On December 28th, 2005, Werner Sunk of Columbia University/WTERT/EEC visited the WTE facility Floetzzersteig in Vienna, Austria. He met Marcus Kuhn, administrator of the plant on site to discuss his questions and see the operating facility.

**General and history**

The WTE facility Floetzzersteig was built between 1959 and 1963 and was the first of its kind in Austria. The plant was to serve two nearby hospitals, a swimming pool and Vienna’s central laundry with steam and heat. Today, the facility recovers energy in three lines from MSW (8.3 t/h each line). After 1985, major investments were necessary to provide gas control that complied with new environmental legislation. A three-stage gas cleaning system was installed (1985), the grate and electrostatic precipitator were reconditioned (1990 – 1993) and a DeNOx plant was implemented (1992 – 1993).

![Figure 1: WTE facility Floetzzersteig, Vienna](image)

Today, the district heating grid of Vienna is approximately 940 km long. Approximately 2.780 MW of thermal output are provided to 220,325 apartments and 4,777 large customers (figures from 2001) to serve with heating, ventilation, air conditioning and water for domestic use.

The heat from MSW energy recovery is in spite of the low installed output of 150 MW (or 5.9 % of the total power) 23.3 % of the total thermal output compared to 72.2 % from power-heat coupling and 4.5 % from peak load facilities. The reason for this lies in the high availability and the year-round operation.
The present steam distribution is shown in Table 1:

**Table 1: Steam distribution (2004)**

<table>
<thead>
<tr>
<th>Customer</th>
<th>Steam [t]</th>
<th>Energy equivalent [MWh]</th>
<th>Percentage [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Baumgartner Hoehe</td>
<td>73,180</td>
<td>52,689</td>
<td>13</td>
</tr>
<tr>
<td>Hospital Wilhelminenspital</td>
<td>5,858</td>
<td>4,100</td>
<td>1</td>
</tr>
<tr>
<td>Swimming bath Ottakring</td>
<td>4,869</td>
<td>3,427</td>
<td>0.8</td>
</tr>
<tr>
<td>Central laundry Vienna</td>
<td>22,611</td>
<td>15,827</td>
<td>4</td>
</tr>
<tr>
<td>District heating grit Vienna</td>
<td>375,385</td>
<td>262,769</td>
<td>66</td>
</tr>
<tr>
<td>Own consumption</td>
<td>97,126</td>
<td>66,527</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>579,056</strong></td>
<td><strong>405,339</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Figure 2 shows the neighborhood of the WTE facility Floetzsteig. Especially the closeness to the residential area as well as to the bulk customers must be emphasized.

![Map of neighborhood](image)

**Figure 2:** Picture of the neighborhood of the WTE facility Floetzsteig

The WTE facility Floetzsteig does not produce any electricity. All energy from the steam is used as process steam by the bulk customers or in the district heating grit.

The city of Vienna pays about $ 180 per ton of MSW for the treatment; private people have to pay about $ 250 per ton.
70 persons work at the WTE facility Floetzersteig. Of these, 56 persons work in 5 working shifts, 7 persons in the administration (management, engineering, analytics, office) and several persons at delivery, machine shops, stack and scale.

Maintenance and minor repairs are operated by the on-site personnel; the 5 revisions per year (4 short revisions of only one line, 1 1-week revision) are operated with help from external companies.

The process (see Figure 5)

1. MSW delivery
The waste is delivered by about 230 trucks (each truck carries 4 to 5 tons of waste). Every truck is weighted and unloads the waste at one of the six tipping stations into the waste bunker (see Figure 4). The waste bunker is divided into two compartments - one part for the daily use, the other part as a stock bunker for the delivery-free days. The stock bunker can hold waste for a maximum of 3 days.

The waste is discarded by two cranes from the bunker into three chutes (see Figure 3) - one for each combustion line - to be burned in the combustion chamber.

![Figure 3: 3 chutes head from the bunker to the combustion chambers](image)

![Figure 4: Unloading the trucks at the tipping stations](image)
Figure 5: Flow sheet of the WTE facility Floetzersteig
2. Combustion grate and boiler
The horizontal grate (W+E Umwelttechnik AG) provides the required, mixing, circulation, stoking and forward motion of the MSW bed to gain a good out burn. The grate is divided in 4 combustion areas, which are supported with the primary combustion air. The primary combustion air is heated up to 170 °C and blown controlled according to the requirements of the 4 combustion areas from the bottom of the grate into/through the MSW combustion bed. Additionally, secondary combustion air is injected with high velocity from the front and back wall of the combustion chamber just above the MSW combustion bed. The generated verruciform turbulences support the mixing of the flue gas with the secondary combustion air to maximize the out burn of the flue gas.

Each of the 3 combustion chambers is equipped with 2 supporting burners fired with natural gas. These burners make sure (see gas inlet on Figure 6), that the temperature in the combustion chamber never drops under 850 °C and the emissions comply with legal requirements - especially during start and shut down of one of the boilers. As the heating value of MSW (8,000 - 9,500 kJ/kg) is equivalent to the heating value of brown coal, the natural gas burners are not needed under normal circumstances. Additionally, the high power output of 11.5 MW of these burners guaranties the heat supply for the hospitals during periods of no MSW combustion.

![Natural gas inlet for the supporting burners](image)

The boiler (natural circulation boiler with 8 ½ paths) of each line is equipped with an evaporator (1695 m², output: 200 °C, 16 bar), a super heater (370 m², output: 270 °C, 16 bar) and an economizer (220 m², input: 105 °C, output: 140 °C). On that way 2.80 tons of steam are produced per ton of MSW. The energy content of one ton of steam is 0.70 MWh or one ton of MSW is equivalent 1.90 MWh after energy recovery. The energy efficiency is about 83 %.

After the supply of the bulk customers the remaining steam is fed into the district heating grit to heat up the return from 60 – 70 °C up to 150 °C.
3. Flue gas treatment

The flue gas treatment plant consists of an electrostatic precipitator, a 2-stage flue gas scrubber (including 2 droplet separators) with a downstream fine dust separator (electrodynamic Venturi) and at the back end a SCR DeNOx plant. Each flue gas treatment line is designed for 55,000 nm³.

The electrostatic precipitator reduces the fly ash load of the flue gas (input temperature 180 °C, min. 160 °C) from 3,000 mg/Nm³ to 30 – 40 mg/Nm³. According to this figures the filtration efficiency is at 99 %. The fly ash on the precipitation electrodes is taped to be collected separately in 2 fly ash silos (see Figure 7). The electrostatic precipitator will be substituted by a bag filter house in the next few months.

Figure 7: Loading station for the fly ash under the 2 silos

The 2-stage flue gas scrubbers inject lime water (pH 1.1) in the first and a sodium hydroxide solution in the second stage to wash out pollutants like dust, hydrogen chloride, hydrogen fluoride and heavy metals (Cd, Hg), respectively sulfur dioxides (input: 250 mg/Nm³, output: 7 mg/Nm³.). The water used by the scrubbers derives from the Danube channel. The flue gas temperature after the first scrubber is 60 °C. Two droplet separators are installed between the two scrubbers and after the second scrubber (before the electrodynamic Venturi) to avoid carryovers from one chemical system to the other.

Figure 8: Bottom level of the three 2 stage scrubbers (pink)
The electrodynamic Venturi reduces the particulate matter (grain size 0.01 – 0.001 m) to < 1 mg/Nm³. As the previous flue gas treatment is very efficient the electrodynamic venturi will be removed in the next month.

After the flue gas scrubbers and the electrodynamic Venturi the 3 lines are combined to enter the SCR DeNOx plant. The input off gas is heated up to 260 °C and ammonium is injected. During passing through the catalyst the NOx react with the ammonium to water and nitrogen. The dioxins and furans are destroyed by catalytic oxidation whereas water, CO₂ and HCl emerge. The 3 layers of catalyst have a volume of 51.9 m³ and a reactive surface of 352 km².

After leaving the SCR the cleaned flue gas is cooled down to 160 °C to be released after passing a fan into the atmosphere by the stack.

4. Waste water treatment

The used water (3.5 m³/h) of the first stage of the flue gas treatment plant is cleaned by a 2 stage waste water treatment facility. Pollutants are reduced precipitation, flocculation, sedimentation and neutralization. 2/3 of the cleaned water is led to the sewer and will be treated a second time at the waste water treatment plant Vienna, the remaining 1/3 is used again in the flue gas cleaning system. The solid residues (see Figure 9) are recovered with a filter press, collected and shipped to a salt mine.

Figure 9: Solid residues from the waste water treatment
5. Solid residues
Based on the MSW volume the volume of the solid residues is about 10 %. Table 2 shows the quantities of solid residues of 1 ton of MSW in the year 2004 and the further disposition of each fraction.

Table 2: Quantities of solid residues of 1 ton of MSW (2004)

<table>
<thead>
<tr>
<th>Residue</th>
<th>Mass [kg]</th>
<th>Percentage of 1 t MSW [%]</th>
<th>Disposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom ash</td>
<td>236</td>
<td>23.6</td>
<td>Waste treatment facility Rautenweg,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Filler in concrete for landfill ring wall</td>
</tr>
<tr>
<td>Fly ash</td>
<td>18</td>
<td>1.8</td>
<td>Salt mine</td>
</tr>
<tr>
<td>Filter cake</td>
<td>0.9</td>
<td>0.09</td>
<td>Salt mine</td>
</tr>
<tr>
<td>Total</td>
<td>255</td>
<td>25.5</td>
<td></td>
</tr>
</tbody>
</table>

The costs for dumping the fly ash and the filter cake in a slat mine are about $ 150.00.

Facts and figures (2004)

General: MSW throughput 209,62672 t
Operating time 8,140 h = 347 d

Generation: Steam 579,056 t
Heat 405,339 MWh

Consumption: Energy el. 17,459,680 MWh
Gas SCR DeNOx 2,802,449 Nm³
Gas supporting burners boiler 368,832 Nm³
Water 163,481 m³
De-salted water 21,275 m³
Lime (CaO) 474 t
Sodium hydroxide (NaOH), 33 % 802 t
Ferric chloride (FeCl₃), 40 % 19 t
Trimercaptotriazin (TMT15) 21 t
Ammonium (NH₄OH), 25 % 372 t
Polyelctrolyte (PE) 0.9 t
Hydrochloric acid, 33 % 17 t

Residues: Bottom ash 55,201 t
Fly ash 3,840 t
Filter cake 196 t

Equipment: Grate W+E Umwelttechnik AG, Zuerich
Boiler AE+E
Electrostatic precipitator AE+E, Type Walther
Flue gas treatment AE+E
DeNOx AE+E
Waste water treatment AE+E
Catalyst Ceram-Frauenthal-Keramik (Mitsubishi license)
Acknowledgments:

The author greatly appreciates the information provided by Marcus Kuhn, administrator of the Floetzersteig WTE facility/Fernwaerme Wien GmbH, Vienna during his visit of the facility. This visit is part of a study on WTE metals recovery sponsored by the Waste-to-Energy Research and Technology Council and North American Metals Company.

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