



INCINERATION PLANTS

Hazardous waste incineration
Wastewater incineration
Sewage sludge incineration

INTRODUCTION

The thermal treatment of hazardous waste destroys harmful substances and recovers the energy contained in the waste for production processes at CHEMPARK.



The thermal treatment of waste, sewage sludge, wastewater and wastewater concentrates is a recognized method of waste management. It is particularly suitable for the safe and environmentally sound disposal of hazardous chemical waste. Incineration in this sense means the oxidation of organic waste to generate carbon dioxide, water and inorganic residues. Part of the latter can be recycled and the remainder can be disposed of safely. Over 300 companies from all over Europe and a small number of overseas customers commissioned CURRENTA Environment with disposing of their hazardous waste in 2007. These include Bayer's subgroups and the companies located at CHEMPARK.

Waste management

The fundamental objective for CURRENTA Environment is the safe and environmentally sound disposal of hazardous waste. The energy released during this process is fed into the site grid in the form of steam. A further aim is to look for ways of recycling slag and ash. Inorganic salts and residues that cannot be reused after incineration are consigned to the controlled hazardous waste landfill site. The incineration of hazardous waste ensures that

- toxic organic substances are completely and definitively destroyed
- risks resulting from improper disposal of hazardous waste (i.e. tomorrow's contaminated sites) are avoided
- the volume of waste is cut significantly

The thermal treatment of organic, toxic substances in hazardous waste incinerators destroys these substances and enables effective recovery of the energy present in the hazardous waste. CURRENTA Environment's hazardous waste incineration plants convert this energy into steam that is fed into the site grid.

Hazardous waste from the chemical/pharmaceutical and chemical processing industries can be accepted in many different forms. In addition to bunkers for solid waste and loading arms for liquid and gaseous substances, there are also, for example, systems for receiving sludge of different consistencies and compositions. The many different kinds of hazardous waste that can be disposed of include:

- production residues in solid, paste and liquid form
- laboratory chemicals
- chemically contaminated packaging
- non-miscible, reactive liquids
- highly halogenated and hot liquids
- insecticides and pesticides
- PCBs
- concentrates

In 2007, customers from all over Europe and some overseas companies commissioned CURRENTA Environment's hazardous waste incinerators with the safe and environmentally sound disposal of their waste, accounting for over 25 percent of the incineration capacity available at that time.

Development of hazardous waste incineration plants

The first incinerator went into operation in 1957 in the Flittard section of the current CHEMPARK site. The experience gained was applied in the construction of incinerators 1 (year of construction 1967) and 2 (year of construction 1976) at the new Leverkusen-Bürrig Waste Management Center.

These rotary kiln waste incinerators are geared specifically to substances that are particularly difficult to dispose of. Development work took a long time as a result of problems with processes and materials. This work focused on optimizing burnout quality and flue gas cleaning.

Incinerator 1 underwent a general overhaul in 1989 and was equipped with the best flue gas cleaning technology available. In 1991/1992, incinerator 2 was also modernized to create a state-of-the-art plant. In 1995, the flue gas cleaning system was further upgraded to comply with the requirements of the German regulations governing emissions (17th BImSchV).

The incinerators must be able to reliably convert waste of different compositions and consistencies into substances that are not harmful to the environment. This requires highly efficient incineration processes, extremely effective downstream cleaning of flue gases and environmentally sound disposal of the slag, dust, salts and wastewater produced. Additional requirements for cost-effective operation include high availability/low susceptibility to failure.

Rotary kiln incinerators proved ideal for disposing of all kinds of waste in liquid, paste and solid form. They are also suitable for the incineration of hazardous waste in all states of aggregation. Downstream from the incinerator is an afterburner chamber fired by liquid waste that ensures thorough mixing and complete burnout of flue gases.

Specific conditions relating to temperature and residence time, an excess of oxygen and high turbulence ensure complete mineralization of hazardous organic waste. ✨

HAZARDOUS WASTE INCINERATORS (VA1 AND VA2)

Step by step: An overview of plant components and processes for the incineration of hazardous waste

CURRENTA Environment operates two hazardous waste incinerators at the Leverkusen site. Together with the landfill site, wastewater treatment plant and further incineration plants, these incinerators form part of the Leverkusen-Bürrig Waste Management Center's disposal network.

Hazardous waste incinerators are made up of three process sections:

- rotary kiln with afterburner chamber
- waste heat boiler for steam generation
- multi-stage flue gas cleaning

There is also an infrastructure for storing waste, distributing it to the various plants and disposing of the residue and wastewater produced during incineration.

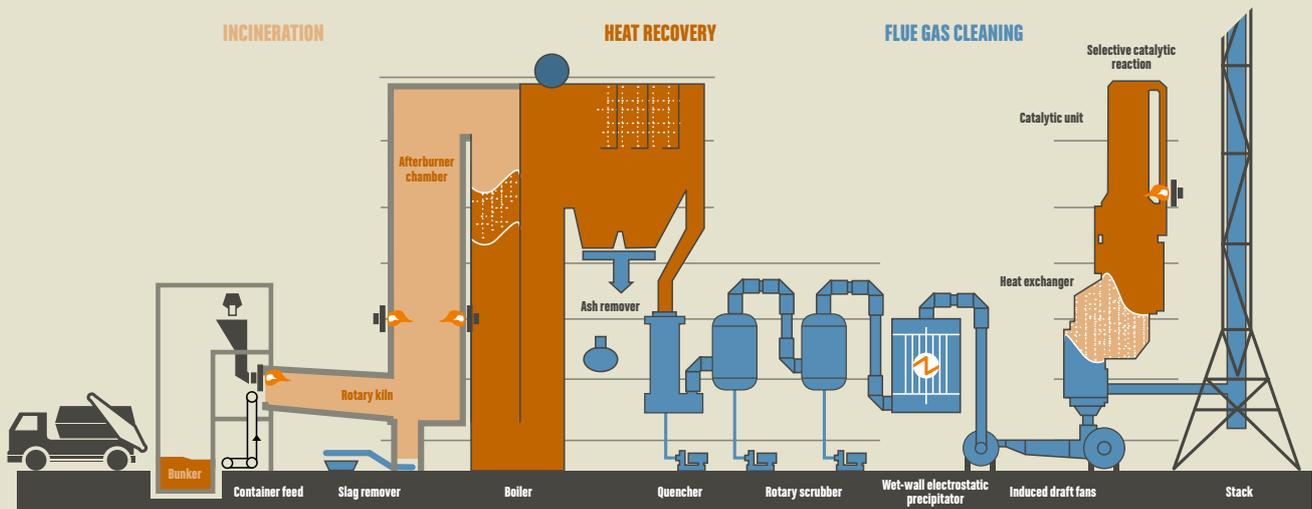
Feeding hazardous waste into the incineration chambers

Combustible solids are extensively sorted in the bunker and collected in different sections. An orange-peel grapple loads incinerator 1's rotary kiln via the furnace feed. Solid waste broken up into small pieces can be fed almost continuously into incinerator 2 using a feed device. The furnace feed and feed device protect the bunker from the rotary kiln by means of a sluice system.

Solid and non-pumpable waste is placed in the incinerators in closed containers. Pumpable liquid waste is transported to the burners either from tank containers through separate pipes or directly from the tank farm. Whether waste is disposed of via separate pipes or the tank farm depends on its physical and chemical properties.

Rotary kiln incinerator

The rotary kiln is a slightly inclined pipe with a diameter of 3.5 meters and a length of approximately 12 meters that is lined with fire-proof material. This inclination and rotation about the longitudinal axis transports waste through the rotary kiln in solid and paste form together with any waste melted by the high temperatures. The temperature at the end of the kiln is around 1,000 °C. The organic waste components are completely oxidized as they pass through the kiln. The inorganic waste components and metallic drum materials form a melt that runs off at the lower end into a slag remover filled with water where it solidifies and is discharged on a continuous basis. The vitreous slag is non-leachable and is suitable for landfilling. Because the rotary kiln is subject to high thermal, mechanical and chemical stresses, it must be regularly relined.



The process of hazardous waste incineration

Afterburner chamber

The afterburner chamber is a vertical cylinder that is also lined with fire-proof material. Burners charged with liquid waste ensure that the incineration temperature required by the authorities is maintained/reached. The section above the burner level up to the top of the afterburner chamber is the afterburner area, which is large enough to comply with/exceed the statutory flue gas residence time (2 sec.). The slag running off from the walls of the afterburner chamber is collected at the bottom of the chamber and removed at regular intervals when the plant is not in operation.

Heat recovery

The hot flue gases leaving the afterburner chamber arrive at the boiler where their energy content is used to generate steam at an overpressure of approx. 41 bar and a temperature of around 350-380 °C. This steam is fed into the CHEMPARK grid as process steam.

Flue gas cleaning

During the subsequent multi-stage process, flue gases are cleaned to such an extent to ensure reliable compliance with the limits of the 17th BImSchV. Reliable compliance means being well within these limits under normal

operating conditions in order to leave a sufficient safety margin. The individual flue gas cleaning devices are described below.

Quencher – The first flue gas cleaning device is a scrubber operating in direct current mode in which flue gas and rinsing solution flow in the same direction. The quencher cools (quenches) the flue gas to its saturation temperature (approx. 70-80 °C). Acids and coarse dust are also removed.

Rotary scrubber (acidic) – In the acidic rotary scrubbers downstream from the quencher, the rinsing solution is fed onto centrifugal wheels, creating a fine film of liquid at right angles to the axis of the device – and thus at right angles to the flow of flue gas.

As this film flows through the device, the flue gas comes into close contact with the rinsing solution, removing further acidic flue gas components and fine dust.

Rotary scrubber (alkaline) – At this stage of flue gas cleaning, the rinsing water is set to a neutral or slightly alkaline pH by adding sodium hydroxide solution. The scrubber removes sulfur oxides and further fine dust from the flue gas.

Electrostatic flue gas cleaning – Next comes the wet-wall electrostatic precipitator. This has a similar structure to a vertical tubular heat exchanger. The flue gas flows through

the tubes, which have spray electrodes clamped centrally in them. These electrodes are subjected to a high voltage and generate an electrical field at right angles to the tube axis.

This field transports electrostatically charged flue gas components – mainly fine dust and aerosols – to the tube walls. Because the tubes are cooled from the outside, the flue gas saturated with water vapor condenses on them. The condensate run-off rinses the deposited dusts and salts from the tube walls.

Induced draft fan

The induced draft fan is located after the wet-wall electrostatic precipitator. It draws the flue gases from the incineration chambers through the incinerator.

Subsequent cleaning

In the mid-1990s, the requirements of the 17th BImSchV made more extensive flue gas cleaning necessary. A catalytic unit is used to reduce the amount of nitrogen oxides in the flue gas and destroy dioxins and furans. This stage of the process is called selective catalytic reduction (SCR).

A heat exchanger and an additional gas burner heat the flue gases to the reaction temperature of approx. 300 °C. Ammonia water is also sprayed into the flue gas. After passing through the catalytic unit, the hot flue gases are used to heat the flue gases on the opposite side of the heat exchanger.

Both rotary kiln incinerators at Leverkusen-Bürrig use a catalytic unit. After this subsequent cleaning stage, the flue gases are released into the atmosphere through a 99-meter-high stack.

Disposal of remaining waste residue

The slag from the rotary kiln and other waste produced are taken to CURRENTA's own hazardous waste landfill site. The acidic and alkaline rinsing water undergoes subsequent treatment at the company's own treatment plant. ☀





A4
AX1
AB20

WASTEWATER INCINERATOR

Step by step: An overview of plant components and processes for the incineration of wastewater

Some wastewater streams cannot be treated biologically because they are not biodegradable, take a long time to biodegrade or contain substances that are toxic to bacteria.

In 1988, the wastewater incinerator was commissioned to dispose of this wastewater.

The main components of the wastewater incineration plant are as follows:

- Intermediate chamber for wastewater
- Incineration chamber
- Boiler for heat recovery
- Flue gas cleaning



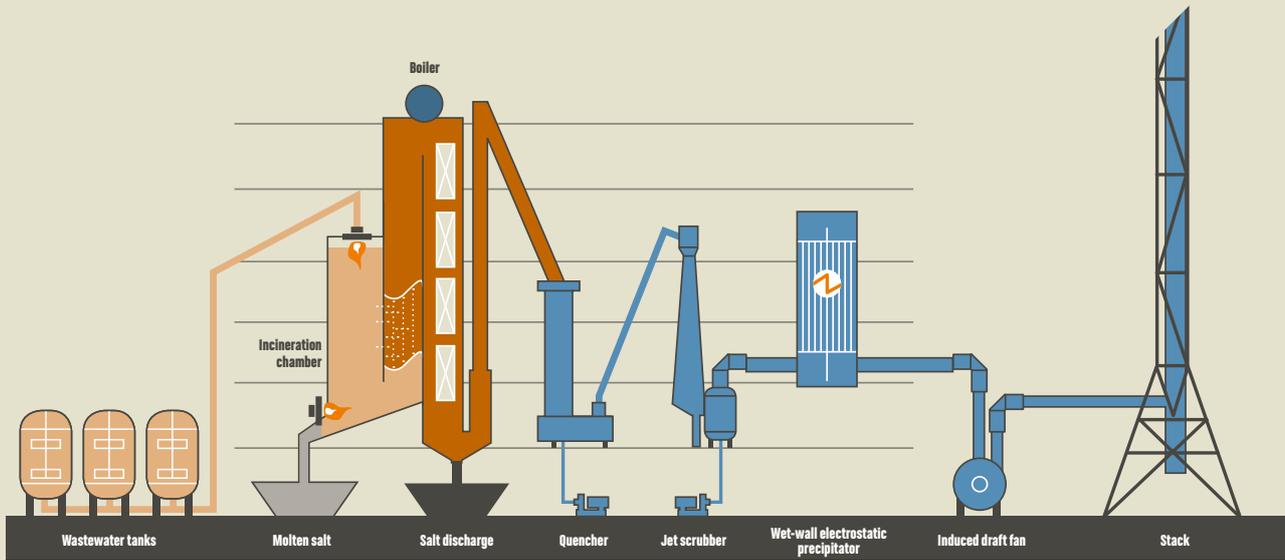
The incineration plants for solid, liquid and aqueous waste in Leverkusen-Bürriq.

Intermediate chamber for wastewater

The wastewater is delivered in tankers, ISO containers or tank containers and fed into the intermediate storage facility, which consists of two tanks with a capacity of 60 cubic meters and one with a capacity of 50 cubic meters. The larger tanks have a corrosion-resistant lining to enable them to be used for all kinds of wastewater. Externally evaporated wastewater (wastewater concentrates) can also be processed.

Incineration chamber

The rectangular or cubic incineration chamber has walls of a tube-fin construction and, as an evaporator, is part of the incinerator's boiler. At the top of the incineration chamber there is a roof burner operated by natural gas or liquid waste. Wastewater is sprayed into this burner and evaporated. The organic components are incinerated and the salts evaporate – at temperatures in excess of 1,000 °C. The evaporated salts are deposited on the “cool” walls of the incineration chamber, which are at a temperature of around 250 °C. The layer of salt on the walls of the incineration chamber acts as an insulator. As the layer gets thicker, the surface temperature increases until it reaches the salt's melting point. The liquid salt runs off and is collected and discharged at the bottom of the incineration chamber.



The route taken by wastewater through the incinerator

Heat recovery

The hot flue gases leaving the incineration chamber arrive at the boiler where their energy content is used to generate steam at an overpressure of approx. 41 bar and a temperature of around 350-380 °C. This steam is fed into the CHEMPARK grid as process steam.

Flue gas cleaning

During the subsequent multi-stage process, flue gases are cleaned to such an extent to ensure reliable compliance with the limits of the 17th BImSchV. Reliable compliance means being well within these limits under normal operating conditions in order to leave a sufficient safety margin.

The individual flue gas cleaning devices are described below.

Quencher – The first flue gas cleaning device is the quencher, a scrubber operating in direct current mode, which means that the flue gas and rinsing solution flow in the same direction.

The quencher cools (quenches) the flue gas to its saturation temperature (approx. 70-80 °C). Acids and coarse salt dust are also removed.

Jet scrubber (alkaline) – After the quencher comes a jet scrubber with rinsing water set to a neutral or slightly alkaline pH by adding sodium hydroxide solution. This mainly removes sulfur oxides and dust.

Electrostatic flue gas cleaning – After the alkaline jet scrubber comes the wet-wall electrostatic precipitation. This has a similar structure to a vertical tubular heat exchanger. The flue gas flows through the tubes, which have spray electrodes clamped centrally in them. These electrodes are subjected to a high voltage and generate an electrical field at right angles to the tube axis. This field transports electrostatically charged flue gas components – mainly fine dust and aerosols – to the tube walls. Because the tubes are cooled from the outside, the flue gas saturated with water vapor condenses on them. The condensate runoff rinses the deposited dusts and salts from the tube walls.

The wastewater incinerator's wet-wall electrostatic precipitator has two depositing fields.

Induced draft fan

The induced draft fan is located after the wet-wall electrostatic precipitator. It draws the flue gases from the incineration chamber through the incinerator. The flue gases are released into the atmosphere through the incineration plant's stack. ✨

SEWAGE SLUDGE INCINERATION

Step by step: An overview of plant components and processes for the incineration of sewage sludge

The sewage sludge incinerator was commissioned in 1988 to incinerate the approximately 60,000 metric tons of sewage sludge produced by the community wastewater treatment plant at the Leverkusen-Bürrig Waste Management Center. Improved processes in the production units reduce the wastewater load and, together with the optimization of treatment processes, help significantly cut the annual levels of sewage sludge.

The sewage sludge incinerator capacity freed up in this way can be used for the thermal treatment of other types of sludge. Additional external sewage, industrial sludge of different consistencies and waste similar to sewage sludge with an energy content of up to $20 \frac{\text{MJ}}{\text{kg}}$ are also accepted for incineration.

The main components of the sewage sludge incinerator are as follows:

- Multiple-hearth furnace
- Afterburner chamber
- Boiler for heat recovery
- Flue gas cleaning

Multiple-hearth furnace

The multiple-hearth furnace is a cylindrical unit eight meters in diameter and twelve meters high with an internal lining. The inside is divided into eight sections by masonry

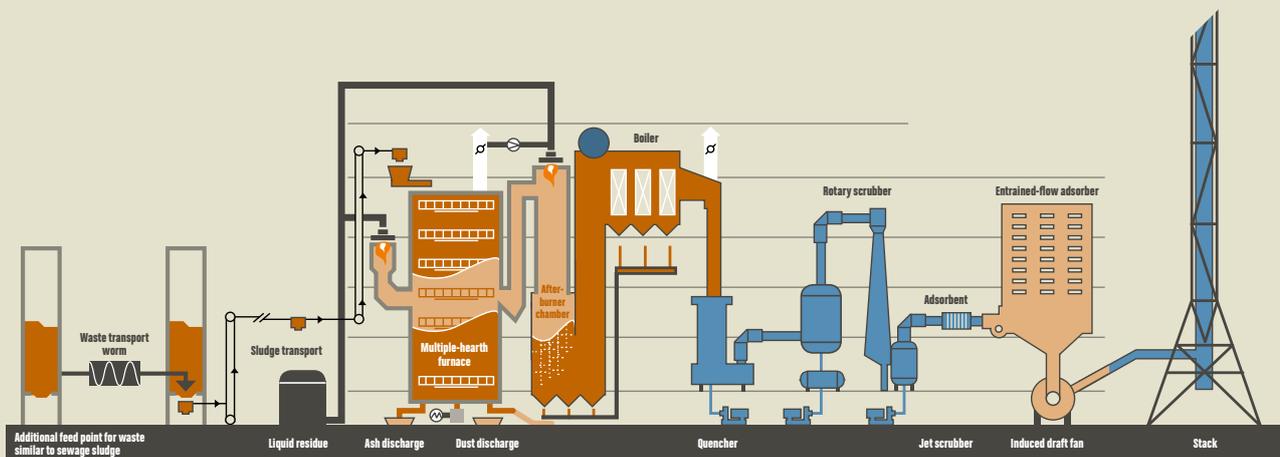
partitions. A (hollow) shaft runs along the axis of the vessel and stirring arms are attached in each hearth. The sewage sludge is fed into the multiple-hearth furnace at the outer edge and falls into the top hearth. This hearth's stirring arms transport the sludge out of the hearth and on to the next hearth through discharge orifices. The sewage sludge winds its way through all the hearths in this way.

The top three hearths constitute the drying zone where water is evaporated from the sewage sludge. The organic components in the sewage sludge are incinerated in the following two hearths. The three hearths at the bottom are used to cool the ash with counterflowing incineration air. This ash is then discharged. The temperatures in the incineration zone reach up to 1,000 °C.

There is a booster chamber on the side of the sixth hearth. This is operated if the sewage sludge does not burn of its own accord.

Afterburner chamber

The flue gases from the multiple-hearth furnace and the exhaust vapors, i.e. evaporated water from the drying zone, are burnt off in the afterburner chamber with the addition of liquid waste.



The process of sewage sludge incineration

Heat recovery

The hot flue gases leaving the afterburner chamber arrive at the boiler where their energy content is used to generate steam at an overpressure of approx. 41 bar and a temperature of around 350-380 °C. This steam is fed into the CHEMPARK grid as process steam.

Flue gas cleaning

Quencher – The first flue gas cleaning device is the quencher, a scrubber operating in direct current mode, which means that the flue gas and rinsing solution flow in the same direction. The quencher cools (quenches) the flue gas to its saturation temperature (approx. 70-80 °C). Acids, heavy metals and coarse dust are also removed.

Rotary atomizing scrubber (acidic) – The remainder of the acids and heavy metals and further dust are removed in the highly effective acidic rotary atomizing scrubber.

Jet scrubber (alkaline) – After the rotary scrubber comes a jet scrubber with rinsing water set to a neutral or slightly alkaline pH by adding sodium hydroxide solution. This mainly removes sulfur oxides.

Entrained-flow reactor – After the jet washer, the flue gas is heated back up to 160 °C. A solid adsorbent is then intro-

duced into the flue gas. The remaining flue gas components, such as heavy metals (Hg), are bound adsorptively to this. The adsorbent is separated off again in a downstream fabric filter.

Reduction of nitrogen oxides – A selective non-catalytic reaction (SNCR) is used to reduce the amount of nitrogen oxides in the flue gas. Ammonia water is sprayed into the flue gas underneath the afterburner chamber at approximately 1,030 °C (afterburning). Ammonia reduces the amount of nitrogen oxides in this temperature range.

Induced draft fan

The induced draft fan is located after the fabric filter. It draws the flue gases from the multiple-hearth furnace through the incinerator. The flue gases are released into the atmosphere through the incineration plant's stack. ✨

QUALITY ASSURANCE AND CONSULTING

CURRENTA Environment has a great deal of know-how when it comes to ensuring sustainable waste management.



Waste recording and waste logistics

Preparatory waste recording and waste logistics are an integral part of waste management. The best possible physical and chemical pre-treatment is established in consultation with the customer and it is decided, for example, whether incineration or landfill is the most suitable disposal method. This decision is based on information relating to

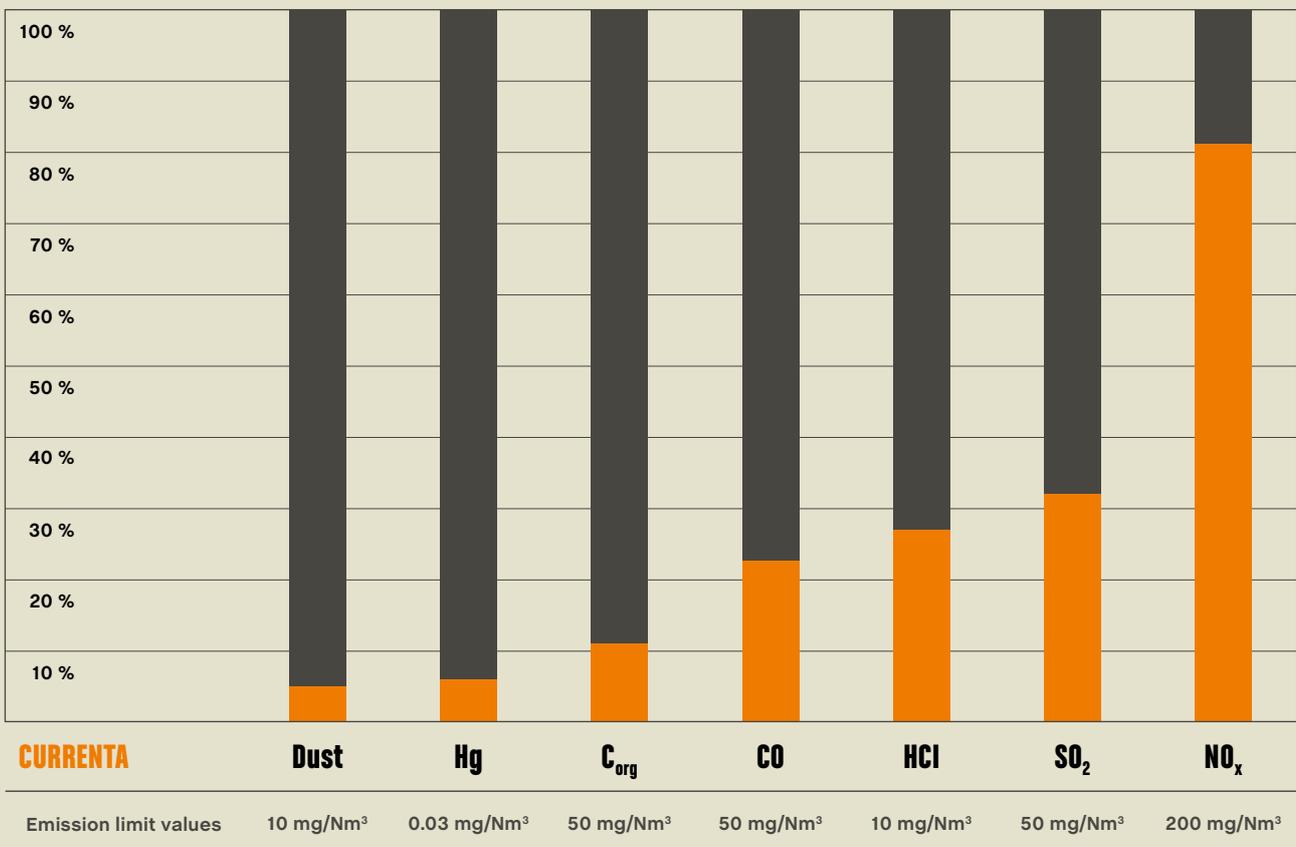
- the quantity of waste and the frequency of delivery
- the form the waste is supplied in
- health and safety measures for handling the waste
- chemical and physical properties
- ignition temperature, flashpoint, calorific value, reactivity and critical components

Based on this information, CURRENTA Environment prepares all the relevant documents and obtains the necessary permits. Quality assurance for waste management is

performed by means of accompanying analyses, the evaluation of shipping documents and use of an internal quality management system that covers all key operations.

Annual emission levels

All four incinerators at the Leverkusen-Bürrig Waste Management Center release their flue gases into the atmosphere through a stack. The graph below shows average emission levels in percent compared to the limits stipulated by the 17th BImSchV. ☀



Average emission levels in percent compared to the limits stipulated by the 17th BImSchV

