Retrofit KVA Horgen, CH
Boosting of the Energy Efficiency and the Automated Operation of a Local District Heating Provider

Authors:
R. Suesstrunk und R. Wild (KVA Horgen)
Modernisation of KVA Horgen, Switzerland

- Service Organisation of Hitachi Zosen INOVA AG
- Reasons for and Objectives of the KVA Horgen Retrofit
- Incineration and Boiler
- Dry Bottom Ash Discharge
HZI – A Full-Service Provider

**Maintenance**
- Own stock of spare parts
- Inspections
- Annual overhauls
- Long term service agreements
- Computer-based Maintenance Management System (CMMS)

**Modernization**
- Emission reduction
- Engineering
- Performance improvement
- Efficiency increase
- Plant modernization

**Analysis**
- Laboratory services
- Measurements, campaigns and analysis
- Remote monitoring software especially developed for incineration plants
- Efficiency studies

**Operational Support**
- Field operation
- Training
- Optimisation of spare parts stock
- Life time calculation

**Operation & Maintenance**
Service Organisation

Service
R. Süstrunk

Assistant
N. Radulovic-Bianchet

Controlling
a.i. R. Brühlhart

O & M
A. Sigg

Service AD
J. Lindemann

Sales & Projects A
A. Pfister

Sales & Projects B
Field Operation
M. Jufer

Engineering
St. Eckert

Spare Parts
M. Stillhart

General

Werkstatt, Lager,
Service CH

Sales & Projects
Execution B

Process &
Basic Engineering

Field Operation

Layout & Design

HZ-KRB
H. Denzler
Our Service Stations

- Service Representative Scandinavia
- Local Service Station UK
- Local Service Stations Germany
- HZ-KRB
- Home base

Hitachi Zosen Inova

HZI – US Inc.
Reasons for and Objectives of the KVA Horgen Retrofit
The City of Horgen

- Horgen is located on the left shore of Lake of Zurich about 30 km from the city of Zurich
- The Community counts about 20’400 inhabitants with over 6’500 households
The District Heating Network of the Horgen Community

- Length of network: approx. 9 km
- Pipeline diameter: 25 up to 250 mm
- Operating temperatures: 75 – 115 °C
- Supplied households: approx. 2’300 (1/3 of all households)
- Sold energy 2014: approx. 42’000 GWh (EfW plant 39’440 GWh)

Why was the network the insurance for the EfW plant?
District heating – KVA Horgen’s Insurance for the Future

The energy concept of the community relies mainly on district heating and gas

Feeding of the district heating network by heat from the EfW plant and the WWT plant → heat production from WWT plant not active

Regional planning: Shut down of EfW plant in 2018, as the waste volume came down.

But where to take the heat from?

There were three main alternatives

- Operation with fossil fuel
- Modification of the existing EfW plant from household waste to biomass
- Geothermal power out of a depth of 3’500 – 4’000 m
  → Not very ecological, too expensive and or not secure enough compared with an upgraded EfW plant

Conclusion:

→ Reduced incineration capacity with approximately same energy production
→ Secure operation until 2030 under the condition: no increase of disposal fee
EfW Plant of Horgen, Switzerland

- Replacement/Modernisation of the existing grate incineration dated 1991 with running operation and same fees / t waste & R1 > 0.65
- Provide same amount of el. - and thermal energy as today, with reduced waste capacity
- Dry bottom ash extractor with loading station to ZAV in Hinwil → (ZAR bottom ash treatment)
- New dry flue gas treatment with Bicar, low-temperature catalyst and additional economiser

Key Data

- **Client**: Zweckverband Abfallverwertung Horgen
- **Start-up**: 2015
- **Technology**
  - Incineration
  - Energy recovery
  - Flue gas treatment
- **Technical data**
  - **Fuel**: Municipal and commercial solid waste
  - **Waste throughput**: 1 x 4.2 t/h
  - **Lower heat value**: 12.8 MJ/kg (10.5 – 15.5 MJ/kg)
  - **Thermal performance**: 1 x 15 MW
  - **Steam power**: 1 x 17.8 t/h (30 bar, 380°C) plus 0.5 t/h steam from boiler drum

HZI Client Event 2016: District Heating - KVA Horgen's Insurance for the Future
Retrofit Sequence

<table>
<thead>
<tr>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
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</tr>
</tbody>
</table>

Demantelling Boiler L2  
Eng Boil L2 Erection  
Masts & Dismantling Testing & Breeding  
FGT L1 Run

Boiler L1 old

FGT L1 new

Boiler L2 old

FGT L2 new
Retrofit Incineration and Boiler
KVA Horgen, Retrofit Furnace / Boiler

- Boiler first pass
- Evaporizer
- Superheater 1 & 2
- Ram feeder and grate control
- 4-zones grate
- CCS
- PA und SA System
- Ash removal
- Bottom ash removal
- Bottom ash loading system
Boiler Dismantling & Assembling

Dismantling evaporizer

Combustion chamber

Assembling burnout ceiling
Modern HZI incineration with low excess air

These nozzles mix oxygen-rich gas from the postcombustion to the main combustion zone.

Double swirl for optimal postcombustion.

Lower nozzles transport «pyrolysis gas» to the middle of the combustion chamber.

Graphic representing the velocity distribution in m/s.
Combustion (Comparison Before and After Retrofit)

- Higher steam flow
- More stable live steam flow
- Steadier combustion
- Faster reaction (Cladding)

- Little O₂ fluctuations
- CO concentration below guaranteed value

- Live steam (t/h) / O₂ (vol% wet)
- CO concentration (mg/Nm³ dry)

Graph showing comparison of live steam and CO concentration before and after retrofit.
Sensors for More Stable Combustion (CCS+)

Additional sensors and control concepts are used for further improving and automating the combustion process.

Targets:
- Less steam flow drops
- Stable combustion (waste bed, fire position)
- Higher degree of automation
Results with CCS+

- Less live steam drops from emptying and overfilling the grate
- Live steam flow closer to setpoint (no loss from control) → Improvement corresponds to 2-3 days of operation per year
- Less manual interventions required

![Graph showing live steam deviation from setpoint with and without CCS+]

**Daily values**

**Average**
Dry Bottom Ash Discharge
Dry Bottom Ash Discharge with Container Loading

Challenges
- Location / limited space
- Space for combustion chamber – Air exclusion
- Dust exclusion
Dry Bottom Ash Discharge with Container Loading II
Container Loading

Dry bottom ash loading with exchangeable containers
### Overview

#### Waste input [t/a]

<table>
<thead>
<tr>
<th></th>
<th>Wet</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>32'000</td>
<td>32'000</td>
<td></td>
</tr>
</tbody>
</table>

#### Water content bottom ash [%]

<table>
<thead>
<tr>
<th></th>
<th>Wet</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

#### Bottom ash quantity [t/a]

<table>
<thead>
<tr>
<th></th>
<th>Wet</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>7'553</td>
<td>6'401</td>
<td></td>
</tr>
</tbody>
</table>

#### Particulate metal content

<table>
<thead>
<tr>
<th>Metal Type</th>
<th>Wet Recovery Efficiency</th>
<th>Dry Recovery Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous metals &gt;10mm</td>
<td>9.4%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Ferrous metals &gt;10mm</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Ferrous metals &lt;10mm</td>
<td>2.4%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Ferrous metals &lt;10mm</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>Non-ferrous metals &gt;10mm</td>
<td>1.6%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Non-ferrous metals &gt;10mm</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Non-ferrous metals &lt;10mm</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Non-ferrous metals &lt;10mm</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>Stainless steel &gt;10mm</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Stainless steel &gt;10mm</td>
<td>95%</td>
<td>95%</td>
</tr>
<tr>
<td>Stainless steel &lt;10mm</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>Stainless steel &lt;10mm</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>Non-ferrous metals &lt;10mm</td>
<td>2.4%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Non-ferrous metals &lt;10mm</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>Non-ferrous metals &lt;10mm</td>
<td>95%</td>
<td>95%</td>
</tr>
</tbody>
</table>

Better recovery efficiency as a result of cleaner metals (no fouling / pollution)

Non-ferrous metals from wet bottom ash

Non-ferrous metals from dry bottom ash
**Comparison Wet – Dry**

<table>
<thead>
<tr>
<th>Metal separation on site [t/a]</th>
<th>Wet</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous metals &gt;10mm</td>
<td>542</td>
<td>572</td>
</tr>
<tr>
<td>Non-ferrous metals &gt;10mm</td>
<td>94</td>
<td>106</td>
</tr>
<tr>
<td>Stainless steel &gt;10mm</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Non-ferrous steel &lt;10mm</td>
<td>54</td>
<td>146</td>
</tr>
<tr>
<td>Bottom ash landfill volume [t/a]</td>
<td>6'850</td>
<td>5'562</td>
</tr>
</tbody>
</table>

**Earnings from metals’ sale [€/a]**

<table>
<thead>
<tr>
<th></th>
<th>Wet</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous metals &gt;10mm</td>
<td>10'840</td>
<td>28'600</td>
</tr>
<tr>
<td>Non-ferrous metals &gt;10mm</td>
<td>94'000</td>
<td>127'200</td>
</tr>
<tr>
<td>Stainless steel &gt;10mm</td>
<td>7'800</td>
<td>12'000</td>
</tr>
<tr>
<td>Non-ferrous metals &lt;10mm</td>
<td>54'000</td>
<td>251'850</td>
</tr>
</tbody>
</table>

Very good recovery efficiency of wet and dry bottom ash for the fraction >10mm (>90%)

Significantly better recovery efficiency in the dry bottom ash recovery for the fine fraction

The high level of metals’ quality (less pollution) achieved with the dry process leads to more earnings
Bottom ash burnout

- In the dry bottom ash discharge we could measure constantly low total organic carbon (TOC)

  TOC = 0.30-0.35 weight %

- Contribution to constantly low TOC:
  - Combustion concept (geometry)
  - Control accuracy/ Burnout control (stable fire position)
  - Dry bottom ash discharge (afterglow)
Thank you for your attention.