Bottom Ash Treatment – „State-of-the-art“ in Germany

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Agenda

► Metal in Waste
► Bottom Ashes
► Methods
► Results
  • Inputs
  • State-of-the-art of bottom ash treatment in Germany
  • Metal qualities
► Conclusions
Bottom ashes

- Long tradition in waste incineration: first plant on the European continent Hamburg 1896
- About 24 Mio Mg/a of waste is incinerated in Germany
- About 5 Mio Mg/a of MSWI bottom ashes
- Recovery of metals
- Utilization of mineral material
- Lack of data on current recovery rates, especially nf metals, state-of-the-art
Metal recovery from bottom ashes from waste incineration – evaluation of the resource efficiency

- Resource potential bottom ashes – waste composition
- Resource efficiency state-of-the-art bottom ash treatment and mechanical waste treatment
- Estimation of the quality of metals
- Evaluation of the resource efficiency
Climate protection potential
Metal recovery

<table>
<thead>
<tr>
<th>Material</th>
<th>kg CO2 Eq/Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>945</td>
</tr>
<tr>
<td>Copper</td>
<td>2106</td>
</tr>
<tr>
<td>Aluminum</td>
<td>9307</td>
</tr>
<tr>
<td>Stainless steal</td>
<td>3096</td>
</tr>
<tr>
<td>“metal mix BA&quot; (80% Fe, 12% Al, 4% Cu, 4% VA)</td>
<td>2081</td>
</tr>
</tbody>
</table>
Metal Potential in Waste
Resource potential

Residual waste in Germany

Metal content [%]


Metal: Metalle, Fe, NE

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MSW Composition in Europe

MSW Composition of the researched Countries (%)

<table>
<thead>
<tr>
<th></th>
<th>A-14</th>
<th>Median</th>
<th>MIN</th>
<th>MAX</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Material</td>
<td>34.1</td>
<td>34.5</td>
<td>23.7</td>
<td>47.7</td>
<td>6.83</td>
</tr>
<tr>
<td>Paper and Cardboard</td>
<td>21.8</td>
<td>19.8</td>
<td>11</td>
<td>40</td>
<td>6.93</td>
</tr>
<tr>
<td>Plastic</td>
<td>11.5</td>
<td>11.5</td>
<td>1</td>
<td>19</td>
<td>1.05</td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td><strong>3.5</strong></td>
<td><strong>3.25</strong></td>
<td><strong>2</strong></td>
<td><strong>6</strong></td>
<td><strong>1.05</strong></td>
</tr>
<tr>
<td>Glass</td>
<td>6</td>
<td>5.8</td>
<td>2.3</td>
<td>11</td>
<td>2.11</td>
</tr>
<tr>
<td>Others</td>
<td>23.1</td>
<td>25.85</td>
<td>7</td>
<td>33</td>
<td>8.31</td>
</tr>
</tbody>
</table>
Methodology

► Questionnaires to all German bottom ash treatment plants
► Cooperation with IGAM (German association of bottom treatment plants)
► Cooperation with ITAD (German association of waste incineration plants)
► Cross-check possibility
► 24 questionnaires from bottom ash treatment plants
→ 25 answers from incineration plant

4,2 Mio. Mg
Methodology

Aspects of the questionnaire:

► Input/ Output

► Origin of bottom ashes

► Technique of treatment of bottom ash

► Quality and characteristics of different metals
State-of-the-art bottom ash treatment

- Bottom ash
  - Sieving different grain sizes
    - Air separation
      - Magnet separator
        - Nf separator
          - Coarse fraction
            - Coarse
            - nf
            - mineral aggregate
            - iron
            - fine fraction
  - > 45 mm
  - < 2 mm
Ageing of bottom ashes

Ageing before treatment [weeks]

Number of plants

- frisch
- 2-4
- 4-6
- 6-8
- 8-10
- 10-12
- ohne Angabe

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Iron recovery

Iron separator
Non ferrous metals

nf recovery

nf separator
Metal qualities extractes from bottom ash

- iron coarse
- iron medium
- iron small
- stainless steel
- brass
- copper
- mixed metal different grain size
- e-motors
- aluminium
Bottom ash treatment results

- Iron: 7.7%
- Foreign matter: 1.3%
- Unburnt: 0.9%
- Mineral aggregate: 89%
## Recovery rates Germany

<table>
<thead>
<tr>
<th></th>
<th>complete</th>
<th>iron</th>
<th>nf</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovered from total BA amount</td>
<td>10,9 %</td>
<td>2,4 %</td>
<td></td>
</tr>
<tr>
<td>Recovery rate</td>
<td>114 %</td>
<td>116 %</td>
<td>104 %</td>
</tr>
<tr>
<td><strong>Best with foreign matter</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovered from total BA amount</td>
<td>10,7 %</td>
<td>1,7 %</td>
<td></td>
</tr>
<tr>
<td>Recovery rate</td>
<td>106 %</td>
<td>114 %</td>
<td>74 %</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovered from total BA amount</td>
<td>7,9 %</td>
<td>1,7 %</td>
<td></td>
</tr>
<tr>
<td>Recovery rate</td>
<td>82%</td>
<td>84 %</td>
<td>74 %</td>
</tr>
</tbody>
</table>
## Metal Recovery Rates Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Recovery Rate (%)</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>63</td>
<td>BMLFUW (2015); CEWEP (2014)</td>
</tr>
<tr>
<td>Belgium</td>
<td>78</td>
<td>Hoornweg, Bhada - Tata (2012); Van Brecht et al. (2012)</td>
</tr>
<tr>
<td>Denmark</td>
<td>25</td>
<td>Hoornweg, Bhada - Tata (2012); B&amp;W Vølund (2014)</td>
</tr>
<tr>
<td>Finland</td>
<td>51</td>
<td>Hoornweg, Bhada - Tata (2012); CEWEP (2014)</td>
</tr>
<tr>
<td>France</td>
<td>73</td>
<td>ADEME (2010); AMORCE (2012)</td>
</tr>
<tr>
<td>Germany</td>
<td>82</td>
<td>Kuchta, Enzner (2015)</td>
</tr>
<tr>
<td>Italy</td>
<td>65</td>
<td>ISPRA (2015); Amato (2013)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>61</td>
<td>Corsten et al. (2013); CEWEP (2013)</td>
</tr>
<tr>
<td>Norway</td>
<td>68</td>
<td>Avfall Norge (2015); CEWEP (2012, 2013)</td>
</tr>
<tr>
<td>Portugal</td>
<td>46</td>
<td>Viegas (2012); CEWEP (2014)</td>
</tr>
<tr>
<td>Spain</td>
<td>49</td>
<td>Andrés Pastor, Rodríguez Perez (2008); Gallardo et al. (2011); CEWEP (2012)</td>
</tr>
<tr>
<td>Sweden</td>
<td>58</td>
<td>Blomqvist (2012); Grönholm (2016)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>64</td>
<td>Hoornweg, Bhada - Tata (2012); Bunge (2015)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>39</td>
<td>Wrap (2010); Zero Waste Scotland (2010); arc21 (2014); Defra (2015); Willows Power &amp; Recycling Centre (2015)</td>
</tr>
</tbody>
</table>

Amount of recovered metals based on data from:
- a study for a single plant / a single plant operator
- a study for a number of different plants
- a study referring to the whole country
Metal Recovery Rates from BA

Calculated based on:

- the concentration of metals in the MSW
- the percentage of recovered metals from the BA

Actual recovery rates may differ due to:

- No actual MSW composition in some cases
- metal recovery data from single treatment plants affecting the representativeness
Particle Size Treated and Metal Recovery

- Particle size limit (mm)
- Recovered metals (% of MSW)
Non ferrous metals
particle size

- Copper
- Brass
- Aluminum
Conclusion

► Advanced technology is applied

► Ø 5 magnet separators for 7.7% iron

► Ø 5 eddy current separators for 1.3% nf

► 89% remaining as mineral material, 0.9% organic matter
Thank you for your attention