# Basic Knowledge
# Air Pollution Control

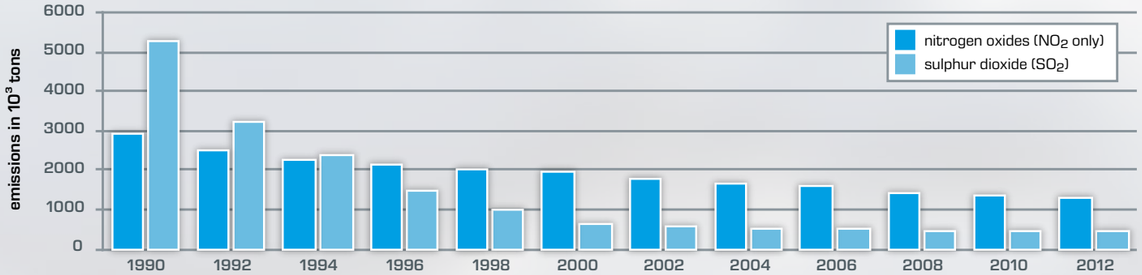
## Air – the basis of life for all living beings

The composition of the atmosphere has changed considerably since the beginning of industrialisation due to the interference of mankind. The destruction of the ozone layer and global warming are becoming ever more visible and are undoubtedly attributable to the excessive discharge of contaminants into the atmosphere. This poses a serious threat to all life on earth. The goal therefore must be to reduce the discharge of contaminants into the atmosphere as far as possible. Primarily, it is desirable to reduce the amount of contaminants that occur. Where this is not possible, the exhaust air must be cleaned by suitable processes.

### Worldwide contaminant transport

The effects of a contaminant entering the atmosphere are not restricted locally. Instead, contaminants are transported by wind over many thousands of kilometres above the earth. This explains why nowadays contaminants are detected in the atmosphere even in the most remote regions far away from civilisation.

The most well-known example is the "Arctic Haze", the yellowish brown haze appearing over the Arctic in winter and spring. Aerosols from the industrial regions in Eastern Europe and Asia are regarded as the main cause for this phenomenon. The aerosols are mainly composed of sulphur and carbon.




Emissions of sulphur dioxide ($SO_2$) and nitrogen oxides ($NO_2$ only) in Germany
Source: Federal Environment Agency, national trend tables for German reporting of atmospheric emissions (published 2014)

### Processes of air pollution control

A number of processes are available for air pollution control, of which most can be categorised into one of the following groups:

- mechanical processes
- biological processes
- thermal processes

### Biological processes

In biological processes, gaseous components are degraded microbiologically. Since the components must be biodegradable and may only be present in low concentrations, the field of application of biological processes is very limited. Biological processes are mainly used for odour problems such as occur in rendering plants, for example.

## Mechanical processes

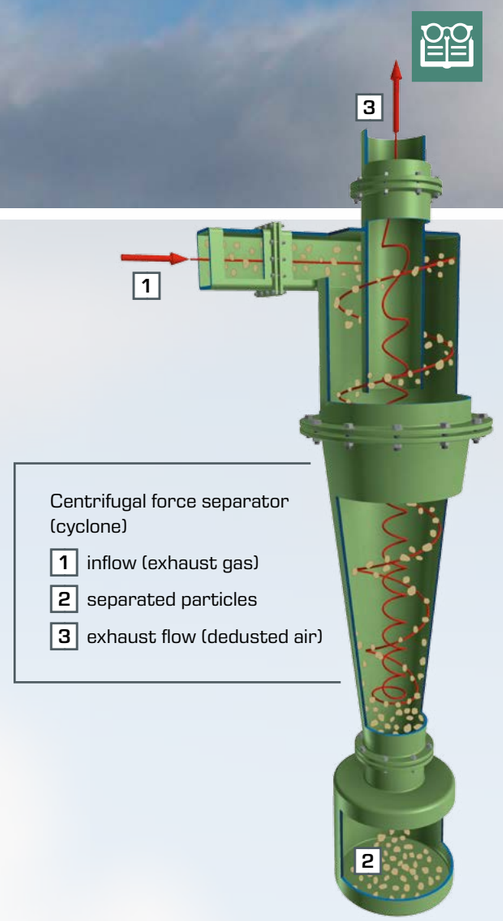
The aim of mechanical processes is separation of particles from an exhaust gas flow (dust extraction). The separation of particulate matter in particular is of great importance.

### Centrifugal force separator (cyclone)

The gas flow to be cleaned is forced into a circular path in a cyclone. The resulting centrifugal force acting on the particulate matter amounts to a multiple of the force of gravity. This explains why this process can also separate very small particles in comparison to simple gravity separation (sedimentation). The separation limit of cyclones is of the order of 10 µm.

### Electrostatic separators

In an electrostatic separator, the particles are first electrically charged. The charged particles then deposit onto an oppositely charged electrode. A layer of dust, which must be removed mechanically every so often, forms on the electrode. An electrostatic separator can be used to separate out particles smaller than 1µm.




Centrifugal force separator (cyclone)

1 inflow (exhaust gas)
2 separated particles
3 exhaust flow (dedusted air)

## Thermal processes

Physical/chemical processes are used to remove gaseous contaminants. Two of the most widespread processes are absorption and adsorption. Both processes are versatile and suitable for removing nitrogen oxides, sulphur dioxide, hydrogen sulphide and carbon dioxide, for example. Essentially, for both processes it can be said that the exhaust gas should largely be free of dust, which means mechanical cleaning needs to take place initially.

### Absorption

At least three components are involved in absorption: the contaminant to be separated, the carrier gas and a solvent. The solvent absorbs the gaseous substance; this can be implemented physically or chemically. In order to ensure that the solvent only absorbs the contaminant and not the carrier gas, the solvent must be adapted to the respective application.

### Adsorption

In adsorption, the contaminant to be removed is bonded to the surface of a solid (adsorbent). As with absorption, this can use either physical or chemical means. Activated carbon is a very frequently-used adsorbent. Adsorption is favoured by low temperatures. The exhaust gas to be cleaned should therefore not be warmer than 30°C.