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# Thermal Waste Treatment Plant Spittelau

## – New Construction to the Existing Plant –

Christian Jonas, Philipp Krobath, Erich Pawelka, Ulrich Ponweiser and Martin Höbler

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1. Plant description

The thermal waste treatment plant Spittelau is steeped in history and tradition. It is one out of four municipal solid waste incinerations plants in Vienna. The plant was built from 1969 until 1971 for the purpose of thermal utilization of municipal waste and household-type commercial waste as well as energy supply of the new General Hospital Vienna two kilometres away via district heating. The plant was equipped with two hot-water boilers to ensure heat supply at all times. Although it is located in the town-centre of Vienna its architectural structure did not differ significantly from the traditional plant structure.

After only six years the plant had utilized one million tonnes of waste. Throughout the following years, pipeline construction over long distances intensified and by 1985 a closed circular pipeline for heating supply had been built around the entire inner city district of Vienna. Among many others, the parliament, the Vienna Burgtheater and the Vienna City Hall, were the first customers of the company Heizbetriebe Wien. The number of supplied buildings increased steadily and the technical plant was further enlarged and adapted to the state-of-the-art. Until today, the pipeline system has been provided with hot water supply from waste incineration plants such as MVA Flötzersteig, SMVA Simmeringer Haide, MVA Pfaffenau, other decentralised plants (Arsenal, Kagran, Leopoldau, Inzersdorf) as well as the cogeneration of the larger KW-Simmering and KW-Donaustadt units.

![Diagram of the closed circular pipeline around the inner city district of Vienna](image)

Figure 1: Closed circular pipeline around the inner city district of Vienna
2. Changes to the plant over the years

2.1. A new era

1987 would become a crucial year in the development of the company Fernwärme as a success story (today: Wien Energie). A fire during an outage for revision destroyed a large part of the plant in May 1987. Some called for an immediate complete shut-down of the entire plant. The massive destruction, however, also represented a great opportunity. The City of Vienna seized this opportunity to reinforce its commitment to green waste treatment and opted for reconstruction of the plant. The people of Vienna were closely integrated into the reconstruction process. Reconstruction comprised the installation of a state-of-the-art flue gas purification plant, a DeNOx system, and a dioxin destruction system. The famous artist and environmental campaigner Friedensreich Hundertwasser designed the façade of the plant. Thanks to his work the reconstructed plant became internationally popular as a work of great artistic merit and a monument to Hundertwasser himself. The waste heat boilers and the peak-load boilers were renewed as well. Spittelau’s emission levels set a new international standard and the plant still has some of the best emission levels in Europe.

2.2. Considerations

The thermal waste treatment plant operates with an average throughput capacity of 250,000 tonnes per year and a district heating output of 60 MWt per hour. The pipeline network has been further expanded up to a length of approximately 1,200 km. 330,000 Viennese households and about 6,500 major energy consumers are currently being supplied with heat.

Meanwhile, Fernwärme Wien has started another supply service: district cooling. In 2006, Wien Energy commissioned one of the first district cooling plants in TownTown. A new central cooling plant with a cooling capacity of 17 MWth in total was commissioned in Spittelau in 2009. District cooling consumers are mainly large-scale consumers such as the General Hospital, Vienna. Existing pipelines for district heating are used for district cooling supply during the summer season.
Cooling is generated via electrical absorbers and electrical compression chillers, which in turn, lead to an increase in energy consumption. The greater demand in energy was taken into account for sizing the new boiler since the entire energy supply of the plant is to be generated through thermal waste treatment.

Waste management in Vienna (the Viennese Model) is based on three pillars: avoidance – separation – recycling. According to Vienna’s waste management anything which cannot be avoided, separated or recycled is utilized for thermal waste treatment. The system of separately collected waste materials in private households and businesses as well as a change in consumer behaviour led to a sharp increase in calorific value and the plant’s throughput decreased accordingly.

The plant faced serious challenges such as new technologies on the market and rising costs for the plant’s operation and maintenance. In addition, some plant parts from the original construction phase had been in operation for more than 40 years. Therefore, in 2006/2007, Wien Energie started first reflections on how to make the plant more profitable, ecologically sound and fit for the future.

External consultants provided several studies in the run-up to retrofit evaluating different approaches in terms of finance and technology and providing feasibility studies as well as financing models. Different solutions were up for debate from exchanging only a few plant parts to a complete plant overhaul. Meanwhile, further consultations started with an external planning office. In addition, a close cooperation with the operating personnel was set up to develop the future structure of the plant.

When the management finally decided on a plant upgrade in 2009, further preparation works started and the official approval procedure was initiated. After obtaining authorisation for construction, the management, in accordance to public procurement law, carried out an international call for tenders for the first lot.

In 2009, a bridge structure was built over a roadway to the plant area in order to establish a site for pre-fabrication and temporary storage during retrofit and to ensure free-flowing traffic on site at the same time.

Damage to the waste treatment plant of the Wärmeverbund Mitte caused a delay in the implementation of the project Spittelau in 2010. During the time-lag, project planning was re-evaluated whereby the electrostatic precipitators were replaced with new fabric filters. The design and parameters of the filters’ internal parts and spare parts correspond to those of the sister plant Flötzensteig. The similarity allows for an uncomplicated exchange of single parts and spare parts among the two plants and, consequentially, facilitates maintenance and keeps costs at a minimum.

2.3. Implementations

Despite the delay, the management stuck to the main objective of a full retrofit and preparatory works were resumed by the end of 2010 whereby civil works were divided into several lots.
There were seven main lots (VE) which were awarded within contracting management:

- **VE construction** construction project, facade and other auxiliaries
- **VE Firing** boiler plant, waste feeding system, fabric filter, ash removal system, cooling water system
- **VE Water-Steam** piping, converters, feedwater and condensate system, exhaust steam system
- **VE Turbine** turbo-generator
- **VE SCR** Catalytic flue gas cleaning plant, heat exchanger
- **VE EMSR** Plant cabling (IE&C), renewing low-voltage distribution
- **VE Demo** Plant disassembling and transport of dismantled material

Only the original two-stage flue gas wet scrubber including the waste water treatment system remained after retrofit. A call for tender for connection to the control system was not necessary since current contracts apply for retrofit works as well.

There was a fierce competition for the highly requested lots. After lengthy and difficult negotiations, internationally well-established contractors were awarded the contracts for carrying out works at this location with international prominence. Another step had been accomplished on the road to a complete plant overhaul.

The following components have been or are currently retrofitted:

- Renewing waste heat boiler 1 und 2,
- Replacing electrostatic precipitator with fabric filters,
- Installing of activated HOK injection upstream of the fabric filter,
- Renewing the DeNOx system with low-temperature catalyst,
- Renewing the hot water supply system,
- Renewing the converters,
- Renewing turbines and generators,
- Renewing ash removal system, including activated HOK,
- Renewing water-steam-system.

Through optimization in energy management power generation will increase threefold while district heat extraction remains stable and the consumption of natural gas as primary energy for the DeNOx plant is reduced by roughly 5M m³.

With the renewed catalyst plant, the heating of the flue gas with natural gas has also become obsolete. This step will be accomplished via heat exchangers which are cleaned with steam soot blowers.

The contractor provided the required expertise and know-how for accomplishing these works during full plant operation.
The history of MH Power Systems Europe Service GmbH

MH Power System Europe Service history goes back almost 90 years. Establishing Lentjes Industrieckessel Service GmbH (LIKS) in 1993, the pooling of power plant service activities took place in the former Lentjes Group. Ever since, this independent service company has continued to lead a successful service business in the industrial and steam generators.

Due change of ownership, the company was renamed with the following names; Lurgi Lentjes Service GmbH (LLS), ThyssenKrupp Xervon Energy GmbH (TKXE) and also Hitachi Power Europe Service GmbH (HPES). With the merger of the respective business area Thermal Power Plants, the Japanese companies Hitachi Ltd and Mitsubishi Heavy Industries Ltd formed MH Power Systems Europe Service GmbH (formerly Hitachi Power Europe Service GmbH) as part of the new joint venture.

3. Scope of supply for the lot firing

MHPS-ES was awarded the contract for implementing a complete, operational and perfectly functioning firing and boiler plant for combustion of municipal waste and household-type commercial waste. The scope of supply included delivery, assembly, and commissioning.

The scope of supply for the lot firing (VE-FEU) comprises the following main components:

- Waste heat boiler
- Grate Firing System
- Combustion air system

Figure 3: Plant Spittelau after completion
- Start up and auxiliary burner
- Slag removal system
- Fly ash removal
- Fabric filter with installed dosage of activated HOK
- Temporary solutions for on-going operation of one waste incineration line during retrofit
• Delivery, assembly, commissioning, trial operation,
• Training,
• Documentation.

**Project Schedule**

The waste incineration lines 1 and 2 were retrofitted successively. Reconstruction started with line 2 disassembled in May 2012. After accomplishing the first project phase the entire plant was shut-down from September 2013 until February 2014. The outage was used for accomplishing construction works on line 2. At the same time the necessary disassembly and assembly works on line 1 and the general plant parts began. The first firing in Line 2 began in 2014. Line 2 was in full operation during the remaining time of retrofit.

Wien Energie set challenging deadlines in order to implement the works for the firing lot (VE-FEU) within the given time frame. The contractor mastered this task well and kept up with the schedule. Retrofitting line 2 was accomplished in due time and the line will be re-commissioned soon.

![Figure 5: Timeline representing retrofit activities](image)

- Line 2 takeover: 24 October 2014
- Construction start Line 1: January 2014
- First fire Line 1: June 2015
- Plant outage: April 2015
- Start Hot Commissioning Line 1: June 2015
- Trial Operation of complete system Line 1: September/October 2015
- Complete takeover of plant: November 2015
3.1. Waste heat boiler/heat recovery boiler

The waste heat boiler is designed as a 4-pass-boiler with separate economizer. The boiler plant is operated in natural circulation and characterized by its compact design. This specific design is vital for the successful construction of the boiler house Spittelau and has proved valuable for other numerous waste treatment plants as well.

Further details can be read in the book Thomé-Kozmiensky und Beckmann, Energie und Abfall, Volume 11.

3.2. Grate firing system

The contractor provided the plant with his reliable and patented air-cooled grate system. (Patentee: Theodor Koch)

The firing system comprises the following parts and components:

- Feeding and charging device (feed hopper/feed chute/charging ram/feed table),
- Grate,
- Grate riddling hopper/slag chute,
- Hydraulics,
- Ash removal/Slag removal,
- Combustion air system (primary and secondary air),
- Start up and auxiliary burners

Isolating damper

Auxiliary firing is provided in order to maintain the required minimum temperature of 850 °C in the combustion chamber (as required by the BImSchV [German Federal Emission Protection Directive]). The hydraulic isolating damper, which is installed between the fuel feeder and the feed chute, protects the combustion chamber unwanted air. The damper is closed during start-up and closes during shut-down as soon as no more fuel remains in the fuel feeder. That is how the damper protects the system against unwanted air infiltration.
Feed chute

The level gauge and the automatic controlled feed table charger are located in the upper area of the fuel shaft. The fuel shaft is equipped with a water-cooling system to protect the chute wall material against thermal damages (e.g. burn-back). The water-cooled area is designed as a rectangular, double-walled sheet metal construction.

The walls are screwed together and welded with a seal seam. The hollow chambers are filled with water.

Charging Ram/Feed table

The feed chute is connected to the feed table. The fuel is fed into the system with a pusher grate pushing the fuel over a cooled step.

The pusher grate is equipped with a clearing stroke to remove gaps or deadlocks during fuel dosage so that the entire fuel on the feed table is shifted to the grate.

Figure 8: Feeding and charging system

3.2.1. Grate

Combustion of the waste is carried out on the MHPS-ES pusher grate.

This robust and easy to care for combustion grate consists of six air zones, each of which is equipped with an independent drive unit. The grate is driven via hydraulic cylinders which are connected to the grate carriage via connecting rods. The clearing strokes are mounted to the grate carriage. The four bearings of the grate carriages are equipped with a special ball and prism construction.
The grate bars are made of high-alloyed heat-resistant Cr-Ni steel and designed as two-side reversed bars. Combustion takes place within and above the fuel bed. The combustion air is induced from below through the grate slots which are distributed evenly over the grate track and ensure little amount of grate riddlings.

The stroke length of the flexible grate tracks is 400 mm. A long stroke guarantees a steady combustion process with a low stroke frequency. The air-cooled grate is designed as a two-track grate with a middle beam and grate bars facing the grate surface. Thermal expansion of the grate steps during operation is discharged from the middle beam to the side beam. The side beams are dimensioned as a flexible, expansion accommodating construction.

### 3.2.2. Grate riddlings chute/slagn chute

The grate riddlings chute below the grate serves for injection of primary air in the combustion chamber and dispatches grate riddlings on the apron conveyor.

The grate carriage including grate carriage bearings as well as the grate drive shaft are located in the hoppers.

### 3.2.3. Hydraulic system

Each incineration line of the firing plant is equipped with an independent hydraulic system.
3.3. Combustion air system

Waste fuel is very heterogeneous. Therefore, the firing system must be able to balance possible irregularities in heat release and changing amounts of fuel supply.

In relation to this the combustion air supply is of great importance in that context. The distribution of air within the system into primary and secondary air streams and the subordinated primary air distribution to the grate’s air zones as well as the secondary air distribution to the front and rear wall are continuously adjusted according to the fuel conditions.

A steam-heated air heater provided for each line improves the combustion process on the grate when burning waste of low calorific value with high water content. The air heater supports also a stable flue gas temperature in the vortex zone of the secondary combustion chamber.

3.3.1. Primary air system

A speed-controlled fan with an impeller, mounted on both sides, transports the primary air from the air intake in the waste hopper via the intake silencer and the steam-heated air heater to the primary air zones of the two-track grate. The air stream in the primary air zone ducts is regulated via controlled dampers according to the on-going combustion process.

The steam-heated air heater, dimensioned as plain-tube heat exchanger with in-line tube arrangement, consists of one high pressure steam and six medium pressure steam air heater steps. The air stream can be redirected around the air heater via a bypass (valve).

3.3.2. Secondary air system

The secondary air is drawn in close to the boiler house ceiling. A speed-regulated air fan transports the secondary air from the air intake via the intake silencer to the upper and lower secondary air zone distributors at the front and rear wall of the first boiler pass. Pneumatically controlled dampers regulate the air stream in the secondary air zone ducts and adjust it to the on-going combustion process.

3.4. Start-up and auxiliary burner

In order to remain within the prescribed emission limit values, the firing system is equipped with start-up and auxiliary burners. The auxiliary firing guarantees the required minimum temperature of the flues gases in the firing plant. For each incineration line the required heat input is provided by two MHPS-ES burners with a central gas lance, which are designed in accordance with TRD 412 (Technical Rules for Steam Boilers). Those reliable gas burners are installed on the side walls of the waste heat boiler and support the drying process if the calorific value drops below 6 MJ/kg.
3.5. Slag removal/fly ash removal

The slag falls through the slag chute into the water bath of the mechanical ash extractor and is cooled down. The water bath provides protection from false air entering the combustion chamber.

An apron conveyor belt is located below the grate riddlings chute and the mechanical ash extractor. The cooled down slag falling from the chute of the mechanical ash extractor and the added dry grate riddlings ash are both transported via the apron conveyor and a vibration conveyor into the slag bunker. The conveying system is designed as a dry system.

3.6. Fabric filter

Within the scope of retrofit the electrostatic precipitators were replaced with new fabric filter with HOK injection for mercury removal. HOK injection is regulated through crude gas and clean gas (downstream of the fabric filter) mercury detection.

A flue gas recirculation at the fabric filter allows for an improved utilisation of the additives and consequentially a further optimization of the operating costs. This was observed during commissioning, in which a necessary modification to the circuit was determined, due to the ash characteristics and their flow behavior in the filter and the
downstream ash discharge elements. In the new arrangement ash is taken from the flue gas passes 2 and 3, and is injected immediately in the flue gas stream before the fabric filter. In addition to the physical improvement of the flow behavior by the coarser ash, this ash is also used as an adsorbent for gaseous heavy metal salts. These salts that usually condense in dust, have contributed to greater difficulties in the flow behavior of the ash. After the addition of the ash transport system, no further problems in the ash transport have occurred.

4. Disassembly

The plant was disassembled in several steps, starting with the outer wall of the boiler plant in line 2. The reason for this was that building a temporary slag removal was only possible for the inner part of line 1. Before disassembling the plants, both lines had to be separated in terms of hydraulics, electricity, gas supply and statics. This was realized during a two-month outage in spring 2012. For this purpose, a suspended auxiliary steel structure was installed to maintain the platforms and the accessibility for line 1 and to ensure further operation of the line. Aggregates such as the secondary air fan and the hydraulic cubicles for the grate drive were relocated in a second stage. At the same time preparatory work for construction and installation of the new chute system for line two were implemented in the waste bunker. A fast completion of those works was imperative since any work within the bunker during operation is prohibited for safety reasons.
A wooden partition wall with flame-resistant foil was installed on the auxiliary steel structure between the two incineration lines. The wall serves as weatherproofing and dust protection and separates the disassembly area from the operational area.

During the two-month outage a new fire-resistant steel structure over the slag bunker had to be installed as well. The new supporting structure was completely independent of the existing architectural structure and was built for the feed water container and the emergency staircase. Its installation proved to be quite difficult and time consuming.

A 75 m high tower crane with a load capacity of 40 tonnes was provided for lifting and hoisting. This was necessary because of the plant’s geometry, site conditions and the very limited space available. The load capacity at the end of the crane beam at 55 m could lift 11 tonnes. Above all, this load capacity was needed for the demounting and assembling of the catalyst plant. All hoisting works had to be conducted over the roof, because access from the side would destroy the famous plant facade by Hundertwasser. Mobile cranes were used only when necessary.

In 2012, re-commissioning of line 1 went smoothly and cleaning and preparatory works for disassembling line 2 started accordingly. After removing the boiler plant, the old boiler house foundations were broken off and the boiler house was lowered about two meters. After lowering the boiler house, the construction of the entire plant started with the assembly of the new boiler steel structure.

From August 2013 there was a 6 month general outage for demounting the remaining parts of line 1 and the electrostatic precipitator. Focus was on disassembling and mounting the catalyst plant and other plant parts since re-commissioning was scheduled in 2013.

5. Assembly

Assembling the new main plant components, namely, the boiler, the firing plant, and the flue gas cleaning plant, required a comprehensive analysis of the existing plant structure, including a record of the available space and sites for delivery. Engineering, construction, and scheduling the assembly of the new components were based on the analysis’ results.
As the plant site offered practically no storage possibilities and the restricted space in the boiler prohibits any subsequent installation of components, a comprehensive and carefully assembly order had to be established. This included extensive assembly planning activities. Plant components such as the ash hopper, start-up and auxiliary burners, numerous headers, pressure part components, and the apron slag conveyor had to be stored temporarily on site and were mounted a later point in time. Installation of those plant parts was realized via maintenance and transport openings on the electrostatic precipitator roof and on the boiler house of line 2. The apron conveyor was installed simultaneously to the construction of the boiler steel structure. The waste feeding system and the grate mounting were implemented according to schedule and assembly order.

The pre-manufactured ECO packages were pulled into vertical position, taken over with a strand jack system and then mounted together. The boiler walls (pass 1, 2, and 3) including buckstays, header, refractory arch and burnout cover were each hoisted into the boiler house, positioned and finally welded into place. The assembly of the third pass and the installation of the sling tubes as well as the hoisting and positioning of the superheater’s two disks took place simultaneously.
In March 2013, the boiler drum for line 2 was delivered and lifted into the boiler house. At the beginning of 2013, works started on the internal piping of the boiler. The boiler pressure test was successfully accomplished on June 13th 2013. Re-commissioning activities took place at the beginning of December. The first fire was scheduled for March 2015.

6. Technical data

Both incineration lines of the thermal waste treatment plant Spittelau are identical in design. The main components before and after retrofit are listed below.

Table 1: Technical data of the main components of the incineration lines of the thermal waste treatment plant Spittelau before and after retrofit

<table>
<thead>
<tr>
<th>Boiler</th>
<th>Unit</th>
<th>Original</th>
<th>New/Retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
<td>Waagner Biro</td>
<td>MHPS-ES</td>
</tr>
<tr>
<td>Boiler type</td>
<td></td>
<td>natural circulation</td>
<td>natural circulation</td>
</tr>
<tr>
<td>Heating surface</td>
<td>m²</td>
<td>2.420</td>
<td>5.001</td>
</tr>
<tr>
<td>Drum content</td>
<td>m³</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Steam capacity</td>
<td>t/h</td>
<td>45</td>
<td>(Saturated Steam) 60.5</td>
</tr>
<tr>
<td>Live stream pressure boiler</td>
<td>bar</td>
<td>32</td>
<td>40</td>
</tr>
<tr>
<td>Live stream temperature</td>
<td>°C</td>
<td>238</td>
<td>400</td>
</tr>
</tbody>
</table>

| Auxiliary firing                |      |                          |               |
| Natural gas burner              | per line | 2                       | 2             |
| Burner capacity                 | MW    | 9                        | 15            |

| Combustion Grate                |      | Original                 | NEW/Retrofit  |
| Manufacturer                    |      | Martin                   | MHPS-ES       |
| Design                          |      | reciprocating grate      | pusher grate  |
| Firing system                   |      | counterflow              | centerflow    |
| Waste throughput                | Mg/h per line | 16-18                  | 16            |
| Calorific design value (Hu)     | MJ/kg | 9                        | 10            |
| Thermal input fuel              | MWth  | 41.1                     | 44.5          |
| Grate surface                   | m²   | 34.5                     | 62            |
| Grate length                    | m per line | 7.5                     | 10.8          |
| Grate width                     | m per line | 4.6                     | 5.74          |
| Grate tracks                    |      | 2                        | 2             |
| Grate cooling                   |      | air cooling              | air cooling   |

| Flue Gas Cleaning               |      | Original                 | NEW/Retrofit  |
| Manufacturer                    |      | AE&E                     | MHPS-ES       |
| Number per line                 |      | 1                        | 1             |
| Procedure                       |      | electrostatic precipitator 2-step wet scrubber | fabric filter with HOK injection SCR-DeNOX system |
| Flue gas amount                 | Nm³/h per line | 85.000                 | 116.000      |
7. Challenges, particularities and conclusion

One of the biggest challenges for retrofit was the location. The plant Spittelau is boarded on two sides by two underground lines, pedestrian zones, bike baths, and railway infrastructure. The third side is bordered with by the old and famous Viennese Stadt­bahnbögen (viaducts on which the tram used to run across); and the forth side, finally by the inner city main traffic route. Such a location hardly provides any storage or pre­fabrication areas. The site camp had to be relocated to another area. Close cooperation of all parties and a sophisticated, fine­tuned logistic system were the only ways to ensure safe transport and quick installation of construction parts while keeping operation roads, emergency driveways and access roads clear. It should be emphasized that the entire pre­construction and storage surface was not larger than 1,700 m².

Another challenge was the stepwise construction procedure, that is, one line was being dis­assembled while the other line was still operating. This means that waste transport traffic had to be taken into account when planning disassembling and assembling of the plant.

The facade was another important factor. The old boiler house was increased by roughly ten meters because of the new boiler geometry. However, all plant parts were integrated seamlessly into the existing Hundertwasser façade and contributed to the artistic character of the building. Once retrofit is accomplished the new plant parts will be hard to distinguish from the old ones.

Spittelau is a prime example of an older plant transformed into a state­of­the­art waste treatment facility, while taking into account the operator’s needs for profitability and the residents’ requirements for high­quality thermal treatment and an aesthetic neighbourhood. The City of Vienna and Wien Energie proved that a technology which is often seen as controversial can be successfully integrated through transparent and accountable planning.

8. Line 2 operating experience

All mechanical work proceeded according to schedule, as you can see from the timeline on page 8.

In addition to the available space in this project another major challenge was the unusual short period from the hot commissioning phase up to the so­called test operation of the line 2. In the test operation, the system had to be demonstrated and checked according to the contractual requirements; the test operation was followed by the partial takeover of the line 2 by the customer.

Within the first 3 months of operation Line 2 was ready for operation. However, not all of the customer’s demands were implemented in the first attempt. For this reason there was a slight delay of about 6 weeks from the end of hot commissioning to the final takeover of the system on 23.10.2014.
This delay was necessary in order to adjust the first operating experience to the circuit of the ash transport system as well as to optimize the burners.

This was observed during commissioning, in which a necessary modification to the circuit was determined, due to the ash characteristics and their flow behaviour in the filter and the downstream ash discharge elements. In the new arrangement, ash is taken from the flue gas passes 2 and 3, and is injected immediately in the flue gas stream before the fabric filter.

In addition to the physical improvement of the flow behaviour by the coarser ash, this ash is also used as an adsorbent for gaseous heavy metal salts. These salts that usually condense in dust, have contributed to greater difficulties in the flow behaviour of the ash. After the addition of the ash transport system, no further problems in the ash transport have occurred.

For the optimization of the burners, normal optimization measures took place. On the one hand the fan characteristic curve had to be adjusted because of unexpected resonances caused by disturbing vibrations generated in the ducts. Furthermore, we optimized the nozzle configuration to meet the required emission values in all areas of operation, which in individual cases are under the statutory emission limits.
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