Environment

Recovery of Precious Metals from Incineration Bottom Ash (RecuLAB™ Au)
The requirements of the circular economy

- Modern society expects solutions to further reduce waste and to better re-use waste materials
- WTE is a quite accepted solution to thermally exploit waste materials
- Final residues can be further processed and prepared for an alternative re-use
- Saving, reducing and decontamination of landfill space
- CO$_2$ footprint reduction on metals and minerals side
- Improving total economics for WTE plant owner / operator, community as well as society
Agenda

- Incineration bottom ash – a short characterization
- Recovery of precious metals from incineration bottom ash
- Way forward – discussion and conclusions
Characterization of incineration bottom ash

- After municipal solid waste (MSW) is treated at a waste-to-energy (WTE) plant, 20 – 25% of the incinerated waste (by weight) remains as gravel-like incineration bottom ash (IBA)
- Major oxides (Al, Fe, Si, Ca) found in IBA sum up to about 45 – 55%
- Additionally, IBA minerals typically contain about 10% - 15% of metals, 10% - 15% of glass and 3% - 5% of ceramics
- Particle and bulk density of IBA is typically 50 – 90% of natural gravel aggregates
- Grading of IBA typically shows that about 25% of the material is < 2 mm and 95% < 65 mm
- The dominant part of the heavy metal, organic and salt contamination can be found in the IBA particles sized < 2 mm
- After storing and weathering, IBA can be processed in a repeatable manner to standardize the material and remove contaminants and recover valuables
- IBA can be used as an artificial aggregate in various application
Macroscopy of IBA

- Mineral coarse (> 4 mm): 32.0%
- Mineral fine (< 4 mm): 15.4%
- Glass (> 4 mm): 43.4%
- Ceramics (> 4 mm): 5.2%
- Ferrous (> 4 mm): 1.3%
- Non-ferrous (> 4 mm): 2.7%

Mineral coarse, Mineral fine, Glass, Ceramics, Ferrous, Non-ferrous
Microscopy of IBA

- An inhomogeneous conglomerate of materials, containing relatively pure glass fractions, ceramics dominated by calcite, quartz and feldspar and minerals dominated by quartz, calcite and melilite.
Grading vs. contamination of IBA

Contamination load (aggregated)

Grading (aggregated)

Pass-Through (%) of total volume

Mesh Size (mm)

0.06125 0.125 0.25 0.5 1 2 4 8 16 31.5 45 63

0 20 40 60 80 100
Contamination per IBA particle size (I/II)
Contamination per IBA particle size (II/II)
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State of the art in IBA metal recovery

- Typically, the treatment of matured IBA is performed offside the premises of a WTE plant.
- Traditionally, the recycling processes for matured IBA is based on crushing and fractioning to allow for the usage of magnet and eddy-current systems for the recovery of ferrous and non-ferrous metals.
- Since 2007, sensor-based sorting devices allow the recovery of alloyed steels and encapsulated metals, enabling another value creation.
- Today, applying latest fractioning systems, a modern IBA recycling system can recover metal particles > 1 mm.
- The LAB Geodur RecuLAB™ NF process for the treatment of matured IBA comprehends leading edge, best available technologies for the treatment of such IBA materials > 1 mm.
- Sales revenues for non-ferrous metals are in Europe in a range of up to 25.- € / to fresh IBA.
RecuLAB™ NF process focus

Metal recovery focus
- Quantity: Increased efficiency on recovery rate (up to 99%) and recovery bandwidth (> 1 mm)
- Quality: Sorting effectiveness and pureness of metals (all metals, even bound in mineral matrix)

Landfill focus
- Volume reduction: Sustainability and protection of landfill space (up to 100% re-use)
- Contamination: Reduction of chemical load in landfill (by up to 100%)

Construction material focus
- Chemical: Reduction of oxidation, carbonization, gas building and leaching
- Physical: Creation of visually attractive secondary construction material within defined construction material specifications
RecuLAB™ NF process flow

Removal of contamination, recovery of metals and proper grading

IBA maturing

Screening

Ferrous / non-ferrous scrap metal removal

Oversized / unburnt material removal

Ferrous metal removal fine

Wind shifting / screening

Crushing

Sorter

Ferrous scrap metal

NF scrap metal

Bulky waste material

Ferrous minerals removal

Ferrous minerals fine

NF metal coarse

NF metal mid

NF metal fine

Non-ferrous metal removal mid-fraction

Minerals fine

Minerals mid
Advantages of RecuLAB™ NF process

- Maximum metal recovery > 1 mm (matured ash)
  - Maximum value creation
  - Minimum leachate of residual minerals
  - Direct commercialization by LAB Geodur

- Minimum crushing of minerals
  - Maximum re-use potential as alternative construction material
  - Minimum dust building
  - Minimum wear

- Successful implementation in different ash treatment sites
Impressions of RecuLAB™ NF treatment site
Impressions of RecuLAB™ NF treatment site
RecuLAB™ Au for treatment of fresh IBA

- Fresh, wet discharged IBA can not be treated easily:
  - High moisture content and large mount of adhesive fine particles hinders an effective recovery of metals and produces recovered metals with high mineral contamination
  - Non-continuous infeed (intermitted quenching process) produces complicated, irregular working conditions for metal recovery equipment
  - Space availability on WTE plant premises is typically limited

- BUT, if the precious and heavy non-ferrous metals in the fraction < 2 mm could be recovered, the revenue potential from non-ferrous metals in fresh IBA could be increased by another 25 – 50%

=> RecuLAB™ Au: LAB Geodur fine ash recycling module for wet discharge systems
RecuLAB™ Au for wet discharged IBA

- Out of 100,000 to of fresh IBA, the following volumes of non-ferrous and precious metals can be recovered in the fraction < 2 mm

  - Au: 25 – 40 kg
  - Ag: 550 – 650 kg
  - Cu: 140 – 180 to
  - Zn: 120 – 200 to

- Other precious metals (Pt, Pd, Cr, Ni, Mo, …)

RecuLAB™ Au cornerstones

- **ONLINE, ONSITE, WET** pre-treatment of wet discharged, fresh IBA, special processing technologies for the fraction < 2 mm;
- Modular concept, e.g. easy integration into existing IBA recycling site, unchanged use of installed IBA recycling technologies for treatment of fraction > 2 mm (optionally updating);
- Small footprint for infeed / outfeed storage through timely processing of IBA;
- Massively reduced dust emissions, also for subsequent conventional treatment of fraction < 2 mm;
- Closed-loop process water management, no waste water expected;
- Improved metal quality in all fractions resulting in higher sales revenues;
- Increase metal recovery rates in fraction > 2 mm as better working conditions for eddy-current systems;
- Further re-use of treated mineral fractions as secondary construction materials if possible
RecuLAB™ Au main modules

- Concentration
- Infeed
- Water treatment
- Fractioning
RecuLAB™ Au integrated into RecuLAB™ NF

WTE plant as is

- Wet discharger

Pre-treatment module (onsite, near quencher)

- 0 – 500 mm
- 0 – 2 mm
- 2 – 100 mm

Fines separator and NF / precious metals agglomerator

RecuLAB™ NF

IBA treatment module > 2 mm (onsite or offsite)

- Hand picking
- 100 mm

- Ferrous scrap
- NF scrap
- Stainless scrap
- NF metals fine
- NF metals medium
- NF metals coarse
- Stainless medium
- Ferrous medium

Concentrator module (centralized, onsite or offsite)

- Metal concentrator

RecuLAB™ Au

- NF and precious metals very fine
RecuLAB™ Au synergy effects for WTE plant

- **Operations:**
  - Regular operation of WTE plant not disturbed
  - Operation with existing operations team
  - Improved working conditions through dust reduction and simplified processing
  - Omission of ash storage for maturation, with this reduced footprint requirements for IBA treatment

- **Investments:**
  - Abandonment for retrofitting in aspiration and dedusting systems
  - E.g. Leasing or JV model for RecuLAB™ Au treatment module
  - Updating of modern metal recovery systems for ash fraction > 2 mm

- **Revenues:**
  - Increased recovery volumes and qualities of existing ash treatment facility
  - Higher metals sales revenues for NF fractions
Contamination of washed ash (I/II)
Contamination of washed ash (II/II)
Contamination of washing water

Pure IBA

Combined ash
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Plants in realization phase
Linthgebiet (CH)

General data
- Place: KVA Niederurnen (CH)
- Customer: Zweckverband Linth
- Contractor: LAB GmbH

Technical data
- Type of plant: Incineration Bottom Ash Treatment Plant
- Technology: RecuLAB™Au
- Type contract: Rent-Buy
- Capacity: 20 t/h
- Raw material: Fresh ash
Plants in realization phase
Linthgebiet (CH)

KVA Niederurnen (Switzerland)
Retrofit of RecuLAB™ Au Module

Capacity: 32,000 t/y
Fraction: 0 – 2 mm
Owner: LAB GmbH
HNF-Metal Trading: LAB GmbH
Commissioning: Jan. 2016
Plant in realization phase
Linthgebiet (CH)
Cornerstones of business model (e.g. rental model for stand-alone situation)

- Leasing model: First down payment e.g. 50%, constant monthly leasing rates, 10 years term
- IBA to be processed: >> 50.000 t / a
- Recoverable metal concentrate < 2 mm: ca. 0.3%
- Sales revenues for metal concentrate: ca. 2’700.- €/t
- Operations cost:
  - Staff: existing
  - Power: 56 kW (50 t/h module)
  - Water: closed loop + 0.5 m³/h
  - Repair and wear: 1% of first down payment
  - IBA disposal cost: unchanged

- WTE plant owner operates fine IBA treatment system with existing staff, coverage of operations, financing cost etc.

- 85% of metal concentrate sales revenues for WTE plant owner, 15% for LAB Geodur as handling fee for commercialization of metal concentrates (open book)

- Operation of fine IBA treatment system remotely supervised by LAB Geodur
# Roles and responsibilities

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<tr>
<th>Role</th>
<th>WTE plant</th>
<th>LAB Geodur</th>
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<tbody>
<tr>
<td>Engineering / permitting</td>
<td>Adaptations and permitting</td>
<td>Planning and integration</td>
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<td>Installation / commissioning</td>
<td>Provision of space, connection of media and power</td>
<td>Installation, commissioning, training</td>
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<td>Financing</td>
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<td>Leasing model / Rental model</td>
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<tr>
<td>Operations</td>
<td>Operation with existing staff</td>
<td>Metal concentrate trading</td>
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<td>Invoicing</td>
<td>Open book, distribution key for metal concentrate revenues</td>
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<tr>
<td>Duration</td>
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<td>10 years</td>
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Timing for RecuLAB™ Au and NF modules

<table>
<thead>
<tr>
<th>Month</th>
<th>Decision of WTE plant</th>
<th>Contract signing / ordering</th>
<th>Permitting</th>
<th>Preparation, adaptation</th>
<th>Installation, training</th>
<th>Commissioning, operation</th>
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Wrap-Up

- Base cornerstone for circular economy as there is a good potential for complete recovery of valuable materials from IBA for re-use (metals, minerals, glass)

- Important value creation for WTE plant owner / operator

- Important step to make for increase of acceptance
  - Inform openly about risks and opportunities
  - Give good examples
  - Walk the talk
  - Step-by-step
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