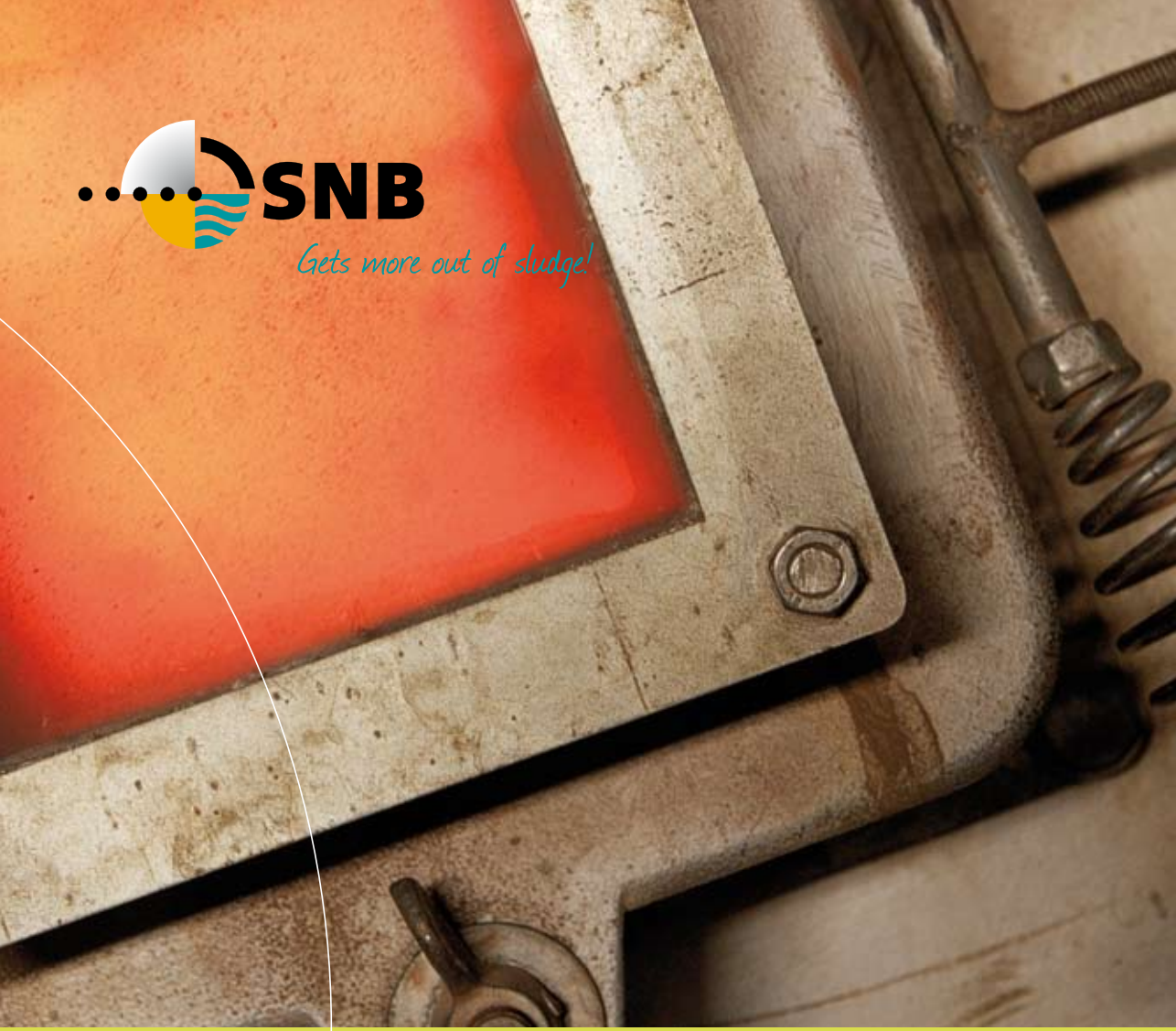
SNB

Gets more out of sludge!



THE SLUDGE INCINERATION PROCESS

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1 SLUDGE SUPPLY

Every day, dozens of trucks drive to the site of Slibverwerking Noord-Brabant (SNB) to empty the sludge from water purification plants. On average, fifty trucks visit the site each day and they jointly deliver circa 1,500 tonnes of sludge.

The sludge is deposited in four special storage bunkers. In total, these bunkers have a storage capacity of **16,000 tonnes**. This storage capacity enables SNB to store sludge in a responsible manner. It also facilitates effective responses to fluctuations in the sludge supply and the processing capacity.

BUNKER MANAGEMENT

The sludge that is delivered to the SNB by water purification plants has different compositions. To ensure that processing is as consistent as possible, SNB mixes the sludge that is deposited in the bunkers, which results in a homogenous sludge quality. The mixing takes place by the various sludge deliveries being deposited in layers on top of one another in the bunkers. Grab buckets that transport the sludge to the sludge incineration installation shovel sludge from several layers. Mixing therefore takes place automatically. If necessary, the sludge can also undergo additional mixing. The grab buckets shovel the sludge from the bunker and each time deposit this in a random spot above a grillage. This ensures that **optimal mixing** takes place.

On the contrary, SNB is also able to collect different quality sludge flows in the various sludge bunkers. This is interesting on account of the initiatives that we are developing relating to deposition of our residues and phosphate recovery.

NO RISK OF BAD ODOURS

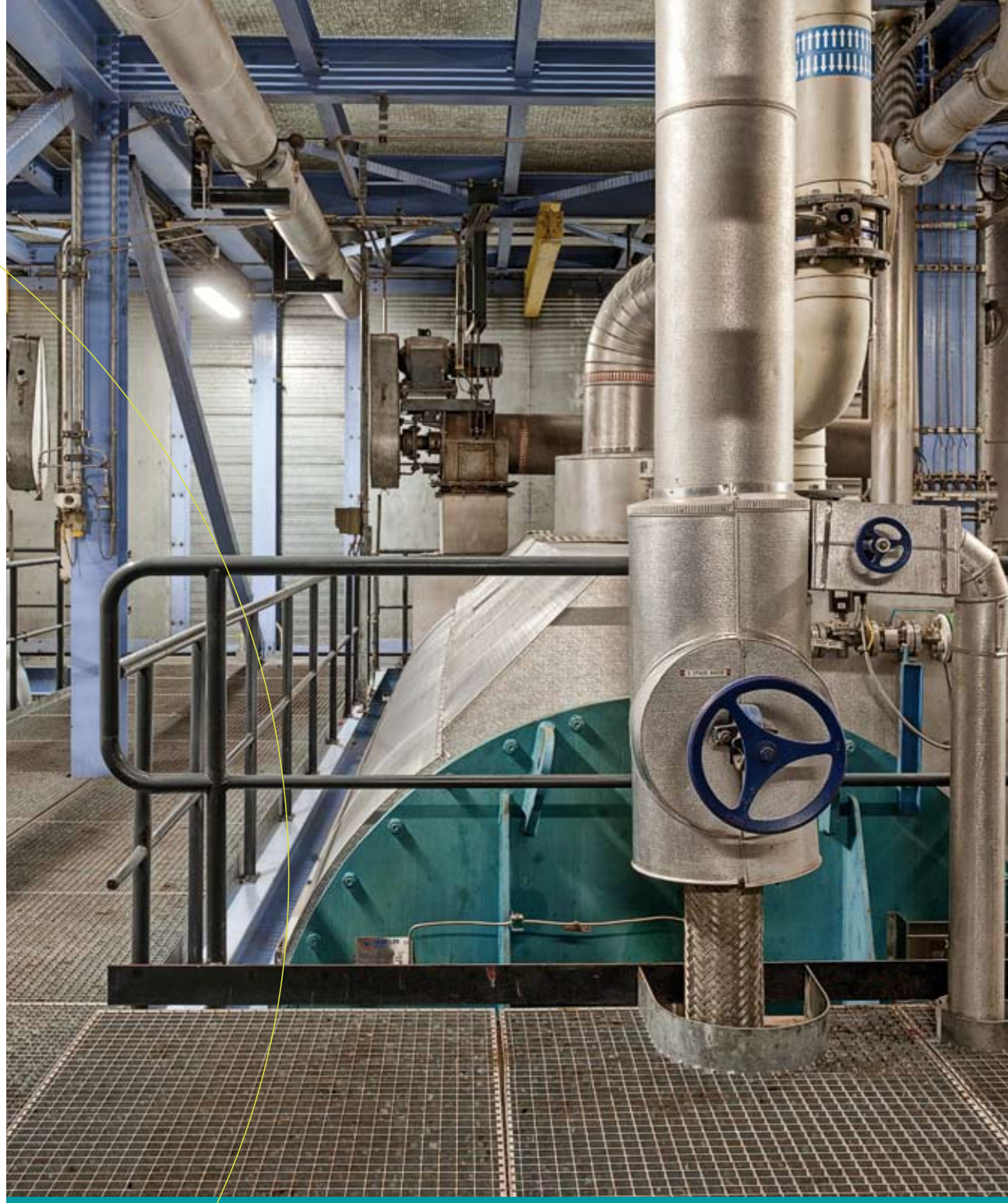
Sludge has a horrible odour. The area surrounding SNB must **not be inconvenienced** by that. SNB has taken various measures to prevent nuisance caused by bad odours. For example, the unloading areas have two interlinked doors. The outside door can only be opened if the inside door – that provides access to the bunker – is closed, and vice versa. This prevents the sludge odour from escaping outside. Furthermore, the air in the sludge bunkers is extracted by the four incineration lines of the sludge incineration installation and co-incinerated in the ovens. SNB also uses a biofilter that can neutralise odours.

2 DRYING

From the bunkers, the mixed sludge goes to an interim silo and from there is transported on conveyor belts to the sludge incineration installation.

The first step in sludge processing is drying. The heat that is used for this is largely obtained from the steam that is released later on in the installation when sludge is incinerated in the ovens. More than two thirds of the **generated steam** in the plant is used for the drying process. That takes place by depositing the hot steam in the dryer's hollow shaft and rotor. These release the heat to the outside, where the water in the sludge partially condenses. During this process, the water level of the sludge falls from 77 percent to 60 percent. That is exactly enough to enable the sludge to combust independently without another fuel being required for this.

There are a couple of reasons for not letting the sludge dry out further still. The first problem that arises when the sludge is dried out even more is that the composition changes. If you dry the sludge to 50 to 60 percent, an **adhesive stage** occurs, where it is barely possible to transport the sludge through the installation. In that situation, extensive damage could occur to the installation. Furthermore, fully dried sludge can easily cause fire or dust explosions. The current business operations preclude this risk.



TOUGH GUYS

SNB's sludge incineration installation has four parallel incineration lines. Each line has two extremely **powerful dryers** that are considerably heavier than most other dryers that are used in the industry. With just one dryer, 80 percent of the sludge that passes through can be dried. The more than sufficient capacity guarantees the continuity and reliability of this essential step. An additional advantage of the large capacity is that it is possible for work to take place using a low steam pressure.

Vapours occur during drying, which deposit in a condenser. The condensate is purified in a waste water treatment plant. A stripper plant removes the ammonia that is present in the dry vapour condensate, after which it is transported to the sewer. This ammonia is used in the ovens for the **reduction** of nitrogen oxides (NO_x).

Limestone removes a high percentage of the sulphur dioxide (SO_2) from the sludge that is present.

3 THE OVEN

Following drying, conveyor belts transport the sludge to the oven to be incinerated. SNB uses fluid bed ovens to incinerate sludge.

Present in the oven are 13 tonnes of sand that is heated to a temperature of between **850°C and 950°C**; the air inlet causes turbulence of the sand. The advantage of a fluid bed oven, in comparison to the ovens with grillage commonly used for incineration of household waste, is that the sand that is used retains its temperature beautifully. When the wet sludge is placed in the oven, that barely has an effect on the temperature in the oven. Furthermore, the turbulated sand makes the sludge totally disintegrate, because of which the innermost part of the sludge – partially on account of the size of the oven – incinerates **properly and evenly**. Sixty-two percent of the dry matter in the sludge consists of combustible organic matter. The remainder is non-combustible and is left behind as ash. These ash particles are blown away with the flue gases.

FLUE GAS CLEANING

A percentage of the flue gases that occur in the oven are immediately cleaned. By adding limestone to the fluid bed, the sulphur dioxide (SO_2) that is present in the sludge – that causes acid rain and smog– is largely removed. The sulphur dioxide binds to the calcium oxide (limestone) which then becomes plaster; this is transported along with the fly ash in the flue gases. The injection of **ammonia** into the oven results in the nitrogen oxides (NO_X) being removed from the flue gases. Nitrogen oxides also cause acid rain and smog.

MINIMAL EMISSIONS

By carefully controlling the temperature and excessive air (addition of oxygen) in the oven, it is possible to control the emissions of laughing gas (N_2O) and nitrogen oxides (NO_X). By doing so, SNB is able to ensure that the emissions at the end of the installation are restricted to a **minimum**. This is an important development as the contribution of the production of laughing gas to the greenhouse effect is 310 times higher than that of CO_2.

4 STEAM BOILERS

The flue gases that leave the ovens cool down in the steam boilers. To cool down the flue gases and to create steam as quickly as possible, SNB uses softened industrial water that is pre-heated in an economizer to temperatures of 160°C to 180°C.

Because the water is under **10 bar pressure**, at these temperatures it is not yet brought to the boil. That does happen once the water in the pipes touches the initial section of the steam boiler with the flue gases of 900°C. The water becomes steam and the flue gases cool down to 200°C.

46 TONNES OF STEAM

The steam is collected in a steam drum, where it is separated from the water circulating in the installation. Per hour, the steam boilers together produce circa **46 tonnes of steam**. Two thirds of this is used to dry the sludge in the first stage. An unusual aspect of this process is that, with the components from the low-energy sludge, the installation runs fully on the energy contained in the sludge. Quite a performance when you consider that three quarters of the sludge that is delivered consists of water!

A percentage also goes to the **evaporation system** to evaporate waste water and a percentage goes to the stripper system that removes ammonia from the dry vapour condensate that occurred when the sludge dried. The rest of the steam generated is used to produce electricity by means of a steam engine.

HOW IS THE GENERATED STEAM USED IN THE INSTALLATION?

Total steam production: 46 tonnes

Use in the installation:

- 30 tonnes for sludge drying
- 10 tonnes to the steam engine for electricity generation
- 3 tonnes to the evaporation system
- 3 tonnes to the stripper system

5 ELECTROSTATIC FILTER

Thirty percent of the ash particles in the flue gases become ‘caught’ in two bends of the steam boiler - in a manner of speaking they ‘go off the road’ – and are transported to an ash silo. Ninety-nine percent of the remaining ash is filtered from the flue gases by an electrostatic filter.

This is a large, rectangular ‘box’ which contains electrodes charged with 70,000 Volts. These electrodes spray negatively charged electrodes around, which attach to the ash particles. The ash particles that have an average size of 0.06 millimetres are now also negatively charged and are attracted by positively charged plates that are fitted to the filter. This results in an **ash layer** on the plates that, every so often, are automatically hit with a hammer. The collected ash is then transported to the ash silo.

Annually, SNB’s sludge incineration installation produces circa 36,000 tonnes of sludge incineration ash. SNB is continually looking for useful applications for its residues. Three quarters of the ash is used in the production of asphalt. A percentage is also used as a filler in a salt mine in Germany. On account of the high phosphate level of sludge incineration ash, for some time SNB has been investigating the possibilities of using the ash for phosphate recycling. Phosphate is a scarce raw material that, over time, will become depleted.

For the complete sludge incineration process, view our film at www.snb.nl

6 FLUE GAS CLEANING

After separating the ash particles from the flue gases, the flue gases are washed in two stages. That is required in order to remove from the gases any further components that are harmful to the environment.

Before the flue gases are washed, they are first of all cooled from 200°C to 160°C using the cold gases that come out of the washer. Once in the washer, the flue gases cool down further still under a **'cold shower'** of circa 75°C, by the evaporation of water, equally to 75°C. The ammonia and acids present in the flue gases – and therefore also heavy metals, the main one of which is mercury – are then absorbed by the water.

Subsequently, alkaline washing takes place which removes the final 30 percent of the sulphur dioxide in the flue gases. The first 70 percent had already been removed in the oven. The waste water from the washer is then evaporated and centrifuged. A **solid residue** remains that mainly consists of salts and this is taken away as hazardous waste. Almost all mercury is collected in the salt that **originally** was present in the sludge.

7 CLOTH FILTER

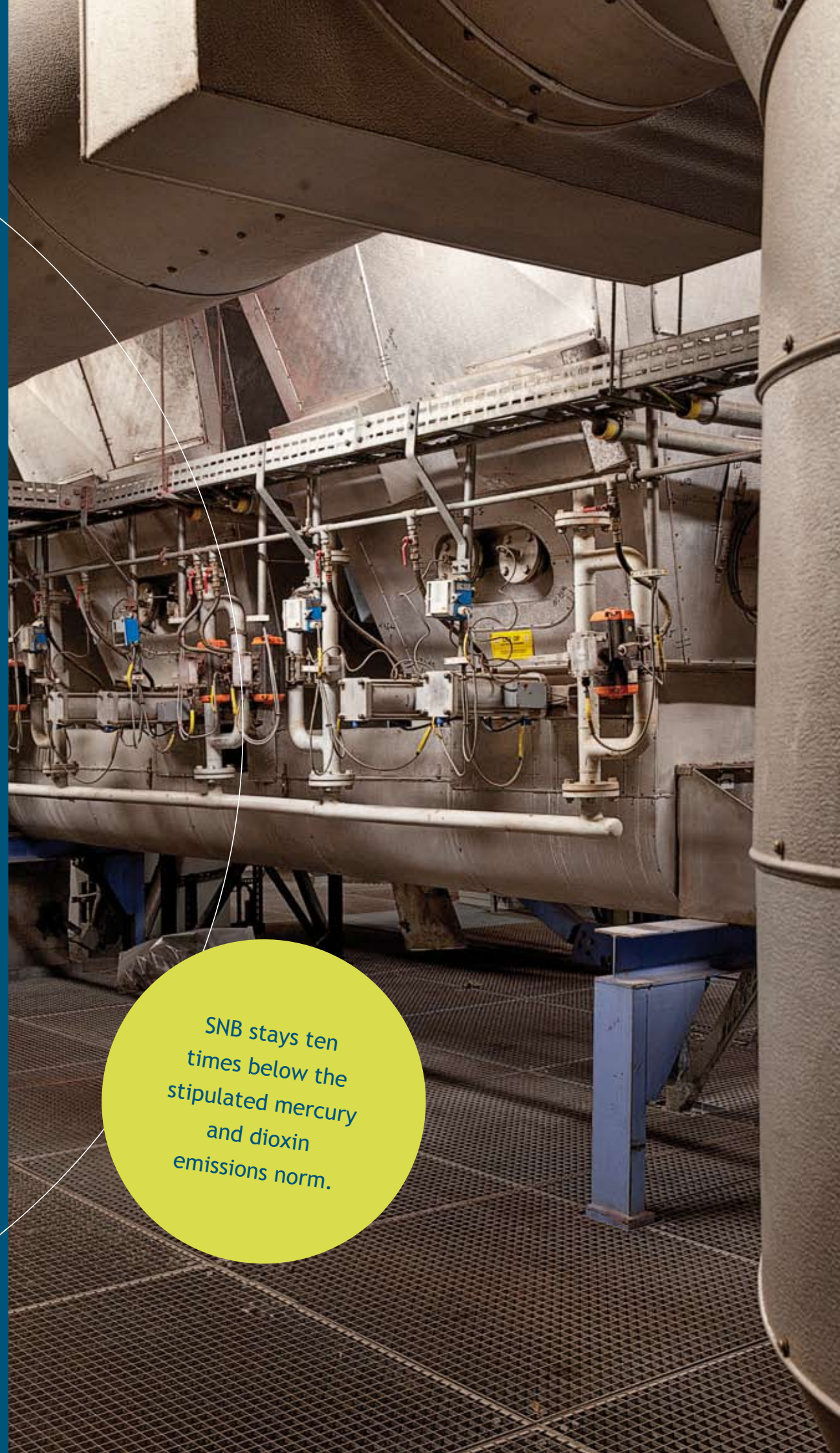
Once the flue gases have been washed, the most harmful components will have been removed. But the mercury that is present – a heavy metal that is very bad for the environment – is difficult to capture and some remains in the flue gases.

To remove that last bit of metallic mercury from the flue gases, a special mixture (adsorbent) is added to the flue gases that attaches to the mercury. Any dioxins that may also be present are also absorbed in this way. Usually, these compounds are already totally destroyed in the oven.

BATTERY SOCK

In the cloth filter – a battery sock with a cloth on top – which the flue gases then **pass through**, the adsorbent remains behind. This adsorbent is used consecutively a couple of time in order to use the adsorbent as little as possible and to produce as few waste substances as possible. The captured loaded **adsorbent** is mainly re-incinerated in the oven to prevent the production of waste substances as far as possible. A small amount is transported to a residual substances silo.

The cloth filter enables the flue gas cleaning to achieve a return of **98 percent** for mercury. That is an excellent score in comparison to other methods of sludge processing. SNB even stays ten times below the stipulated mercury emissions norm. The same applies for the dioxin emissions. Thanks to the **good combustion** and the cleaning in the cloth filter these can barely be measured.



8 THE CHIMNEY

The flue gases are now cleaned. Before they leave the installation, the emission values are measured and checked in the control room. SNB's emission values are so low that they have no perceptible effect on the environment.

This means that SNB more than satisfies the requirements of European legislation regarding flue gas emissions. Almost all emissions are so low that it would be difficult to achieve a further reduction and, moreover, it would be almost impossible to measure these.

Some of the flue gases are transported via a **700-metre-long pipe** to a neighbouring calcium producer. This company uses the CO_2 that is present in the flue gases for the production of high-quality calcium products. However, before transport, in a flue gas cooler any water (30%) that is still present is firstly removed from the flue gases by cooling the gases down from 110°C to 50°C. SNB uses the water for the flue gas washing earlier in the process and this is partially used in the calcium producer's process. This exchange project contributes to a more **sustainable ecology** at the Moerdijk industrial site and has ensured that SNB's CO_2 emissions are significantly reduced.

The flue gases that cannot be used by the calcium producer enter the air via a sixty-metre-high chimney.

THROUGH PROCESSING BY SNB:

- The waste volume is reduced to less than 10 percent of the original volume;
- The residues, mainly incineration ash, can be reused and can potentially be used as a raw material for phosphate products;
- The organic material in the sludge can be used as fuel to enable the sludge incineration process. SNB then requires no other fuels. The organic material is converted into CO_2 which again can be advantageously used by a neighbouring company;
- All organic pollutants that are present in the sludge (POPs: persistent organic pollutants, PCBs, medicine residues, dioxins, hormonal substances, etc.) are destroyed in full during incineration and therefore removed from the environment;
- The poisonous mercury is removed in a small, separate waste flow. SNB has a use for this where the mercury is no longer released;
- The heavy metals in the sludge are fixed in the fly ash and, even during the further processing of the fly ash, are not released into the environment;
- As far as possible, during incineration, efforts are made to avoid new harmful compounds from occurring. If that does happen, the flue gas cleaning will make sure that these are re-captured.

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