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Feniks Recycling

AFVALZORG

Long term stabilization of Sb in MSWI bottom ash

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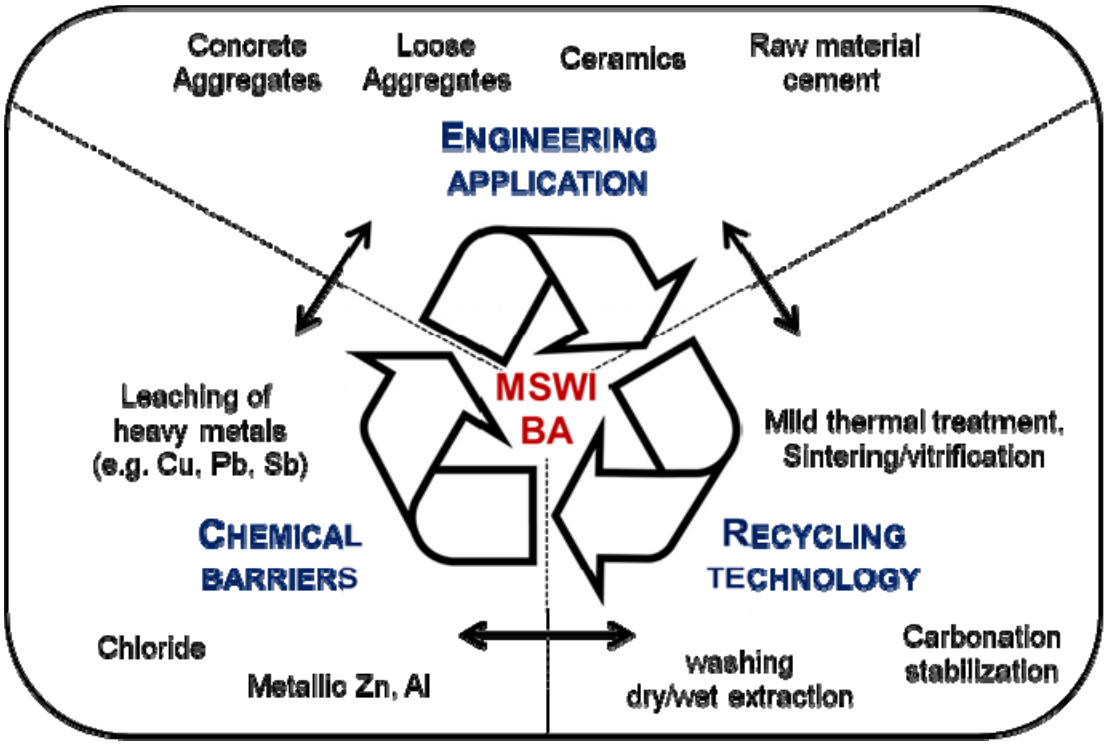
Cyprus 2016 conference, 23/06/2016

MSWI Bottom Ash



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MSWI Bottom Ash

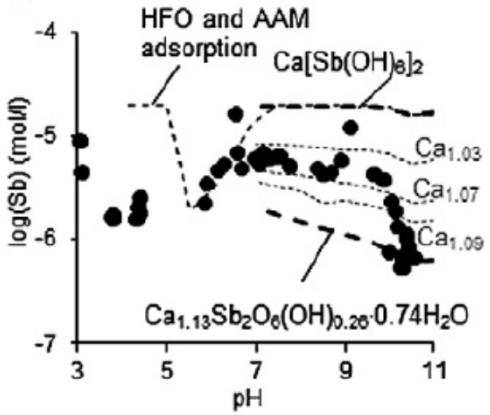
- Each application: specific chemical barrier
- Most barriers can be overcome!

- Some problems remain, or more strict legislation

- Netherlands: Green Deal
  - By 2017: 50% of BA in applications without protective measures
  - By 2020: No more use in applications with protective measures
  - Enhanced recovery of NF metals

  - Most problematic: leaching of Sb

Sb leaching



- Sb leaching known to be governed by:
  - Formation of calcium antimonates (romeites)[1]
  - Adsorption to iron (hydr)oxides
  - Formation of iron antimonate (tripuhyite, $FeSbO_4$)[2]
  - (Incorporation in ettringite)
  - All pH dependent!

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1: Cornelis et al..: Antimony leaching from MSWI bottom ash: Modelling of the effect of pH and carbonation. Waste Management 32, 278-286 (2012)

2: Okkenhaug et al..: Treatment of air pollution control residues with iron rich waste sulfuric acid: Does it work for antimony (Sb)? Journal of Hazardous Materials 248, 159-166 (2013)

Reduce Sb leaching

- Based on these mechanisms: addition of
  - Fe- and Ca- salts
  - Industrial waste streams containing Fe- and Ca-salts
- Experimental
  - Short term leaching behavior
    - Lab batch tests
  - Middle-long term leaching behavior
    - Outdoor field tests
  - Long term leaching behavior
    - Lab carbonation tests

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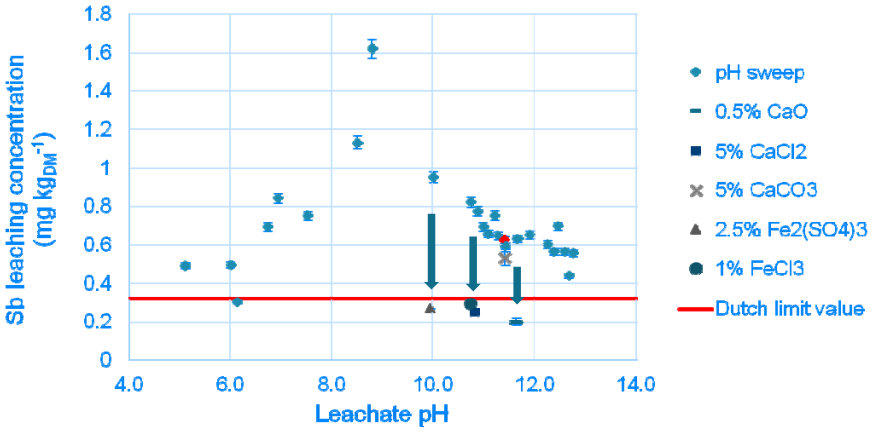
Short term leaching behavior

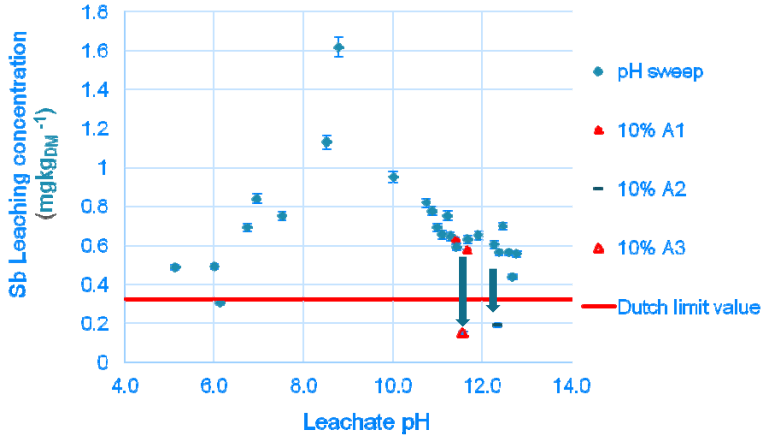
- pH dependent leaching behavior

- Addition of:

Fe- and Ca-containing compounds



Fe- and Ca-containing industrial residues (10%)



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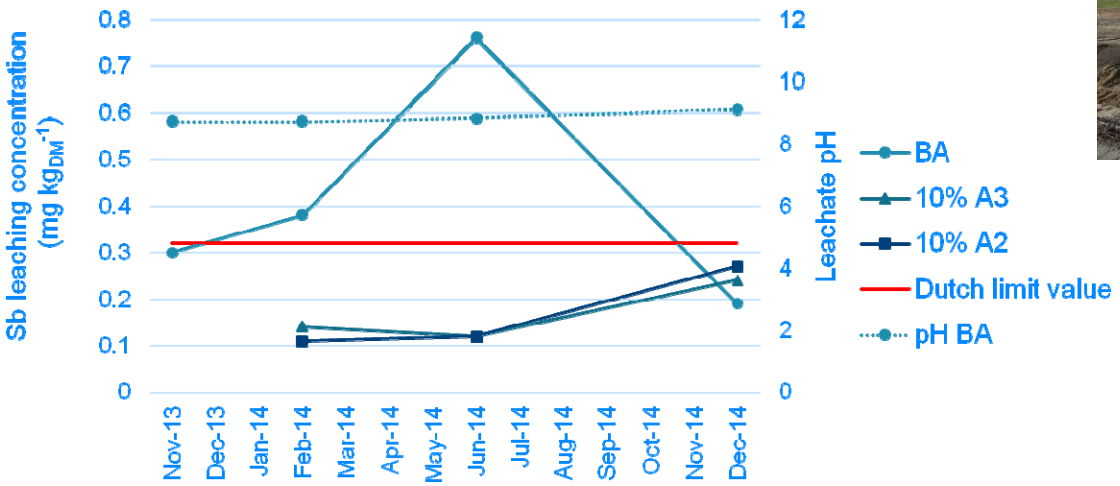
Short term leaching behavior

- Additives:
  - Ca-compounds
    - CaO, $CaCl_2$: formation and precipitation of romeites
    - $CaCO_3$: less soluble, no precipitation
  - Fe-compounds
    - Formation of tripuhyite
  - Industrial residues
    - Formation of Ca-antimonates (A2, A3: soluble Ca-compounds)
    - No adsorption on iron oxides (A1: no soluble Ca-compounds, iron oxides)

Middle-long term leaching behavior

- Outdoor field tests



- Sb concentrations initially decreased
  - Lower than untreated BA & regulatory limit value
- Increase slightly over time as pH decreases
  - Romeites become more soluble at lower pH values

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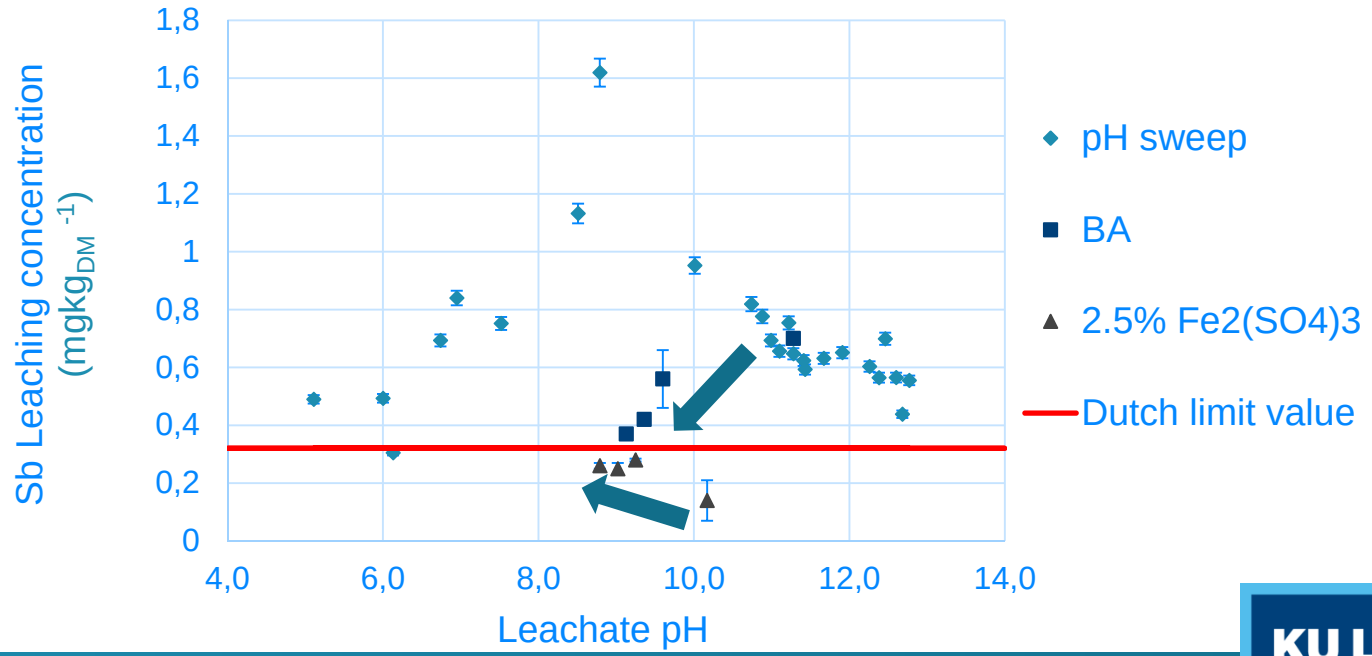
Long term leaching behavior

- Carbonation
  - BA: decreasing
  - $Fe_2(SO_4)_3$: initially lower, increasing



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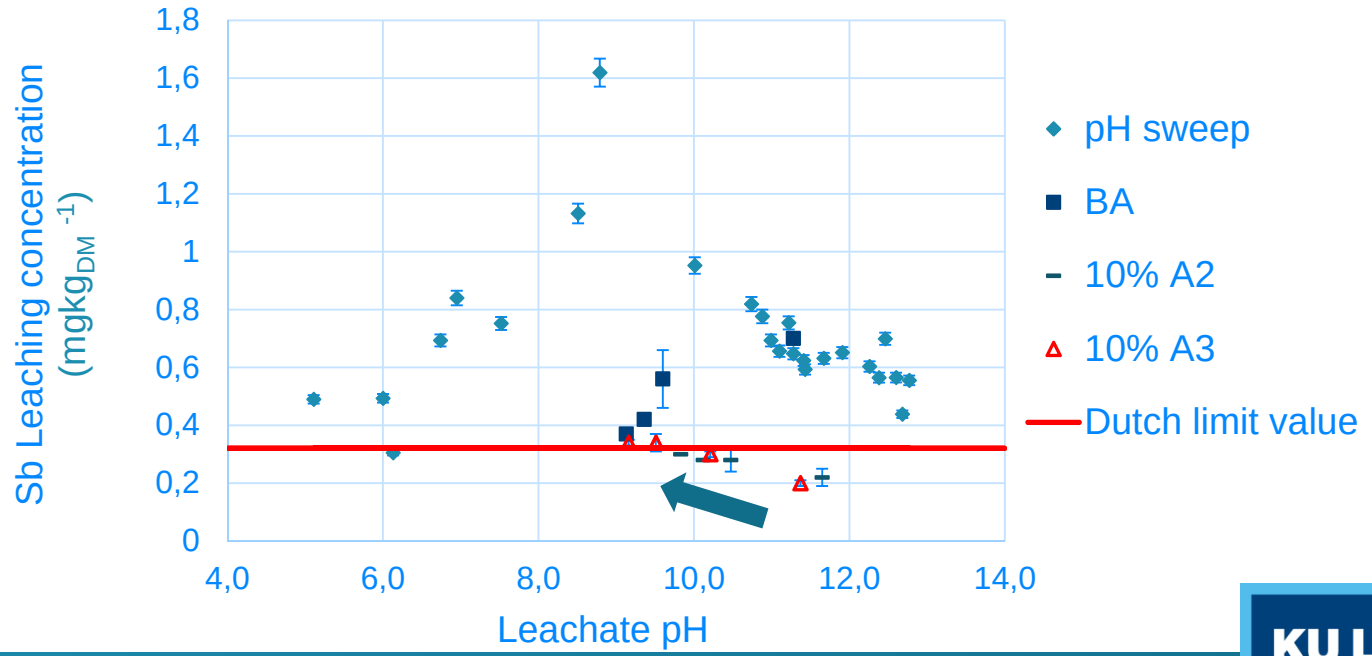
Long term leaching behavior

- Carbonation
  - A2: initially lower, increasing, below limit value
  - A3: initially lower, increasing, around limit value



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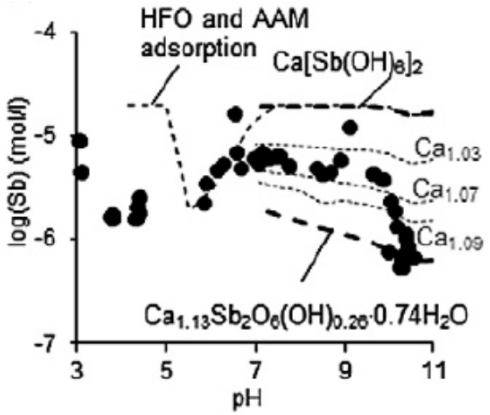
Long term leaching behavior

- Sb leaching from treated BA increasing after carbonation
  - Romeites more soluble at lower pH[1]



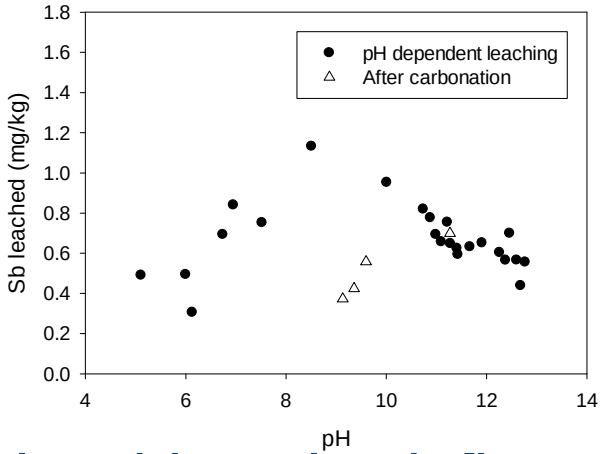
- Sb leaching from untreated BA decreases after carbonation
  - Can not be explained by 4 mechanisms

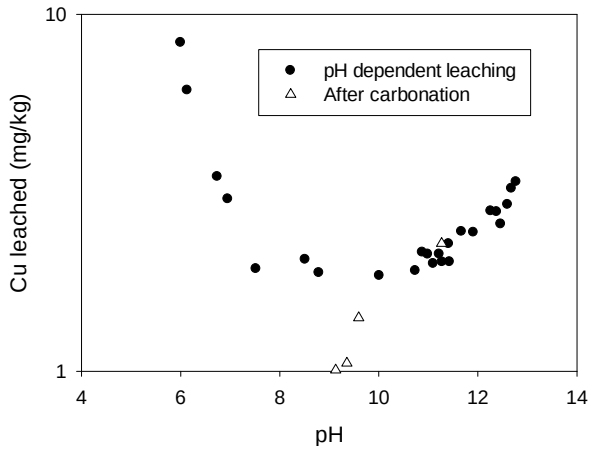
1: Cornelis et al..: Antimony leaching from MSWI bottom ash: Modelling of the effect of pH and carbonation. Waste Management 32, 278-286 (2012)

Additional tests

- Explain Sb leaching from untreated BA after carbonation
- Leaching behavior similar to Cu leaching

Sb





Cu

- Sb leaching also influenced by organic acids?
  - Sb known to form complexes with organic acids[3]
  - Heat treatment (400°C, 30 min)
  - Addition of activated carbon

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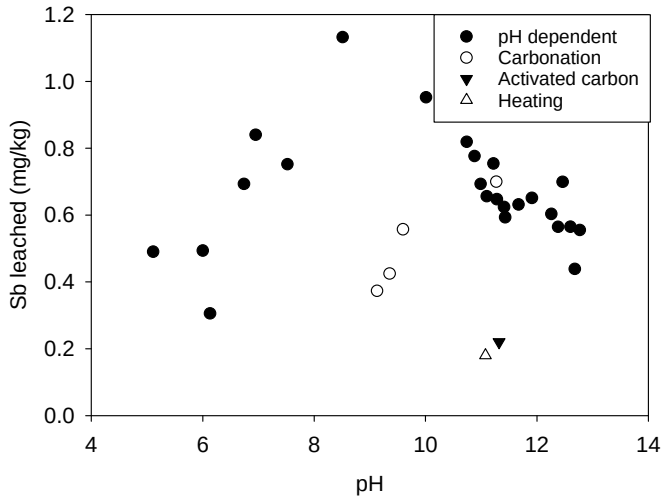
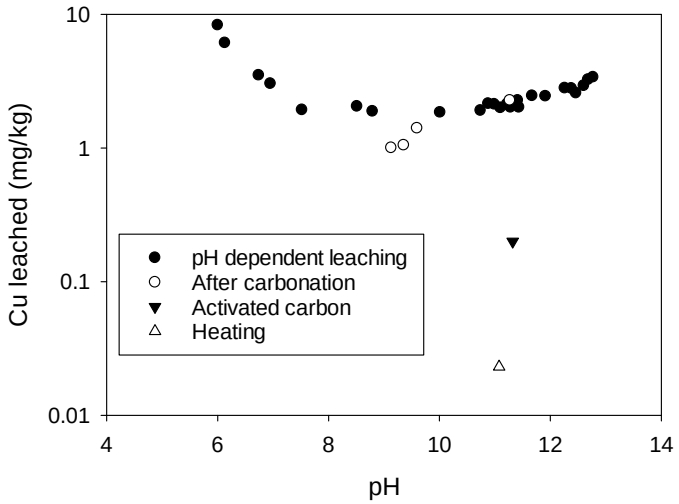
3: Steely et al.: An investigation of inorganic antimony species and antimony associated with soil humic acid molar mass fractions in contaminated soils. Environmental Pollution 148, 590-598 (2007)

Additional tests

Leaching behavior after heat treatment and AC addition

Sb





Cu

- Behavior similar to Cu
  - AC addition: adsorption of complexes on AC
  - Heat treatment: decarboxylation of organic acids
  - Carbonation: adsorption of organo-metallic complexes[4]?

4: Arickx et al..: Effect of carbonation on the leaching of organic carbon and of copper from MSWI bottom ash. Waste Management 30, 1296-1302 (2010)

Conclusions

- Sb leaching from MSWI BA can be reduced by addition of chemical compounds and Ca- and Fe-containing industrial residues

- Effect of addition endures in middle-long and long term leaching experiments

- More insight is gained in mechanisms governing Sb leaching from MSWI BA:
  - Plausible that organic matter plays a role
  - Influence needs to be further investigated

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Thank you!

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