
**Guidance on best available
techniques and best
environmental practices**

Common Techniques

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Common techniques

Common techniques for emission reduction

This chapter provides general information on control techniques which are applicable across all the point source categories listed in Annex D. Additional information specifically relevant to the individual sectors may be found in the chapter pertaining to the sector in question.

In order to consider all possible options relevant to the sector of interest, it is necessary to consider both the common techniques described in this section and the specific techniques described for each sector.

Particle-bound emissions of mercury can be captured to a varying extent by dust-cleaning devices. Most of the dust-cleaning techniques are generally applied in all sectors. The degree of mercury control depends on the chemical state and form of the mercury, e.g., whether oxidized or elemental. Elemental mercury is mostly not captured in

dust-cleaning devices: the mercury-removal efficiency of these devices can be enhanced by oxidizing the gaseous mercury. The most commonly used techniques for dust abatement are bag filters and electrostatic precipitators (ESP).

A common technique across sectors for specific mercury removal is to use activated carbon, either injected into the flue-gas stream or in a filter bed. To improve the removal efficiency of the activated carbon oxidizing agents can be used (e.g. injected in the flue-gas stream or adsorbed on the activated carbon).

Fabric filters

Bag filters (fabric filters, textile filters) use filtration to separate dust particulates from gases. They represent one of the most efficient and cost-effective types of dust collectors available and can achieve a collection efficiency of more than 99.99 per cent for very fine particulates. Gases enter the filter device and pass through fabric bags. The bags can be made of different materials (e.g., woven or felted cotton, synthetic or glass-fibre material) depending on the properties of the flue-gas.

To improve the ability to filter dust and enhance the life the filter material is often coated. The most common material is chemically inert limestone (calcium carbonate). It increases the efficiency of dust collection via formation of a so-called filter cake. A filter cake improves the trapping of fine particulates and provides protection of the filter material itself from moisture or abrasive particles. Without a pre-coat the filter material allows fine particulates to bleed through the bag filter system, especially during start-up, as the bag can only do part of the filtration leaving the finer parts to the filter enhancer filter cake.

Gaseous mercury will mainly pass through a bag filter. To make the process more efficient, therefore, gaseous mercury should be converted as far as possible into its oxidized form, which can bind to particles. The efficiency of the bag filter can be increased with different measures, e.g., coupling with dry or semi-dry sorbent injection (spray drying), and providing additional filtration and a reactive surface on the filter cake.

Electrostatic precipitators

Electrostatic precipitators (ESPs) use electrostatic forces to separate dust particles from exhaust gases. The dust-laden gases flow through the passage formed by the discharge and collecting electrodes. The airborne particles receive a negative charge as they pass through the ionized field between the electrodes. These charged particles are attracted to a grounded or positively charged electrode and adhere to it. The material collected on the electrodes is removed by rapping or vibrating the collecting electrodes, either continuously or at predetermined intervals. Precipitators can usually be cleaned without interrupting the airflow.

The main factors affecting the collection efficiency of electrostatic precipitators are electrical resistivity and particle size distribution. Other influencing factors are temperature, flow-rate of the flue-gas, moisture content, conditioning agents in the gas stream or an increased collection surface.

A wet ESP operates with water vapour-saturated air streams (100 per cent relative humidity). Wet ESPs are commonly used to remove liquid droplets such as sulfuric acid mist from industrial process gas streams. A wet ESP is also commonly used where the gases are high in moisture content, contain combustible particulate, or have particles that are sticky in nature.

Wet scrubbers

There are two different types of wet scrubbers used, one primarily for de-dusting and the other for the removal of acidic gaseous compounds.

In wet de-dusting scrubbers, the scrubbing liquid (usually water) comes into contact with a gas stream containing dust particles. Vigorous contact of the gas and liquid streams yields high dust removal efficiency. Humidification leads to the agglomeration of fine particles, facilitating their collection. Examples of such scrubbers are Venturi scrubbers, Theissen scrubbers or Radial Flow scrubbers. The dust removal efficiency of these units can be higher than 98 per cent, but the final concentration of dust is relatively high (over 5 mg/Nm³).

Wet scrubbers dedicated mainly to the removal of acidic gaseous compounds (often of the spray tower type) remove such pollutants as SO₂, HCl and HF. A liquor is used to absorb the compounds. They often clean the gas which has been already de-dusted.

The “cleaned” gases from both types of scrubbers normally pass through a mist eliminator to remove water droplets from the gas stream. The water from the scrubber system is either cleaned and discharged, or recycled to the scrubber.

Elemental mercury absorption can be improved by the addition of sulfur compounds or activated carbon to the scrubber liquor (Miller et al., 2014).

Precipitation is another measure often used to remove oxidized mercury in scrubbing waters. Sulfur compounds can serve as a flocculation agent, added to the scrubbing water to convert soluble mercury efficiently into an insoluble compound. In order to bind the mercury directly after its conversion in the liquid phase, another possibility is to add activated carbon to the scrubbing water (Bittig, 2014).

Re-emission of mercury can occur when reducing compounds such as sulfite are present in the scrubbing water. In this case, mercury can be converted back to elemental mercury and re-emitted (Keiser, et al., 2014). This can be avoided by ensuring the presence of ions with which mercury can react to form compounds, such as fluoride, chloride, bromide or iodide.

Summary of dust cleaning devices

Table 1 provides information on the performances of dust-cleaning devices

Table 1

Performance of dust-cleaning devices expressed as hourly average dust concentrations

	Dust concentrations after cleaning (mg/m ³)
Fabric filters	< 1 – 5
Fabric filters, membrane type	< 1
Dry electrostatic precipitators	< 5 – 15
Wet electrostatic precipitators	< 1 – 5
High-efficiency dust scrubbers	< 20

Source: extracted from the Guidance document on best available techniques for controlling emissions of heavy metals and their compounds from the source categories listed in Annex II to the Protocol on Heavy Metals (ECE/EB.AIR/116, 2013)¹

Sorbents and oxidizing agents

Activated carbon is an effective sorbent for mercury capture from flue gas. The activated carbon can be injected into the flue gas upstream of dust-cleaning devices, bag filters or ESPs, or the flue gas can be distributed throughout a carbon filter bed. The effectiveness of activated carbon for mercury control is temperature-dependent. Specifically, the mercury capture or removal capacity of a particular sorbent typically increases as the flue gas temperature decreases. The flue gas temperature is primarily determined by plant design and operating factors. Depending on plant specifics, such as flue gas constituents and operation of the dust control device, mercury removal is relatively effective at temperatures below 175 °C with standard activated carbon. Special high temperature activated carbon sorbents exist for capture of mercury above 175 °C and generally up to 350 °C.

All activated carbons are combustible and, under certain conditions, auto-ignitable, and explosive. The fire and explosion risk is dependent on the combustion and explosion characteristics of the pulverized product, and also

¹ Note there is an issue with oxygen levels used as a proxy for the amount of dilution occurring, and further investigation should be done.

on the process and plant conditions. Quality activated carbon is highly processed and poses a lower risk of fire and explosion than low quality carbon. Partially activated carbons can pose a high risk, however, and may require special handling. The adsorbent should be selected carefully and used with proper handling guidance, including fire and explosion-preventing equipment, (e.g., avoidance of low-velocity air flows through beds, avoidance of large-volume deposits in the process by continuous and monitored discharge from the hoppers to avoid fire risks, and good housekeeping for spill cleanup). Dilution of carbon with inert material can suppress the potential for explosion. In applications where activated carbon is added to gas streams which have little process dust it may be advantageous to blend carbon with non-combustible sorbents (Licata et al., 2007; Derenne et al., 2008)

Mercury capture can be enhanced by adding oxidizing agents (i.e., halogens) to the flue gas or by using activated carbon impregnated with halogens or sulfur. These techniques are described in more detail in the sector chapters. There is a potential risk that dioxins and furans could appear as a result, particularly in the by-products, e.g., in the ashes and sludges. This should be taken into account.

Activated carbon waste should be handled in accordance with Article 11 (Mercury wastes) and in accordance with any applicable national regulations.

Table 2 shows the minimum expected performances of activated carbon techniques for mercury removal.

Table 2

Minimum expected performances of activated carbon techniques for mercury removal expressed as hourly average mercury concentrations

	Mercury content after cleaning (mg/m³)
Carbon filter	< 0.01
Sulfur-impregnated carbon filter	< 0.01
Carbon injection + dust separator	< 0.05
Injection of brominated activated Carbon+ dust separator	0.001

Source: extracted from the Guidance document on best available techniques for controlling emissions of heavy metals and their compounds from the source categories listed in annex II to the Protocol on Heavy Metals (ECE/EB.AIR/116, 2013)

The degree of mercury control in table 2 is largely dependent on the chemical state and form of the mercury (e.g., whether oxidized or particle-bound), and on the initial concentration. The application of these measures depends on the specific processes and is most relevant when concentrations of mercury in the flue gas are high. Examples of performance levels of single techniques or combinations of techniques are given in the sector documents.