Keppel Seghers
- Keppel Corp
- Keppel Seghers Thermal Division

Water-Cooled Grate
- principles
- cases: Modena (Italy) + Amsdorf (Germany)

Boiler Prism
- principles
- cases: AZN (the Netherlands) + Modena (Italy)
Global foot-print in 25 countries and 20,000 employees
Revenue of US$ 4 billion and profitable
Commitment to high level of corporate governance
Offshore & Marine

Shipyard in Brownsville, Texas
Environmental Technology

Atlanta, Georgia
Keppel SEGHERS

Thermal

WtE

Biosolids

Water
Biosolids Drying & Pelletizing

Baltimore, MD
Fluidized bed combustion

Spokane, WA
## WtE References

- Antwerp ISVAG Belgium  2x288 ton/day  MSW
- Mannheim Germany     1x600 ton/day    MSW
- Ohtsuki Japan        2x54 ton/day     MSW
- NanShan Shenzhen China 2x400 ton/day  MSW
- Orebro Sweden        1x200 ton/day    Industrial Waste
- Bao An Shenzhen China 3x400 ton/day    MSW
- Collefero Italy      4x278 ton/day    RDF
- Modena Italy         1x540 ton/day    MSW
- Suzhou China         3x350 ton/day    MSW
- Changshu China       2x330 ton/day    MSW

- Antwerp INDAVER Belgium  1x533 ton/day  Industrial + MSW
- Kwan-Ju Korea         2x200 ton/day    MSW
- Ui-JeongBu Korea      2x100 ton/day    MSW
- Asslar Germany        2x44 ton/day     MSW
- Antwerp INDAVER Belgium  2x319 ton/day  Industrial + MSW
- Ghent IVAGO Belgium   2x139 ton/day    MSW
- MokDong Seoul Korea   2x200 ton/day    MSW
- Kempten Germany       1x194 ton/day    Biomass
- Amsdorf Germany       1x186 ton/day    RDF
WtE References

Location: Shenzhen, China
Capacity: 5 x 400 TPD
Start-up: 2004
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**Water-Cooled Grate**
  • principles
  • Examples: Modena, Italy + Amsdorf, Germany

**Boiler Prism**
  • principles
  • cases: AZN (the Netherlands) + Modena (Italy)
Grate Type as function of Heating value

SEGHERS multi-stage grate

- 2,600 – 6,600 Btu/Lb (air-cooled)
- 4,300 – 7,700 Btu/Lb (Hybrid)
- 6,500 – 12,900 Btu/Lb (water-cooled)

from 2,600 to 12,900 Btu/Lb
Main Characteristics

- Absorbed power ≈ 3% total thermal load
- Cooling water
  - temperature inlet 60 - 80 °C
  - temperature outlet 90 - 110 °C
  - pressure inlet 3 - 8 bar
- Long lifetime > 32,000 h
- Primary air for incineration only, not for grate cooling
- Closed cooling water circuit
- Long elements with few connections
- Negligible grate siftings (< 1%)
- Can be retrofitted on any grate type
Location: Modena, Italy

Capacity: 1 x 717 TPD

Heating values (HHV):
  average: 6000 BTU/Lb
  high     : 8040 BTU/Lb

Horizontal Boiler (390°C, 50 bar)

Start-up: 2006
Recent projects

Location: Amsdorf, Germany

Owner: Romonta GmbH

Capacity: 1 x 205 TPD

Heating value (HHV):
  average: 6150 BTU/Lb
  high:    7100 BTU/Lb

Horizontal Boiler (400°C, 40 bar)

Start-up: 2004
first year availability: 92.2%
## WtE Watercooled Grate Plants
### Reference List

<table>
<thead>
<tr>
<th>Place</th>
<th>Client</th>
<th>Waste type</th>
<th>Grate type</th>
<th>Calorific Value (kJ/kg)</th>
<th>No. of Lines</th>
<th>Capacity (tonnes/day) per Line</th>
<th>Thermal Power (MWth)</th>
<th>Start-up</th>
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<tbody>
<tr>
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<td>Meta</td>
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<td>SAKAB Sydkraft</td>
<td>Industrial Waste Watercooled / Aircooled</td>
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<td>2001</td>
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</table>

⇒ total number of operating hours: + 120,000

100% availability of all WC grates
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  • Keppel Corp
  • Keppel Seghers Thermal Division

Water-Cooled Grate
  principles
  cases: Modena (Italy) + Amsdorf (Germany)

Boiler Prism
  • principles
  • cases: AZN (the Netherlands) + Modena (Italy)
HT Corrosion: Definition

25 - 200°C
‘Dewpoint Corrosion’

200 - 450°C
‘Chlorine Corrosion’

450 - 600°C
‘Chlorine - Sulphate Corrosion’

> 600°C
‘Sulphate Corrosion’

Boiler Corrosion

Gas
N₂, O₂, H₂O, CO, HCl, SO₂

Solid
NaCl, KCl, ...

Liquid
KCl / FeCl₂, KCl / ZnCl / PbCl₂, ...

HT Corrosion

. 200°C < T_{metal} < 450°C
  (max. 550°C → sulphate corrosion gains importance)
. primarily chlorine corrosion
. relevant during normal operation
Less corrosion if:

1. early sulphatisation is promoted  
   (low $T_{FG}$, good mixing, sufficient oxygen & S available)

2. impact velocity & FG recirculation zones are minimised / avoided  
   (uniform flow pattern & well behaved transition 1$^{st}$ - 2$^{nd}$ pass)

3. hot spots are avoided  
   (good mixing, stable process, homogeneous waste mix)

4. volatilisation of salts is limited  
   (low $T_{furnace}$; seek reasonable burnout; operate a ‘soft’ fire)

5. chlorine contents of the waste is limited  
   (max. allowable Cl-contents ~ S, Na, K, Pb, Zn, Si ; Cl/S-ratio!)

6. flue gases & fly ash are burnt out completely  
   (avoid local lack of $O_2$ & local production of heat)
Top view SEGHERS Boiler Prism
Seghers Boiler Prism
View on Prism after 9,000 h operation
WtE Prism Plants
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<th>No. of Lines</th>
<th>Capacity (tonnes/day) per Line</th>
<th>Thermal Power (MWth)</th>
<th>new / retrofit</th>
<th>Steam Parameters (°C / barg)</th>
<th>Start-up</th>
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(1) : AC : Air Cooled / WC: Water-Cooled

⇒ combined operating experience: + 25 years
Case 1: AZN (the Netherlands)

Technical Data

- 3 x 700 TPD @ 5200 BTU/Lb
- steam at 1,450psi, 750 F
- start-up in 1997

Problems

- high flue gas temperature at inlet 2nd pass (1740 F)
- severe corrosion (roof, EVA, SH), lifetimes:
  - eva screen < 2 yrs
  - final SH < 3,5 yrs
  - frequent unplanned shut-downs
- high maintenance & repair costs
- excessive slagging (grate + SA-zone)
- availability < 7,500 hrs
Retrofit of AVI AZN-Moerdijk, Holland
Case 1: AZN: Performance Validation 1

- 8 acoustic transceivers (AGAM)
- 5.2 m above SEGHERS prism
- Implemented on all 3 lines
- 22 paths $\Rightarrow$ 22 avg. temperatures
- Cycle time: 60 - 70 sec.
- On-line 2D picture (CR)
- www.budi.de/produkte/agam
Case 1: AZN: Performance Validation 1: Results

Standaarddeviatie 15-min. gemiddelde van 13 padtemperaturen AGAM
lijn 1 & 3 op 30 juli 03

line 1 (no prism)
line 3 (with prism)
Case 1: AZN: Performance Validation 1: Results

Less corrosion if:

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6. flue gases & fly ash are burnt out completely
   (avoid local lack of $O_2$ & local production of heat)
• Corrosion rate measurements over 2 years indicate a decrease in wall thickness loss by a factor 5 - 10.

• The following additional benefits were observed:
  • 8% increase in throughput
  • 50% increase in ‘reisezeit’
  • 6% increase in availability
  • 14% decrease in maintenance costs
  • 54% decrease in natural gas consumption
  • 29% decrease in ammonia consumption

⇒ Pay Back Time of 3,1 yrs
Case 2: Modena (Italy)
Keppel Seghers
  • Keppel Corp
  • Keppel Integrated Engineering
  • Keppel Seghers Technology Portfolio
  • Keppel Seghers Thermal Division

Water-Cooled Grate
  • principles
  • case studies: Modena (Italy) + Amsdorf (Germany)

Boiler Prism
  • principles
  • case studies: AZN (the Netherlands) + Modena (Italy)

R&D Focus
• increased energy efficiency (electrical, CHP)

• reduction of boiler side corrosion

• optimised combustion concept
  (reduction pollutant load through primary measures)

• improve cost-effectiveness of flue gas cleaning components

• integrated flue gas cleaning components

• increase residue quality & re-use potential (ash & APC residues)

• novel applications for FB systems
Thank You