Agenda

- Introduction of SBENG
- Aspects concerning the design of EfW boilers
- Examples of large scale EfW plants
- Linköping boiler concept
- Tekniska Verken Project: Lejonpannan in Linköping
Roots of the Company

Noell-KRC Energie- und Umwelttechnik GmbH

(Energy from Waste & Flue Gas Cleaning)

11/1999

11/2002

09/2014

Noell-KRC Energie- und Umwelttechnik GmbH
Ownership Structure

NIPPON STEEL & SUMITOMO METAL CORPORATION

100%

NIPPON STEEL & SUMIKIN ENGINEERING CO., LTD.

100%

Steinmüller Babcock Environment GmbH
NSENGI - Business Field “Environmental Solutions”

- Waste Gasification and Melting Technology/(Direct Melting System, DMS)
- Gasification Recycling Facility for Waste Tyre
- Biomass Gasification
- Biomass to Ethanol Technology
- Processing harmful and difficult-to-treat materials
- Soil remediation
- Groundwater cleaning
**NSENGI – Reference list of DMS in Japan and South Korea**

- **Number of records:** 42 references  
  (World’s highest number)
- **Facility size:** 100,000 ~ 230,000 t/annual  
  (World’s largest capacity)
- **Term of operation:** 34 years  
  (World’s longest term)

1. **Akita (2002)**
2. **Kamaishi (1979)**
5. **Yangsan (2007)**
7. **Kitakyushu**

> : In operation

> : Under construction

[Map with locations and facility images]
Product Divisions of SBEng

Flue Gas Cleaning

Energy from Waste

After Sales Service
SBEng’s Core Competences and Strengths

- Own developed and proven grate technologies
- Long-time engineering expertise in boiler design
- FGC concepts tailored to client’s requirements
- Design of core components by own specialists
- Balance of plant design
- Integrated management system for quality, health, safety and environment
- Contract execution as general contractor
- Our after sales experts support our clients after takeover
EfW Plants built by SBENG in Sweden

Halmstad

Borlänge

Uddevalla

Jönköping
After Sales Service

- Spare Parts Management
- Plant inspections/ revisions
- Repairs
- Engineering provider
- Refurbishment/Uprating
- Service contracts
After Sales Service Capabilities

1. Video endoscopy
2. Optimization of load distribution
3. Thermographic analysis
4. Analysis of Machines
Aspects concerning the Design of EfW Boilers

Process design aspects, such as
• Steam parameters
• Excess air ratio
• Flue gas outlet temperature
mainly define the efficiency of the boiler plant.

Mechanical design aspects, such as
• Vertically or horizontally arranged convective heating surfaces
• Bottom or top suspended boiler
• Overall plant size
mainly define the plant layout.
Four Pass Vertical Boiler
Klaipeda/ Lithuania

www.steinmueller-babcock.com
Four Pass Horizontal Boiler
Kristiansand/ Norway
# Horizontal versus Vertical convective Pass

<table>
<thead>
<tr>
<th></th>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boiler Concept</strong></td>
<td>3 vertical radiation passes, convective heating surfaces in a arranged horizontally in 4th pass.</td>
<td>4 vertical passes. The 1st pass as empty radiation pass, 2nd radiation pass evtl. with platen heating surfaces. Convective heating surfaces in 3rd and 4th vertical passes.</td>
</tr>
<tr>
<td><strong>Area required</strong></td>
<td>Approx. 20-30% more of boiler length.</td>
<td>Additional space required for sootblowers in terms of distances between two boilers and overall plant width.</td>
</tr>
<tr>
<td><strong>Overall height</strong></td>
<td>3 radiation passes allow for lower boiler height.</td>
<td>The vertical concept increases the height of the building.</td>
</tr>
<tr>
<td><strong>Extraction of ash</strong></td>
<td>About 6 or more hoppers + rotary locks or double flaps and a collecting sifting conveyor.</td>
<td>The minor amount of ash is carried over to the FGC system downstream of the boiler.</td>
</tr>
<tr>
<td><strong>Heating surface cleaning</strong></td>
<td>Pneumatic rappers with frequent operation. Low energy consumption.</td>
<td>Steam sootblowers with high efficiency. Operation once per shift. Steam consumption slight negative impact on rated power output of turbine/generator.</td>
</tr>
</tbody>
</table>
Bottom supported versus top suspended Grate and Boiler
### Bottom supported versus top suspended Grate and Boiler

<table>
<thead>
<tr>
<th>Component</th>
<th>Bottom Supported</th>
<th>Top Suspended</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steel Structure</strong></td>
<td>Separate steel structure for boiler house required.</td>
<td>Top suspended boiler allows for integrated steel structure for boiler house.</td>
</tr>
<tr>
<td><strong>Grate suspension</strong></td>
<td>For small units bottom suspension of grate and boiler is appropriate since there is only little compensation required. Also very large grates can be bottom suspended due to high loads.</td>
<td>Top suspended boiler allows for top suspended grate -&gt; no difference in thermal expansion -&gt; no compensation required. -&gt; Good excess under grate.</td>
</tr>
<tr>
<td><strong>Furnace</strong></td>
<td>Adiabatic combustion chambers can be bottom suspended due to high loads of refractory.</td>
<td>SBENG’s standard layout with top suspension of feeder, grate and boiler for plants from 35 MW up to 110 MW.</td>
</tr>
<tr>
<td><strong>Waste Feeder</strong></td>
<td>Large units rather use standing waste feeder due to high loads of waste in the chute.</td>
<td></td>
</tr>
</tbody>
</table>
Plant Size – Modular Design of SBENG Grates

1 track

2 tracks

3 tracks

4 tracks

intermediate sizes are also available
4-Track Grate at EfW Plant Berlin Ruhleben
Pros and Cons of large-scale Facilities

**Pros:**

- Foot print
- Volume of facility
- No. of process and instrument/control equipment related to throughput
- Investment cost
- Combustion conditions without aux. fuel
- Sensitivity against off spec fuel
- Labour cost
- Maintenance cost

**Cons:**

- Effort for fuel storage during down time of one unit
- Part load capability regarding over all throughput
Grate & Boiler Technology
Range of gross Heat and Throughput

LHV 5 – 20 MJ/kg

Capacity 18 – 150 MW/h

Throughput 6 – 50 Mg/h
RDF Plant Rüdersdorf/ Germany

Location
Rüdersdorf, Germany

Purchaser
Vattenfall Europe
Waste to Energy GmbH

Fuel
Refuse derived fuel

Capacity
114.2 MWth
1 x 32.9 t/h
12 500 kJ/kg

Grate System
Forward moving grate
(water-cooled)

Year of Start Up
2008

SBEng Scope of Supply
Firing system
Steam generator
Gas cleaning

www.steinmueller-babcock.com
RDF Plant Rüdersdorf/ Germany

Boiler efficiency        86,5 %
Power production        ~ 29,9 %

Thermal Flow Diagram with Reheating

Gross
Heat Release         MW       110
Throughput            Mg/h     27.3
LHV                  MJ/kg     14.5
LSt Pressure          bar      90
LSt Temperature       °C      420
Location
Berlin Ruhleben, Germany

Purchaser
Berliner Stadtreinigungsbetriebe

Fuel
Municipal solid waste

Capacity
90 MWth
1 x 36 t/h
9 000 kJ/kg

Grate System
Forward moving grate

Year of Start Up
2012

SBEng Scope of Supply
Turn-Key
(Replacement of 4 small units by one new line, incl. Flue gas cleaning, Civil, connecting work to the existing plant)
EfW Plant Berlin Ruhleben/ Germany  2/2
EfW Plant Linköping/ Sweden

Location
Linköping / Schweden

Purchaser
Tekniska Verken i Linköping AB

Fuel
Municipal Solid Waste & Biomass

Capacity
88.14 MWth
1 x 30.22 t/h
10 500 kJ/kg

Grate System
Forward moving grate

Year of Start up
2016

SBEng Scope of Supply
Grate Boiler / Steam Generator / Ancillary Equipment
Grate System

- Forward moving grate
- Air-cooled
- Inclination: 12.5°
- No. of grate tracks: 3
- No. of grate zones: 5
- No. of grate steps: 2
- Grate length: 12.0 m
- Grate width: 9.475 m
Furnace and 1st Boiler Pass

**Furnace**
- Centre flow configuration
- Excess air ratio 1,44
- Protection by Inconel cladding

**Boiler**
- Steam parameters 42,5 bar/ 400 °C
- Steam mass flow Mg/h 107,8
- Flue gas flow (MCR) Nm3/h 150.536
- FG temperature °C 165
WE MAKE THE WORLD A CLEANER PLACE

Let's work it out together