Recovery of resources in Bottom Ash – Second stage

ISWA Working Group, Wien, April 2015
Jens Kallesøe, Afatek A/S
Overview

1. About Afatek
2. New Recovery Standard
3. Research on metals in the fines
4. Next generation metal sorting plant
5. Recovery of minerals
6. Conclusion – How far are we?
About Afatek

- Owned by 5 public waste companies
- 30% of the DK-market – 200,000 tons of Bottom Ashes (BA)
- 4 sites for treatment of BA
- 100% is recycled: 6-7% iron, 1-2% metal, 90% minerals for road construction

1) I/S Vestforbrænding, I/S Nordforbrænding, I/S KaraNoveren, I/S AffaldPlus, I/S Refa
New Recovery Standard
What BAT could the market offer in 2011?

What we got:

- Metal sorting, 2 – 50 mm by (Eddy Current Technique)
- Recovery of stainless steel, 16 – 50 mm (Sensor Technique)
- Upgrading techniques for recovered metals
- High Quality gravel for road construction
We became able to recover more metals of all types:

- Aluminum, Copper, Zinc, Brass, Stainless Steel a.o.
- Recovery rate increased by 50% (from 1,500 to 2,240 tons/year)
- Load on natural resources decreased – Saving CO₂
- Within the next 2 years more than 90% of the potential will be recovered
Results

**NFE metal yield, [% of mass in band]**

<table>
<thead>
<tr>
<th>Size Range</th>
<th>Heavies</th>
<th>Alu</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-5 mm</td>
<td>0.5%</td>
<td>1.2%</td>
</tr>
<tr>
<td>5-10 mm</td>
<td>0.3%</td>
<td>1.3%</td>
</tr>
<tr>
<td>10-50 mm</td>
<td>0.4%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Potential (2 - 50 mm): 3.0 %, (0.5 – 2 mm): 3.0 %
Sorting efficiency: 55 % - 75 %
Upgrading of metals - Mixed metals 2 – 50 mm

Upgraded from 3% to 50% (Eddy-Current separator)

Upgraded from 50% to 90% (Mechanical/EC separators)
Upgrading of metals - Stainless Steel 8-50 mm

Upgraded from 1 % to 15 % (Sensor machine with air jets)

Upgraded from 15 % to 95 % (Crushing, screening, magnet, EC)
Recovery of metals from the fines
Development of separation technology – supported by the Danish EPA

Metal recovery from fine BA – Development and Demonstration Programme 2014:

- Develop separation technology for fine metals
- Establish commercial metal potential
- Establish relation between metal yield and moisture content in fine bottom ash

![Graph showing size distribution of bottom ash particles with labels: 2% yesterday's standard, 19% new standard, and 24% next generation.](image)
Wissensforum

Development of separation technology – supported by the Danish EPA

Temperature

Screening efficiency

Water content

Sorting efficiency

4.500 x 24/2 x 1/60 = 900 Hz
(4.800 x 36/2 x 1/60 = 1.440 Hz)

4 month

3 month

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Development of separation technology – supported by the Danish EPA

Level and Composition

NFE metals in band, [% of dry matter] 900 Hz

<table>
<thead>
<tr>
<th>Size</th>
<th>Light [%]</th>
<th>Heavy [%]</th>
<th>Gnmsn. [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-1 mm</td>
<td>0.32%</td>
<td>0.19%</td>
<td>0.52%</td>
</tr>
<tr>
<td>0.5-1 mm</td>
<td>0.31%</td>
<td>0.14%</td>
<td>0.52%</td>
</tr>
<tr>
<td>0.5-1 mm</td>
<td>0.38%</td>
<td>0.22%</td>
<td>0.52%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0.80%</td>
<td>0.68%</td>
<td>1.10%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>1.08%</td>
<td>0.48%</td>
<td>1.10%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0.44%</td>
<td>0.37%</td>
<td>1.10%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0.28%</td>
<td>0.24%</td>
<td>1.10%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0.38%</td>
<td>0.37%</td>
<td>0.90%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0.43%</td>
<td>0.40%</td>
<td>0.90%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0.80%</td>
<td>0.61%</td>
<td>0.90%</td>
</tr>
<tr>
<td>1-2 mm</td>
<td>0.31%</td>
<td>0.31%</td>
<td>0.90%</td>
</tr>
<tr>
<td>2-4 mm</td>
<td>0.52%</td>
<td>0.52%</td>
<td>0.52%</td>
</tr>
<tr>
<td>2-4 mm</td>
<td>1.10%</td>
<td>1.10%</td>
<td>1.10%</td>
</tr>
<tr>
<td>2-4 mm</td>
<td>1.10%</td>
<td>1.10%</td>
<td>0.90%</td>
</tr>
<tr>
<td>2-4 mm</td>
<td>0.90%</td>
<td>0.90%</td>
<td>0.90%</td>
</tr>
</tbody>
</table>

Melting results

NFE metals in band [% of dry matter] 900 Hz

<table>
<thead>
<tr>
<th>Size</th>
<th>Blandet 1-2 mm</th>
<th>Vest 14 2013 1-2 mm</th>
<th>Vest 14 2013 2-4 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Au</td>
<td>0.0000%</td>
<td>0.0000%</td>
<td>0.0000%</td>
</tr>
<tr>
<td>Ag</td>
<td>0.0013%</td>
<td>0.0007%</td>
<td>0.0006%</td>
</tr>
<tr>
<td>Sb</td>
<td>0.0004%</td>
<td>0.0002%</td>
<td>0.0002%</td>
</tr>
<tr>
<td>Ni</td>
<td>0.0010%</td>
<td>0.0005%</td>
<td>0.0008%</td>
</tr>
<tr>
<td>Mn</td>
<td>0.0055%</td>
<td>0.0032%</td>
<td>0.0020%</td>
</tr>
<tr>
<td>Pb</td>
<td>0.0559%</td>
<td>0.0316%</td>
<td>0.0307%</td>
</tr>
<tr>
<td>Zn</td>
<td>0.0087%</td>
<td>0.0091%</td>
<td>0.0138%</td>
</tr>
<tr>
<td>Cu</td>
<td>0.1988%</td>
<td>0.1526%</td>
<td>0.0982%</td>
</tr>
<tr>
<td>Al</td>
<td>1.0224%</td>
<td>0.5952%</td>
<td>0.8249%</td>
</tr>
</tbody>
</table>
How can we control moisture content?

In 2015 85% of the ash is discharged by use of a pusher => option for semi-dry /dry ash.

Vestforbrænding - pusher
- Ovn 6: Fisia Babcock pusher
  - Pusher
  - Kort opholdstid i vand
  - Vand presses ud

Refa - vandbad
- Ovn 6: Vølund, lameltransportør
  - Vandbad
  - Lang opholdstid i vand
  - Slaggen kædes op – dårlig dræning

BA discharge systems

In 2015 85% of the ash is discharged by use of a pusher => option for semi-dry /dry ash.
Next Generation Sorting Plant
New sorting plant ver. 2.0

- 3 lines for fine bottom ash: 0.5 - 4 mm
- 3 lines for coarse bottom ash: 4 - 50 mm

JENS KALLESØE, AFATEK A/S  |  "RECOVERY OF RESOURCES IN BOTTOM ASH – SECOND STAGE"  MAY 2015
New sorting plant ver. 2.0

**Key figures - equipment:**
- single deck flip-flow screens
- eddy current separators for NFE recovery with magnets for ferrous recovery and ferrous-oxide by-pass
- sensor machines for recovery of Stainless Steel and FE+NFE residues
- wind sifters for removal of not burned paper and plastics
- control of dust

**Key figures - economy:**
- Capacity: 100 tons/h (pre-sorted bottom ash)
- Investment: 7 mill Euro
- NFE recovery (180,000 t/y): 2,500 t/y = 2,7 mill Euro/y
- NFE recovery (250,000 t/y): 3,500 t/y = 3,7 mill Euro/y
- Gate Fee: 10 Euro/ton
RECOVERY OF MINERALS
According to “Indbygningsforskrift for slagge i vejbygning, marts 2012”, the following tests should be carried out:

- Total Organic Content (TOC): DS/EN 13137

Result is:

- Since march 2012 all deliveries of BA gravel from Afatek is declared
- Information about the construction product is now available for both the constructor and the controlling authority
BA gravel in roads – unlimited?

Test road Nordhavn, Copenhagen
- Present: Limited traffic load
- Future: Unlimited traffic load
- Revision of standard for construction of roads, the Danish Road Directorate
CONCLUSION
Conclusion

- We are close to recover metals in 90 % of the BA (wet/dry ash)
- BA gravel is a valuable resource in road construction
- Viable, in terms of both economy and environment
Where are we in the circular economy?
Access to further information:

Learn more about Afatek and our projects at www.afatek.dk - here you will also find access to our results and reports.

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