Flue gas cleaning technologies

DOOSAN Lentjes

Your partner for modern flue gas cleaning

We look back on decades of experience in the field of flue gas cleaning. Since 1984, we have been reliably supplying systems for gas cleaning in various projects worldwide. Whether for thermal waste treatment or sewage sludge incineration plants, power stations or industrial facilities – Doosan Lentjes offers the right flue gas cleaning concept for your process and specific requirements.

Compliance with all emission regulations

Our competences include (semi-)dry and wet processes for the separation of particles and pollutant gases as well as technologies for flue gas denitrification and heat extraction. Strict emission regulations according to the European BREF documents (Best Available Techniques Reference) or the 13th, 17th and 44th BImSchV are reliably complied with.

Flexible combination options

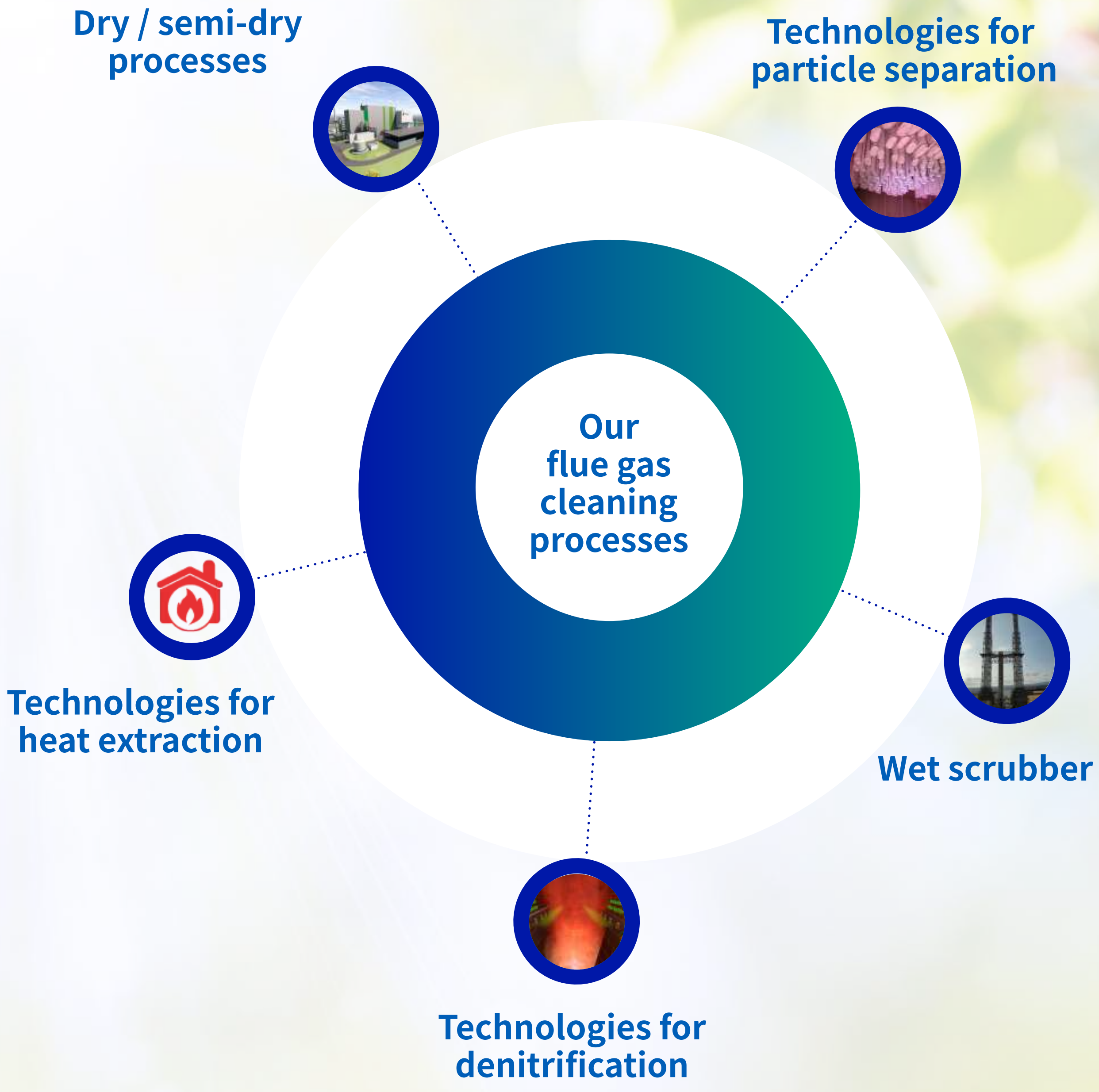
Depending on your individual project requirements, framework conditions and emission limit values to be complied with, a flexible combination of different technologies is possible, from which we design and deliver a customised solution for you.

Optimised cost structure

Our flue gas cleaning systems benefit from a compact design and a small footprint. Flexible integration into existing infrastructure is possible while maintaining economic aspects. Load-optimised system operation and the associated efficient use of the resources ensure reduced operating costs.

Centre of Excellence for flue gas cleaning

As a Centre of Excellence for flue gas cleaning within the Doosan Group, we have our own Research & Development (R&D) capabilities. Our focus is therefore always on providing you with solutions that meet or exceed the current state of the art, have a high level of competitiveness and meet market trends.



The advantages of our flue gas cleaning technologies at a glance:

Compliance with strict emission regulations according to the European BREF documents (Best Available Techniques Reference) **or the 13th, 17th and 44th BImSchV**

Flexible combination of different technologies and systems – depending on the emission limits to be complied with

Optimised investment, operating and maintenance costs

Semi-dry and dry processes for cleaning the flue gases

Semi-dry Circoclean® flue gas cleaning

Our semi-dry Circoclean® process is a proven, robust, wastewater-free process for the separation of various pollutants such as SO_2, SO_3, HCl, HF, dioxins and furans, as well as heavy metals such as mercury from the flue gas.
The process can be used for plants burning biomass, RDF or domestic and industrial waste, in the industrial sector and downstream of coal- and oil-fired boilers. Furthermore, this process replaces a spray dryer for the treatment of waste water from other flue gas cleaning stages.

The process

Before entering the circulating fluidised bed reactor (Circoclean® reactor), the absorbents are injected into the flue gas. Hydrated lime ($Ca(OH)_2$) and activated carbon (AC) are usually used.
The flue gas flows through the reactor from below, causing the fly ash contained in the raw gas and the additives to form a fluidised bed. Acidic components in the gas, dioxins, furans and heavy metals are separated in this fluidised bed. Due to an intensive mass transfer and a high velocity in the circulating fluidised bed, a high separation efficiency is achieved.
The optimum flue gas temperature and moisture content for the operating conditions are set by the additional injection of water into the Circoclean® reactor.

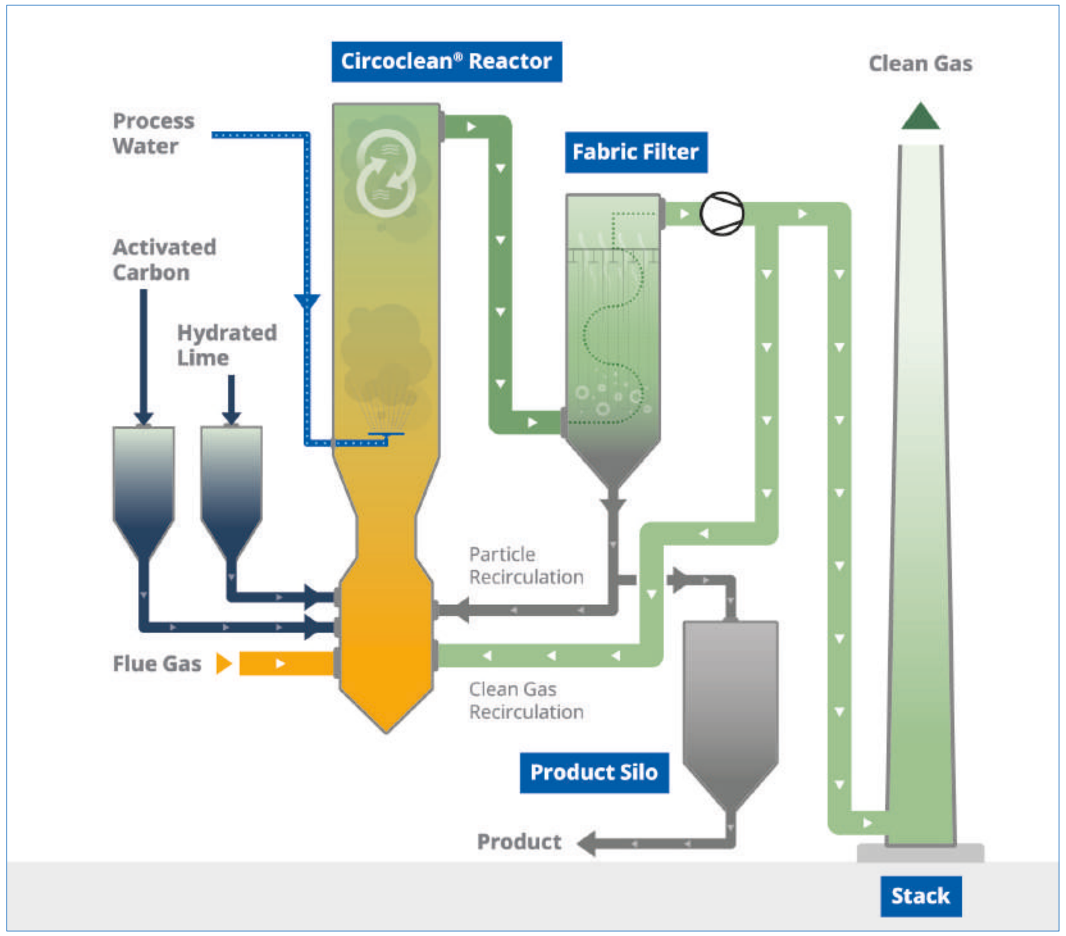
The gas then enters the fabric filter. After the separation of solid particles in the filter, a large part of the additives is returned to the Circoclean® reactor to achieve efficient use of the absorbents.

Optimised design

Our Circoclean® flue gas cleaning process benefits from an optimised design that significantly reduces the required footprint. The design eliminates the use of high wear rotating parts, which not only reduces investment costs but also maintenance. This design ensures a high degree of plant availability. The hydrated lime used as an absorbent can be obtained on site from burnt lime to further reduce operating costs.

The advantages of our semi-dry Circoclean® flue gas cleaning at a glance:

- Proven technology with worldwide references in various fields of application
- Compliance with all emission limits according to European BREF documents and 13th, 17th and 44th BImSchV
- Almost complete separation of SO_3, avoiding maintenance work related to sulphuric acid corrosion
- Comparatively low investment costs and reduced maintenance requirements
- Wastewater-free operation, contributing to high cost efficiency
- Insertion of wastewater from downstream wet treatment stages possible
- Flexibility to adapt to future, even stricter emission limits
- Compact design that allows easy retrofitting
- Optimised absorbent consumption through additive recirculation
- High plant availability



Thermal waste treatment, Olsztyn, Poland
Capacity: 1 x 110,000 t/a (RDF)
Gas volume flow: 1 x 92,000 m^3/h (STP, wet)
Circoclean® flue gas cleaning

Dry FER-DI® flue gas cleaning

As a simple and cost-effective alternative for applications with moderate concentrations of pollutants, we offer the dry FER-DI® process (Flexible Economic Reagent Direct Injection). Acid gases such as SO_x, HCl, HF as well as dioxins and furans and heavy metals such as mercury are reliably removed.

Installations are possible in plants for the thermal treatment of waste, in biomass incineration facilities, in the industrial sector and downstream of coal- and oil-fired boilers.

The process

Depending on your individual requirements, we use either sodium bicarbonate ($NaHCO_3$) or hydrated lime ($Ca(OH)_2$) as absorbent in combination with activated carbon (AC).

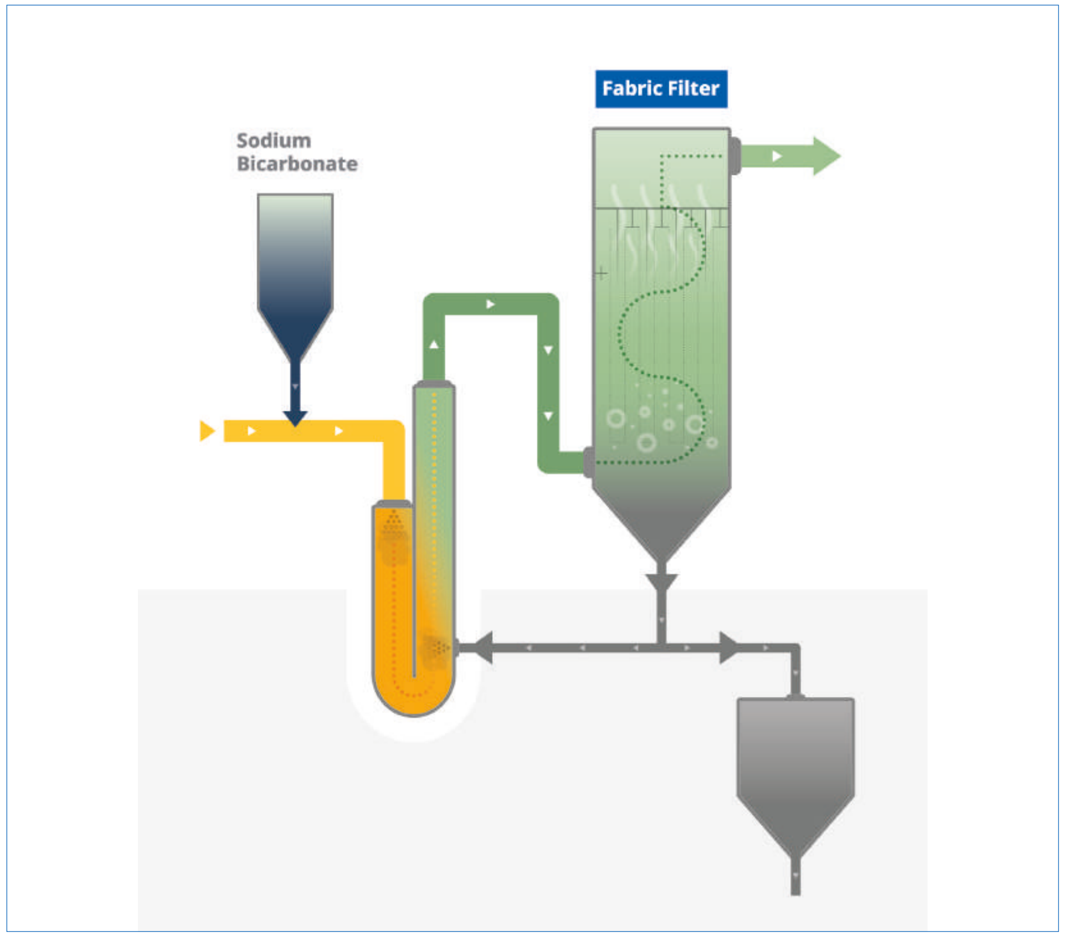
The absorbent is added directly to the hot flue gas at the outlet of the boiler. The pollutants contained in the raw gas react with the additives and are then separated in a downstream particle filter system (fabric filter). If economically feasible, a large proportion of the solid particles separated in the fabric filter are returned to the duct area in order to make optimum use of the separation potential of the absorbent used. A part is withdrawn from the process for disposal.

Optimised costs

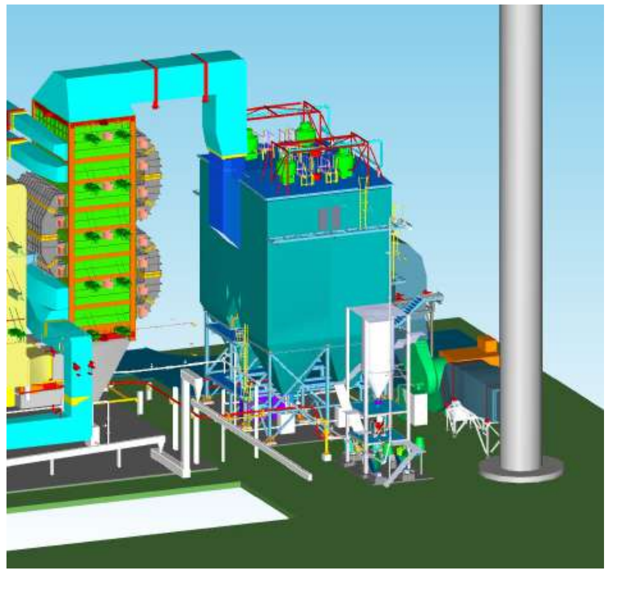
The FER-DI® process benefits from an even more compact plant design with minimal space requirements, which also reduces your investment costs. At the same time, the simple concept allows for minimal maintenance and operating costs.

The advantages of our dry FER-DI® flue gas cleaning at a glance:

- Simple procedure for moderate pollutant concentrations
- Compliance with all emission regulations according to the BREF documents and the 13th, 17th and 44th BImSchV
- Plant design in the smallest possible space
- Optimised investment, maintenance and operating costs



Biomass combustion, Sodegaura, Japan
Electrical power: 1 x 75 MW_e
Gas volume flow: 1 x 235,000 m^3 / h (STP, wet)
FER-DI® flue gas cleaning



Particle separation technologies

Solid particulate removal systems are an essential component of modern flue gas cleaning and are essential for compliance with applicable emission regulations. Depending on specific project requirements, we offer state-of-the-art fabric filters or electrostatic precipitators for your process.

Fabric filters

Our fabric filters are used to separate the finest particulate pollutants. In addition, they act as a fine filter stage for gaseous acidic substances such as SO_x, HCl and HF as well as heavy metals, dioxins and furans in conjunction with our Circoclean® and FER-DI® system. Clean gas values of 5 mg/Nm^3 particle concentration and also significantly below can be permanently achieved.

Fields of application

Applications are possible in the field of waste, sewage sludge and biomass incineration, downstream of boilers fired with RDF, coal or oil, as well as in the industrial sector. Low dust emissions are reliably maintained even with changing fuel qualities and load conditions.

The fabric filters are usually designed with several chambers so that the plant components can be easily separated from the flue gas flow for inspection and maintenance purposes.

The process

The particle-laden flue gas enters the filter chamber from below via the raw gas inlet. The low inflow velocity promotes the pre-separation of coarse particles and ensures uniform flow distribution. The gas flows through the filter hoses, in which the solid particles stick, from the outside to the inside. The filter cake that forms on the hoses is removed by means of compressed air cleaning, falls into the filter funnels and can be discharged.

We have a reference list of more than 50 fabric filters installed in different types of plants worldwide.

Low-pressure pulse jet (LPPJ) fabric filter

For installations of a certain minimum size, we mostly apply our low pressure pulse jet (LPPJ) fabric filter.

The main advantage of this type of filter is that the low purge air supply pressure is less than 1 bar (g), as opposed to 2 to 7 bar (g) for conventional systems, which means that significantly less energy is required for the cleaning process. In addition, the required compressed air can be generated with a simple rotary piston blower.

High-pressure pulse jet (HPPJ) fabric filter

For smaller flue gas volumes, we typically use our high-pressure pulse jet (HPPJ) fabric filter, which in this case can be constructed more cost-effectively from small chambers.

Electrostatic precipitators

With our proven electrostatic precipitators, we can remove particulate matter from the flue gas and achieve clean gas values below 8 mg/Nm^3.

Fields of application

Applications are possible in sewage sludge, waste and biomass incineration plants, downstream of steam generators fired with RDF, coal or oil, and in the industrial sector.

Phosphorus recovery

In mono sewage sludge incineration plants, electrostatic precipitators usually form the first stage of flue gas cleaning downstream of the boiler. The pre-separation of particulate matter in the electrostatic precipitator ensures low-pollutant ash, which serves as the basis for the phosphorus recovery required by law.

The process

After the flue gas enters the electrostatic precipitator, dust particles are negatively charged using spray electrodes (cathodes).

The particles pass through a strong electric field where they are attracted to positively charged collecting electrodes (anodes) and stick. Periodic tapping cleans the precipitation electrodes, causing attracted dust to fall into the ash hoppers of the electrostatic precipitator. The gas cleaned of dust particles leaves the electrostatic precipitator via the clean gas hood.

We have over 100 electrostatic precipitator references worldwide.

Mono sewage sludge incineration,
Belfast, Northern Ireland
Capacity: 24,000 t/a (sewage sludge, dewatered sewage sludge, screenings from the the sewage treatment plant)
Multi-stage flue gas cleaning system incl. electrostatic precipitator

Wet scrubbers

We have decades of experience in the design, construction and optimisation of wet scrubbers. To date, over 200 wet flue gas cleaning systems based on Doosan Lentjes technology have been installed in various plants around the world.

Our technology can be applied in sewage sludge incineration plants, in power plants as well as in industrial facilities and plants for the thermal treatment of waste.

Due to the optimal utilisation of additives, wet scrubbers are used when you aspire to keep the operating costs for additives and the amount of residual material low.

If lime-based additives are used (e.g. limestone or hydrated lime), the valuable material gypsum can be produced instead of residual material to be landfilled. Furthermore, the use of wet scrubbers as the second stage of a flue gas cleaning system is an option if your aim is to achieve particularly low emission values.

Separation of the pollutant load

Depending on individual project requirements and goals, we offer acidic and alkaline systems. If a separation of the pollutant load in the wastewater is required, acidic and alkaline wet scrubbers are designed as separate cleaning stages. This is done either in a sequential design with separate scrubbing towers or in a combined scrubber design.

The combined scrubber provides for integration of the acid scrubber into the alkaline one, with both systems separated by a separating floor. This design reduces both space and resource requirements and optimises investment and operating costs.

If separation of the pollutant load is not necessary, the toxic substances SO_x, hydrogen chloride (HCl), hydrogen fluoride (HF), ammonia (NH_3) and mercury (Hg) can in principle be separated in an alkaline system.

Cement plant, Kjøpsvik, Norway
Gas volume flow: 280,000 m^3/h (STP, wet)
Alkaline wet scrubber

Acid wet scrubbers

Our acid wet scrubber systems are primarily used to absorb the pollutant components HCl, HF, NH_3 and Hg from the flue gas. An acid scrubber is usually operated in combination with a separate alkaline SO_x scrubber. The Doosan Lentjes variant of integrating both scrubber stages in one scrubbing tower is more cost-efficient.

The process

The flue gas enters the acid scrubber above the absorber sump. It flows upwards through the absorption zone in a countercurrent process before entering the alkaline stage through a separating floor.

In the acidic stage, the flue gas quench takes place. The missing amount of liquid can be compensated by blowdown water from the alkaline stage. Since the scrubbing solution used contains recirculated absorbent, the acidic stage usually does not require additional sorbent if neutralisation of the wastewater takes place externally.

Maximum process efficiency

To increase process efficiency, a fluidised bed generator – a so-called tray – is installed below the nozzle level. A fluidised bed forms on the tray as an additional absorption zone that intensifies the contact between flue gas and scrubbing suspension. Our patented technology with a variable tray allows the geometry to be adjusted during operation and thus ensures optimum separation performance across all load ranges.

Mercury separation

For additional separation of mercury (Hg), precipitant is dosed into the absorber sump, which chemically binds Hg.

Alkaline wet scrubbers

If the alkaline scrubber is preceded by an acidic cleaning stage, the absorption of sulphur dioxide (SO_2) and sulphur trioxide (SO_3) as well as the partial absorption of the remaining pollutants mainly takes place in it. If your project does not require separation of the pollutant load in the wastewater, the alkaline wet scrubber can be used as a stand-alone solution to absorb all toxic substances contained in the flue gas (SO_2, SO_3, HCl, HF, NH_3,Hg).

The process

The flue gas enters the alkaline scrubber from below. The absorbent is distributed in the flue gas via nozzle levels using the counterflow principle. Depending on the requirements and project conditions, limestone, milk of lime, caustic soda or seawater, for example, can be used as a sorbent. If lime-based additive is used (e.g. limestone or hydrated lime), the valuable material gypsum can be produced instead of residual materials to be landfilled.

The washing solution used is recirculated by means of pumps in order to optimise the use of the absorbent. In the process, a reserve spray level with stand-by pump enables high plant availability.

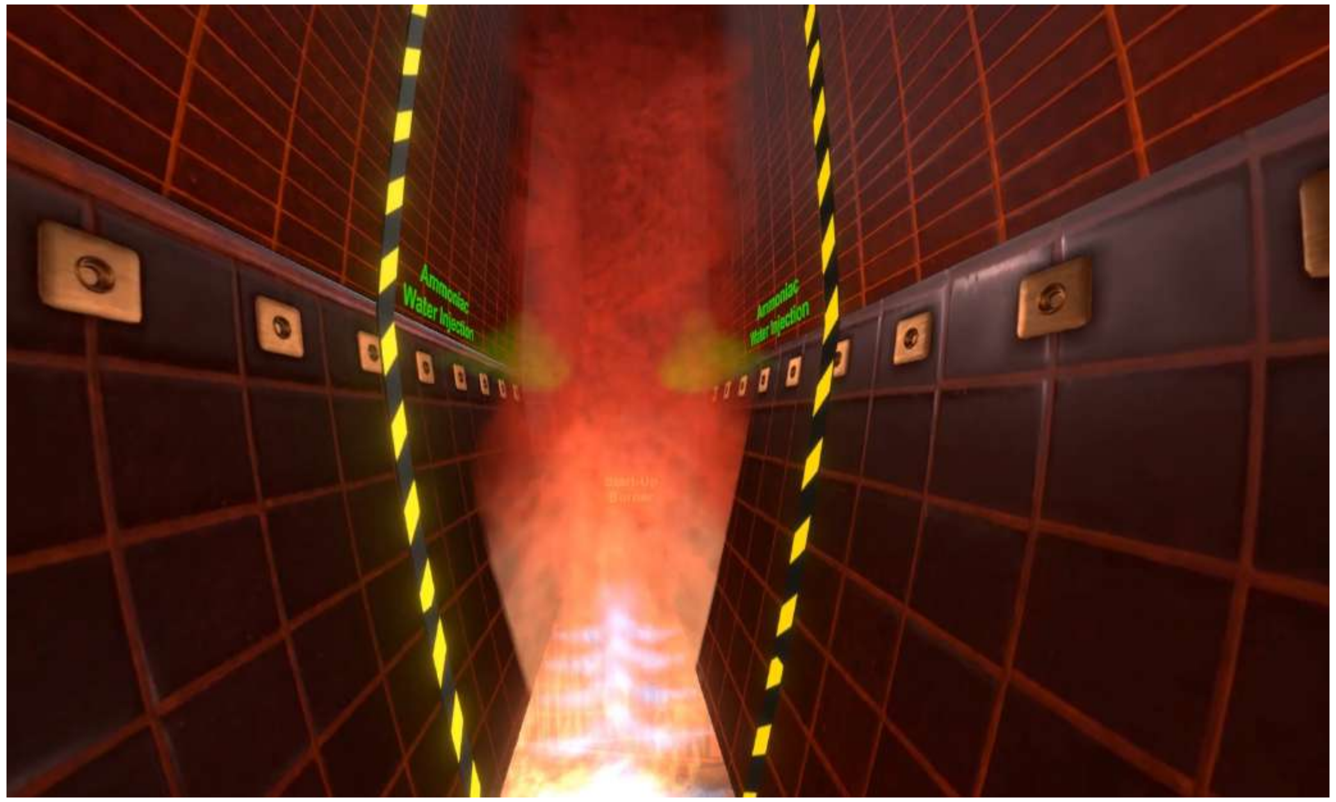
Denitrification technologies ($DeNO_x$)

For the denitrification of flue gases – i.e. the separation of NO_x emissions – we offer you customised solutions depending on the required emission limits. Our portfolio includes both processes integrated into the combustion (primary measures for nitrogen oxide reduction) and separate (secondary) applications.

Selective Non-Catalytic Reduction (SNCR)

The selective non-catalytic reduction (SNCR) process separates NO_x emissions by injecting a reagent into the first boiler pass. The reducing agent can be either ammonia water or urea (NH_2CONH_2), which reacts with the nitrogen oxides (NO, NO_2) to form nitrogen (N_2) and water.

The SNCR process reduces the NO_x emissions in the flue gas to values in the upper range of the BREFs.



Ammonia water injection in the first boiler pass to reduce nitrogen oxide emissions (SNCR)

The SCR system installed at the Moneypoint plant in Ireland is operated with urea as a reducing agent

Selective Catalytic Reduction (SCR)

If your project requires compliance with stricter NO_x emission limits, we can offer a separate selective catalytic reduction (SCR) system with which you can achieve NO_x limits in the lower range of the BREFs.

The SCR system essentially consists of the reducing agent injection, a metering and mixing section and the catalytic reactor, which is equipped with several catalyst layers, depending on the requirements. The layers are made up of individual catalyst modules.

The process

Before the flue gas enters the upper section of the SCR reactor, the reducing agent (usually ammonia water) is finely atomised and evaporated in the flue gas duct. To optimise the reaction conditions, a static mixer is installed downstream of the ammonia water injection. This improves the mixing of the reducing agent with the hot flue gas. The amount of ammonia water to be injected depends on the quantity and NO_x content of the flue gas.

While ensuring a low NH_3 slip, the NO_x emissions are separated in the reactor. Selective reduction at the catalyst produces nitrogen (N_2) and water vapour (H_2O) from the nitrogen oxides (NO and NO_2) by adding ammonia water (NH_4OH). The catalyst used is specially tailored to the requirements of your process in terms of its chemical, physical and geometric properties.

SCR circuit variants

Depending on the project-specific conditions, the SCR can be designed as a high-dust, low-dust or low-temperature application. The high-dust SCR is integrated directly into the boiler pass, where the flue gases still have the temperature of about 300-400 C° necessary for the catalytic reaction. In the low-dust variant, the SCR is installed downstream of the flue gas cleaning system. Pollutants such as SO_x or dust are already removed from the gas, which has a positive effect on the service life of the catalytic converter. In order to reach the temperature required for denitrification, the flue gas is (re)heated e.g. with a gas/gas heat exchanger, steam heat exchanger or gas burner. The design of a low-temperature application also provides for the integration of the SCR downstream of the flue gas cleaning system, but without the installation of heat exchangers.

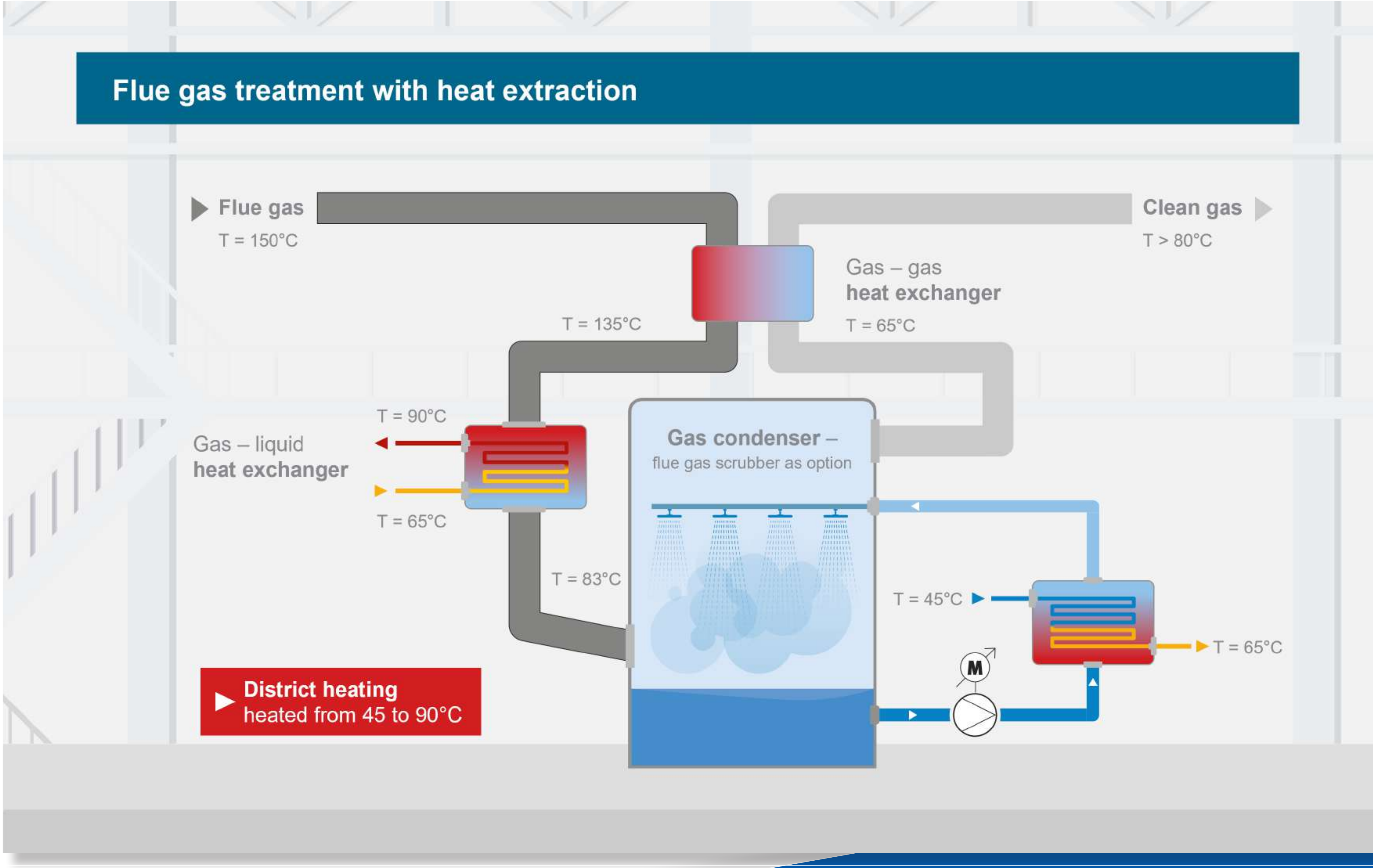
Technologies for heat extraction

Heat recovery

For optimised heat recovery, both gas-gas and gas-liquid heat exchangers are integrated, depending on the requirements. This offers the possibility of increasing efficiency through combustion air and feedwater preheating or district heat extraction.

Flue gas condensation

The extraction of district heat can be increased even further by flue gas condensation. In this process, the flue gas is cooled well below the dew point and the resulting condensation heat is transferred to the cooling circuit. This can be done in a separate heat exchanger in the clean gas or integrated into a wet scrubber.



Selected references

Dinslaken, Germany

Waste wood incineration

Fuel:
Waste wood (class I-III)

Project data:
Electrical power: 2 x 20 MW_e
Flue gas volume flow: 2 x 112,000 m^3 / h (STP, wet)
Flue gas cleaning technology: Circoclean®
$DeNO_x$ technology: Selective Catalytic Reduction (SCR)

Doosan Lentjes is responsible for supplying a complete flue gas cleaning (FGC) system for the new waste wood-fired CHP plant in Dinslaken, Germany.

The selected flue gas cleaning system will ensure that the plant will be the first of its kind to fully comply with all emission limits according to the revised European BREF documents.

The FGC will be delivered under a consortium contract for the construction of Lot 1, which Doosan Lentjes is executing. This comprises the supply, installation and commissioning of two incineration process lines. The new plant is expected to be commissioned in 2023.

Olsztyn, Poland

Thermal waste treatment

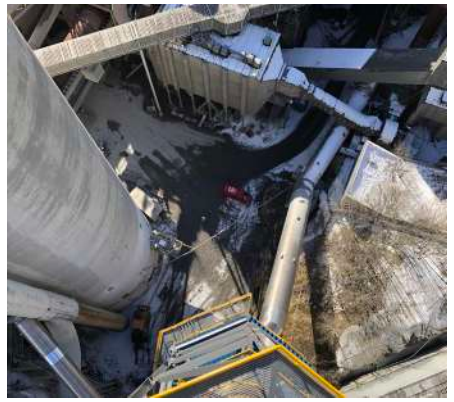
Fuel:
Refuse Derived Fuels (RDF)

Project data:
Thermal capacity: 48 MW_{th}
Flue gas volume flow: 1 x 92,000 m^3/h (STP, wet)
Flue gas cleaning technology: Circoclean®
$DeNO_x$ technology: Selective Catalytic Reduction (SCR)

Doosan Lentjes has been contracted by the plant operator, Dobra Energia dla Olsztyna, to supply a complete flue gas cleaning (FGC) system for the new thermal waste treatment plant in Olsztyn, Poland. The owner of the new facility is the local utility MPEC Olsztyn.

Doosan Lentjes is responsible for the turnkey construction including engineering, fabrication, delivery and commissioning of the entire FGC plant. The emission limits according to the revised BREF documents will be reliably met. The plant is scheduled for completion by 2023.

The project is part of a consortium contract for the delivery of the entire waste incineration plant, which Doosan Lentjes is executing together with its consortium partner, Doosan Heavy Industries & Construction.



KjØpsvik, Norway

Cement production

Source of emissions:
Cement

Project data:
Capacity (equiv.): 60 MW_e
Flue gas volume flow: 280,000 m^3 / h (STP, wet)
Flue gas cleaning technology: Seawater FGC

Doosan Lentjes was commissioned by NORCEM AS with the turnkey retrofit of a seawater flue gas desulphurisation (FGD) plant for a cement plant in Norway.

By using the proven seawater process, the customer benefits from an economical solution that takes ecological aspects into account: In a small space and with minimal investment and operating costs, the plant achieves a desulphurisation level of up to 95 %. This reliably ensures compliance with local emission regulations.

With Doosan Lentjes as general contractor, the customer received an integrated solution that met the challenge of ongoing operation with minimal downtime during the retrofit.

Sleco, Belgium

Sewage sludge incineration / waste co-incineration

Fuels:
Sewage sludge, household waste, light fraction of sorted household waste

Project data:
Thermal capacity: 45.5 MW_{th}
Flue gas volume flow: 3 x 105,000 m^3/h (STP, wet)
Flue gas cleaning technology: Circoclean®
$DeNO_x$ technology: Selective Non-Catalytic Reduction (SNCR)

Doosan Lentjes has supplied a Circoclean® multi-stage flue gas cleaning system for a sewage sludge and waste incineration plant in Belgium for Sleco, a joint venture between waste management companies Indaver and Sita Belgium. The project was part of a larger contract awarded to Doosan Lentjes, which included the design and supply of the entire three-line plant.

The three incineration lines are each equipped with a bubbling bed furnace and a waste heat boiler with integrated SNCR. The flue gas cleaning system comprises (per line) a Circoclean® reactor and a downstream fabric filter, as well as an NaOH-based wet scrubber.

The flue gas cleaning system ensures that the plant reliably complies with all requirements with regard to emission guidelines.

Doosan Lentjes

Doosan Lentjes provides proprietary environmental technologies for thermal waste treatment and energy generation. Our areas of expertise include the incineration of renewable fuels such as waste, sewage sludge and biomass, heat recovery systems and flue gas cleaning equipment. We deliver flexible solutions for long-term waste disposal safety and climate-friendly steam and power generation.

As a member of the global Doosan Group, Doosan Lentjes is part of a strong international network of companies providing complementary technologies, skills and value to customers the world over.

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