Environmental Studies
FACT SHEET
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Control of Air Pollution

Air pollution sources

The major UK sources of common air pollutants are summarised in Table 1.

Table 1. Common air pollutants

Pollutant	Major source
NO_x (NO, N_2O, NO_2)	• Transport • Coal-burning power stations
SO_2	• Coal-burning power stations • Other industries burning coal
Smoke	• Transport (especially diesel vehicles) • Fossil fuel burning industries
Hydrocarbons	• Transport • Industry • Petrol filling stations
Methane	• Landfill sites • Flooded paddy fields
CFCs	Fridges, foam packing, aerosol cans* *Although banned under the Montreal Protocol CFCs are still used for these purposes in developing countries

Controlling pollution

General methods

Most air pollution in the UK comes from burning fossil fuels so the easiest way to decrease emissions is to burn less coal, oil, gas, petrol and diesel. All energy conservation techniques (improving energy efficiency, using shared transport, park & ride, insulation techniques etc) will therefore help to control pollution.

Since gas contains much less nitrogen and sulphur compounds than coal, substituting gas for coal in power stations (i.e. using gas instead of coal) will also help reduce emissions of NO_x and SO_2.

Specific methods

1. Reducing SO_2 emissions

Coal contains sulphur. When coal is burned in power stations, the sulphur is oxidised to SO_2, and if nothing is done to capture it, it will be released in the chimney (flue) gases. SO_2 is one of the two main gases that contribute to acid rain.

The most common technique for removing SO_2 from the flue gases uses wet scrubbers in a process known as **wet flue gas desulphurisation**. Effectively, a wet scrubber sprays limestone into the flue gases.

The SO_2 is removed, according to the following equation

$$\underset{\text{Sulphur dioxide}}{SO_2} + \underset{\text{limestone}}{CaCO_3} + \tfrac{1}{2}O_2 + 2H_2O \rightarrow \underset{\text{gypsum}}{CaSO_4 . 2H_2O} + CO_2$$

The gypsum can then be sold to make plasterboard for builders. Wet scrubbers can remove 99% of the SO_2.

In **dry flue gas desulphurisation**, hydrated lime is used to absorb the SO_2. This produces calcium sulphite ($CaSO_3$), which is disposed of in landfill or is used to make cement. Flue gas desulphurisation also helps remove sulphur trioxide, which would otherwise react with water to form sulphuric acid – corrosive to the chimney and a major component of acid rain.

Flue gas desulphurisation can be considered good because:
- It decreases SO_2 emissions
- It produces a useful product

but not-so good because:
- it increases demand for limestone which has to be quarried (noise, dust, visual pollution) often from National Parks (designated because of their landscape value).

2. Reducing NO_x emissions

All fossil fuels contain nitrogen (N). Burning them releases NO and NO_2. Importantly though, the amount of NO released depends upon the combustion temperature; the higher the temperature, the more NO is released. Thus, reducing the peak temperature in any form of combustion (power station or vehicles) will decrease NO emissions.

In vehicles, increasing the percentage of fuel to air can also decrease the amount of NO released. Similarly, in power stations, designing the combustion chamber so that it slows the rate at which air and fuel are burnt will increase the percentage of N_2 emitted but decrease the percentage of NO.

Flue gas denitrification can also be used in power stations. Ammonia or urea is injected and this converts NO into N_2.

$$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O$$

Catalytic converters

The catalysts are precious metals such as platinum and rhodium inside the vehicle exhaust case. These cause:

- CO to be oxidised to CO_2
- Hydrocarbons to be oxidised to carbon dioxide and water
- NO to be reduced to N_2

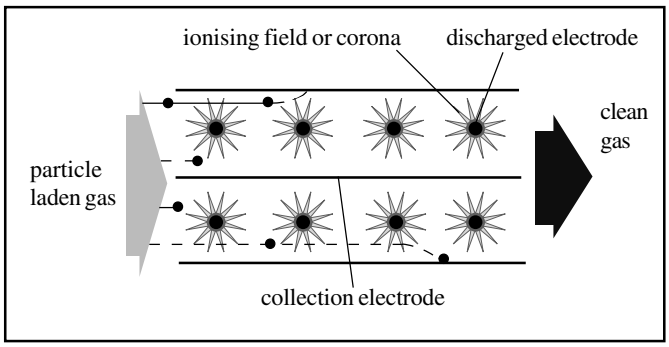
Thus catalytic converters reduce the formation of photochemical smog (NO_x, hydrocarbons and ozone) acid rain (SO_2 and NO_2) but increase the emissions of CO_2 – a greenhouse gas.

Exam Hint: *70% of students in the 2003 exam could not name the three gases which contribute to photochemical smog. Learn* ***the basic facts*** *- you will probably be asked to* ***apply them*** *in the exam.*

3. Reducing smoke

Electrostatic precipitation removes smoke by causing the particles to become ionised i.e. they are given a slight negative charge. This causes them to be drawn towards positively charged plates, to which they stick. They can then be collected for disposal. Electrostatic precipitators are used in power stations, cement factories, steel plants, printing, textile and vinyl coating industries (Fig 1).

Fig 1. Electrostatic precipitators



Cyclone separators remove grit, dust and smoke particles from waste gases. The gas is made to spiral around a funnel and as the particles collide with the walls they lose energy and slide down to the bottom where they are collected.

Bag filters remove dust and smoke from waste gases – the finer the filter, the greater the percentage of particles that can be collected.

Scrubbers can be used to remove dust and smoke particles from waste gas streams.

4. Reducing hydrocarbons

Petrol contains hydrocarbons such as benzene, which can escape from vehicle engines and from petrol stations when vehicles are filled up. Hydrocarbons will then contribute to the formation of tropospheric ozone - which can cause eye and throat irritation, interfere with plant growth and damage building materials. As the petrol tank is being filled, the vapours inside the tank are displaced. The most effective way of reducing these emissions at petrol stations is to collect the gases before they escape and condense them back into a liquid.

5. Reducing methane

The most important anthropogenic (man-made) sources of methane are landfill sites and flooded paddy fields. In both cases the methane (CH_4) is formed as a result of microbes breaking down organic matter in anaerobic conditions (hence more CH_4 is released than CO_2). Emissions from landfill sites can be reduced by:

- Encouraging recycling and composting (where the aim is to encourage aerobic breakdown)
- Collecting the methane and burning it as a fuel

Emissions from flooded paddy fields can be reduced by:

- Breeding more varieties of rice that grow in dry soils
- Encouraging the production of alternative crops that do not require flooding.

6. Reducing CFCs

The Montreal Protocol has been successful in reducing the emissions of CFCs. Alternatives such as hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) are broken down faster than CFCs and therefore do less damage. In order to compare the harmful effects of CFCs and the substances that have replaced them in some countries, we can use the concept of ozone depletion potential (ODP) where:

$$\text{ODP} = \frac{\text{ozone depletion due to compound}}{\text{ozone depletion due to CFC11}}$$

Table 2 shows the ODPs of some of the substances that have replaced CFCs.

Table 2. Ozone depletion potentials of different halocarbons

Halocarbon	ODP	Lifetime (years)
CFC11	1.00 (by definition)	60
CFC12	0.90	120
HCFC22	0.05	15.3
HCFC 123	0.017	1.6
HFC 125	0	28.1
HFC 134a	0	15.5
Carbon tetrachloride	1.1	50

As the table shows, many of the CFCs that have been released over the last 30 years will stay in the atmosphere – destroying the ozone layer – for a long time yet.

Air pollution legislation and bodies

Environmental Protection Act (1990): In England, Wales and Scotland this Act regulates any industrial process that has a major impact on the environment and includes airborne pollutants.

EPA (1995) introduced a system of Local Air Quality Management (LAQM).

Environment Agency (England & Wales) authorises the operation of the most polluting processes. Local authorities in England and Wales are responsible for authorising and controlling release to the air from less polluting processes. Local Authorities also apply BATNEEC (Best available technology not entailing excessive cost) principles – they force companies to buy and use this technology.

Sources of info

www.nottingham.ac.uk and then click on The Environmental Guide: good source of basic information on nature and control of air pollution

Colls Jeremy (1997) Air Pollution – An Introduction. E & FN Spon. Good source of detailed information.

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