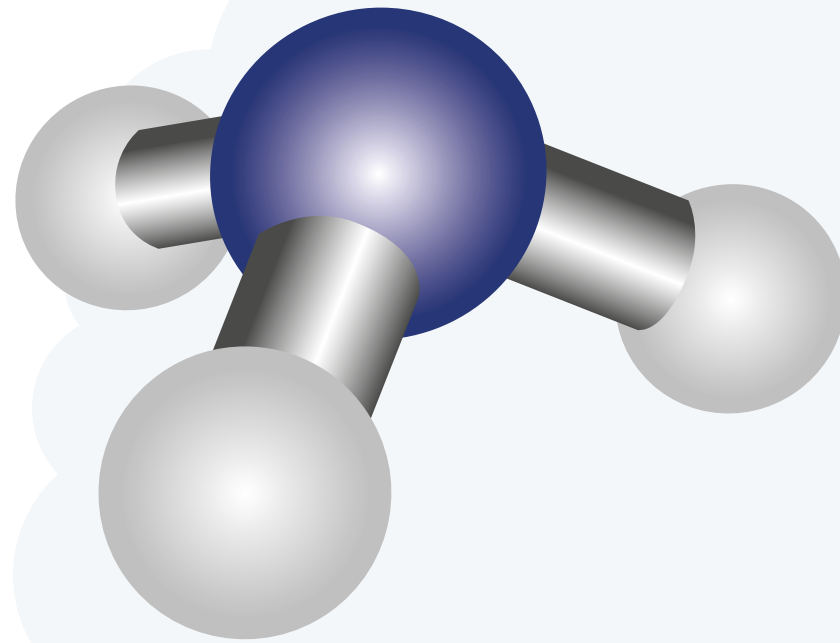
Ammonia (NH₃) is a very soluble colourless gas with a strong pungent smell.

It is primarily released from animal waste and fertiliser use, vehicle exhaust and other processes.

This forms secondary pollutants with the acid pollutant of SO₂ and NO_x to produce ammonium (NH₄⁺). These can then be move by the air over large distances from the initial source.

The biggest source of ammonia release is from agriculture including the intensive rearing of animals and crops.

When ammonia and the ammonium pollutants fall to the ground, they add to the nitrogen enrichment effects, increasing the growth of some plants, including trees.



Secondary pollutants



Ground level ozone

Ground level ozone (O_3) is a colourless gas that is a major component of atmospheric smog.

Some ground level ozone also comes from higher in the atmosphere.

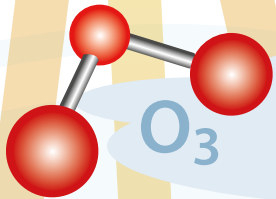
It is formed by chemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOC) in the presence of sunlight.

Primary pollutants can be transported over long distances by wind, generating ozone, meaning that rural areas can experience high ozone levels.

Ozone can cause irritation to the respiratory tract and eyes, causing chest tightness, coughing and wheezing, especially amongst those with respiratory and heart problems.

You can actually smell ozone from your fresh washing if it's left out during a hot day or after a heavy thunder storm!

Ozone also is a damaging air pollutant to plants, as it reduces growth and productivity including food crops. Ozone (O_3) also affects buildings and building material.

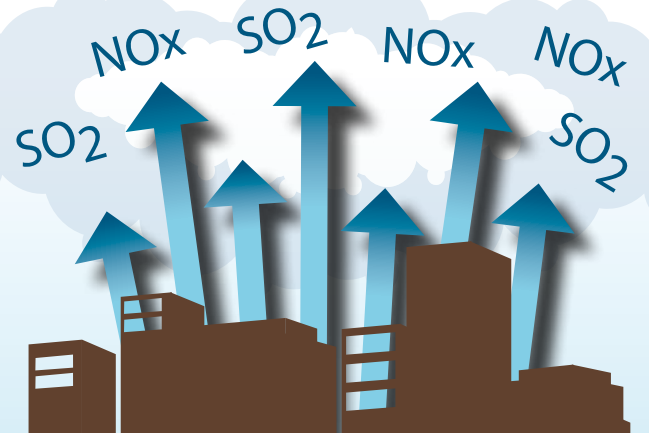


Acid rain

Acid rain is formed when sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) react in the atmosphere with water, oxygen and other chemicals to form various acidic compounds.

These compounds are transported in the air by the wind, until they fall to the ground in either wet or dry form.

When the compounds fall to the ground, they can cause damage to plants, including trees. They can also increase the acidity levels of our soils, rivers, lochs and streams, affecting the delicate balance of ecosystems that live in these environments.

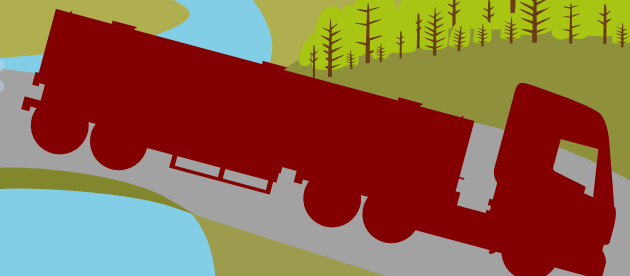


Acid rain



Acid rain also accelerates the decay of irreplaceable buildings, statues, and sculptures.

The pollutants that cause acid rain - sulphur dioxide and nitrogen dioxide can also be damaging to human health. As these gases interact in the atmosphere, they can form fine sulphate and nitrate water droplets which can irritate the air ways and cause irritation to eyes.



Nutrient enrichment

Nutrient enrichment compounds are pollutants that contain nitrogen such as NO_x and NH_x.

They can be transported long distances when nitrogen oxides and ammonia react in the atmosphere with water and other chemicals, until they fall to the ground in either wet or dry form.

NH₃

SO₂

NO_x

Nutrient enrichment caused by such pollutants increases the availability of nitrogen for plant growth, this can result in changes in habitats and loss of important plant species.

When nitrogen availability exceeds the demand from plants, the excess is leached out, increasing the levels in our lochs and rivers.

Wet deposition

Dry deposition

