INVESTIGATION OF HEAVY METAL RELEASE AT A MUNICIPAL SOLID WASTE INCINERATION FACILITY – AN EXCELLENT EXAMPLE FOR THE UNIQUE POTENTIAL OF INTRINSIC RADIOTRACER APPLICATION TO THE INVESTIGATION OF INDUSTRIAL PROCESSES IN CHEMICAL ENGINEERING

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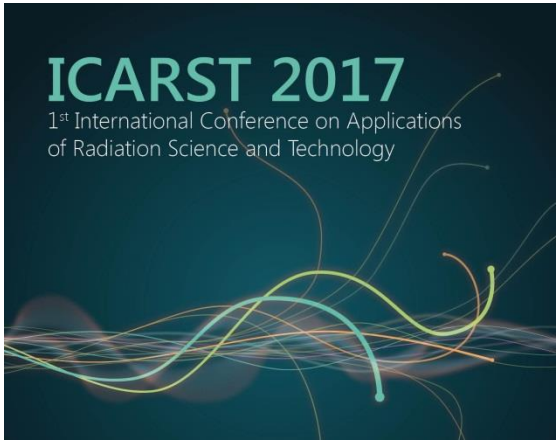

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What is a (radio)tracer?

One of the much available definitions:

„An identifiable substance, such as a dye or a radioactive isotope, that is introduced into a biological or mechanical system and can be followed through the course of a process, providing information on the pattern of events in the process or on the redistribution of the parts or elements involved.“

Tracers

Extrinsic
(or physical)

Intrinsic
(or chemical)

<u>Extrinsic</u> tracers are often sufficient for industrial application

BUT NOT

for the investigation of phase transfer!

Starting position

Quality of municipal solid waste incineration (MSWI) residues (**bottom ash, fly ash**) **is unsatisfactory**

!!! HEAVY METALS !!!

↓

Simple reuse of mineral residues is a problem
(without any further processing)

Proposal for solution

Separation of heavy metals already during the incineration process!!!

Reduction of the heavy metal content **in the bottom ash** by volatilization of them by primary measures

➔ **Enrichment** of heavy metals **in the fly ash**

Advantages:

- **simple reuse of bottom ash** (without additional processing)
- **retrieval of heavy metals** from the fly ash

Problem of heavy metal separation in MSWI

problematic heavy metals:

Zn, Pb, Cu

more or less volatile | **nearly non-volatile**

Detail of the nuclide chart

Black boxes: stable isotopes contained in the natural isotope mixture

Red boxes: positron (and gamma radiation) emitters

Blue boxes: electron (and gamma radiation) emitters

Problem of heavy metal separation in MSWI

problematic heavy metals:

Zn, Pb, Cu

more or less volatile

$^{68}Zn(n,\gamma)$ ^{69m}Zn

$T_{1/2} = 13.8h$

$E_\gamma = 439$ keV

metal sheets

(1 - 2 mm)

nearly non-volatile

$^{63}Cu(n,\gamma)$ ^{64}Cu

$T_{1/2} = 12.7h$

$E_\gamma = 511$ keV

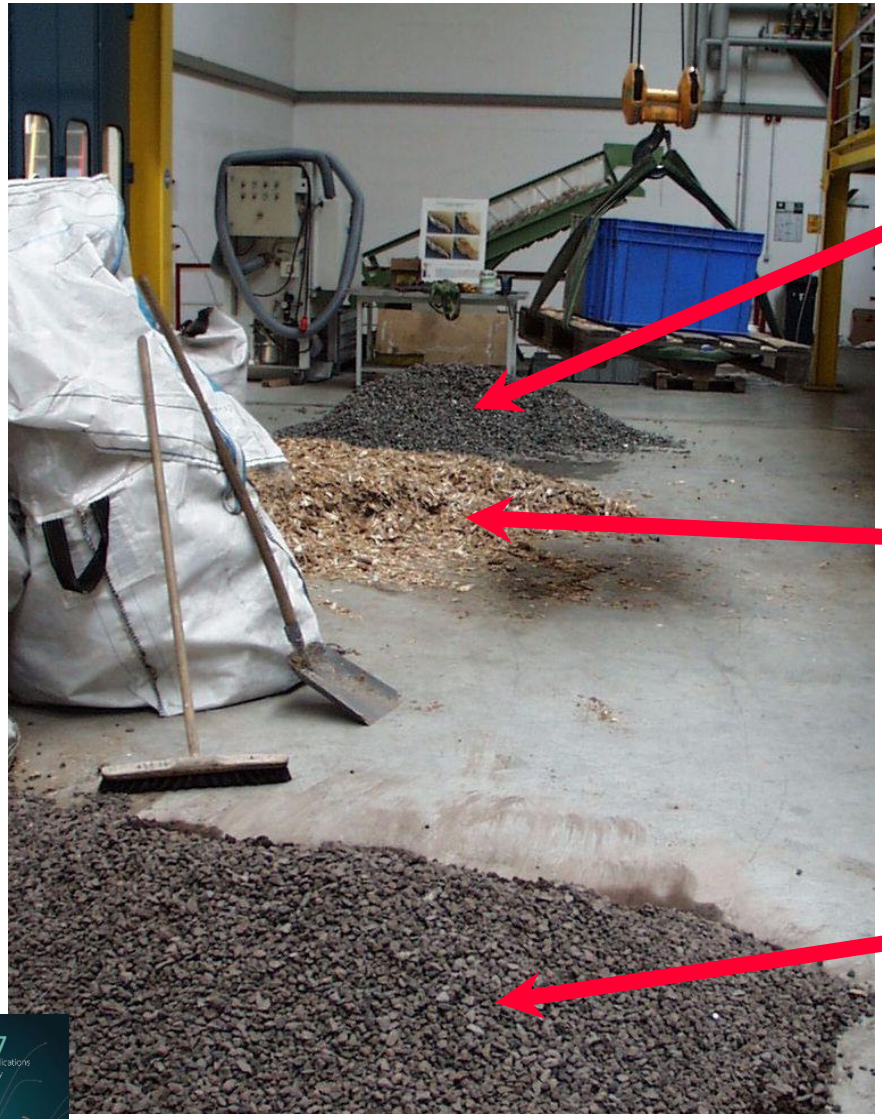
metal spheres

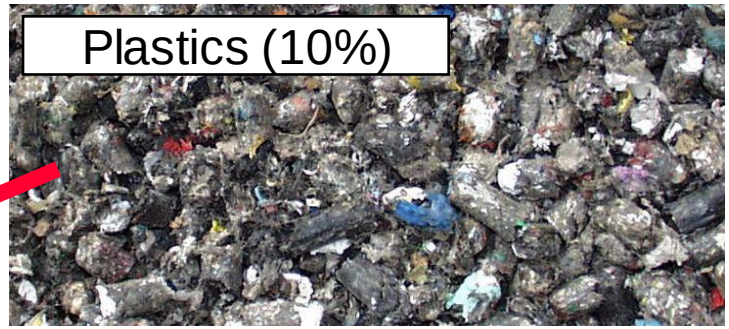
(0.2 - 0.6 mm)

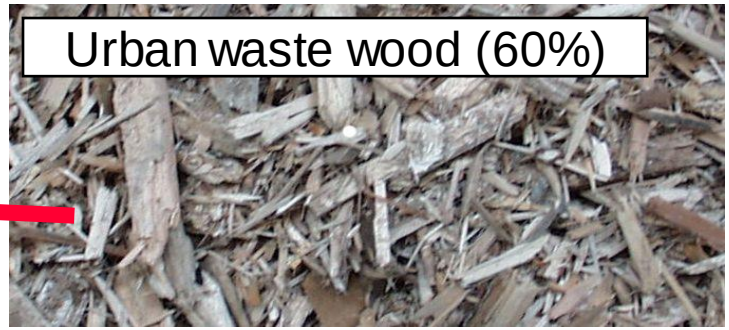
Objectives of radiotracer measurements

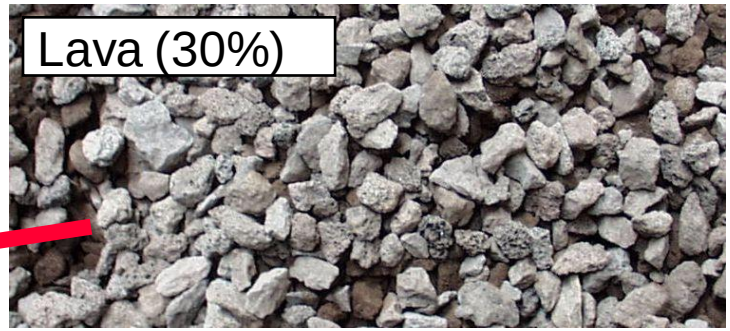
- **Firstly**, investigation of the behavior of the **metallic forms**
- Localize the place **where** the evaporation occurs
- **Verification of hypotheses** for the volatility of Zn & Cu: (from theory and lab-scale experiments)
  - A good zinc evaporation occurs at:
    - High temperatures &
    - Reducing conditions
  - Copper is negligibly evaporated

Synthetic model waste (SMW)



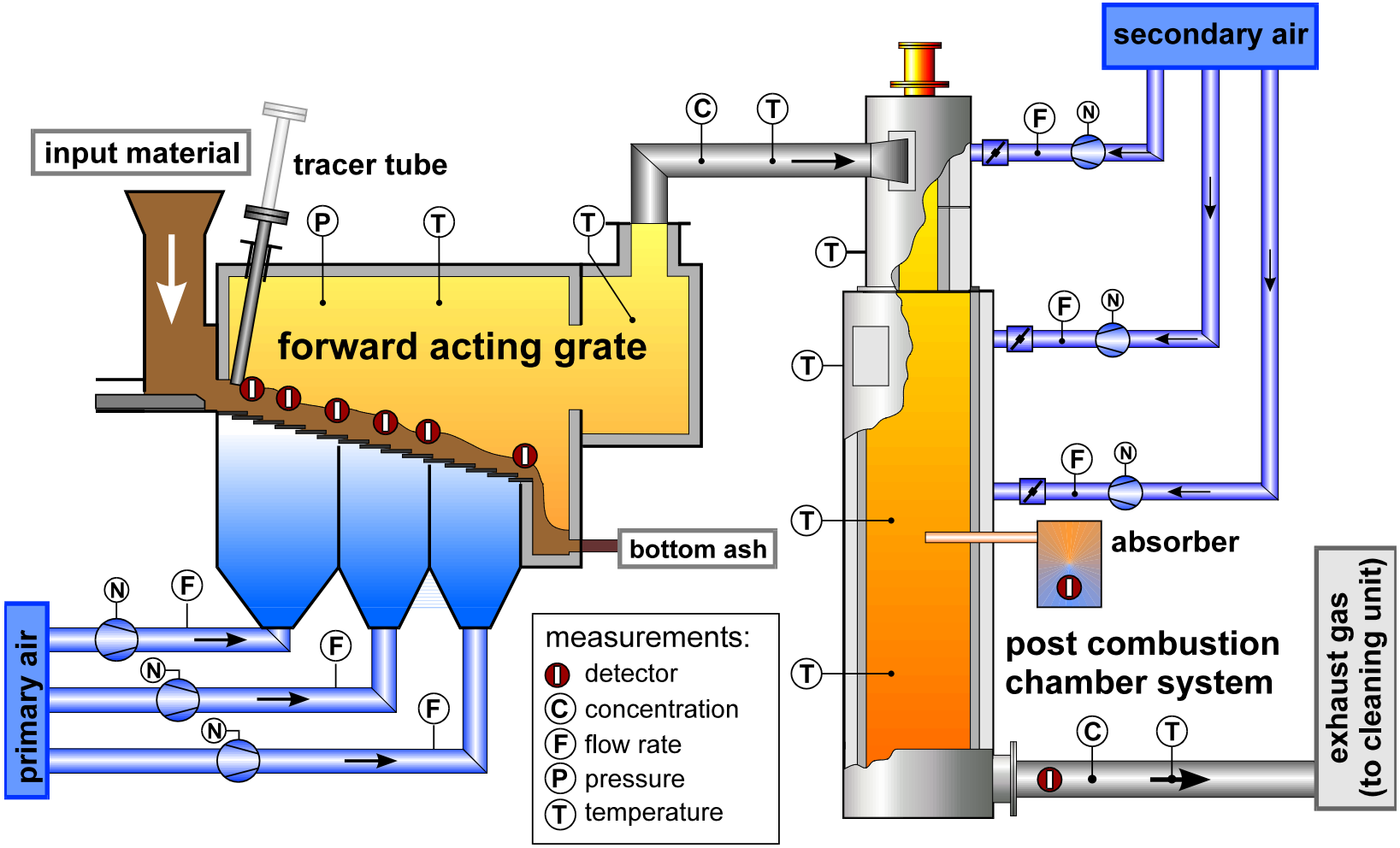




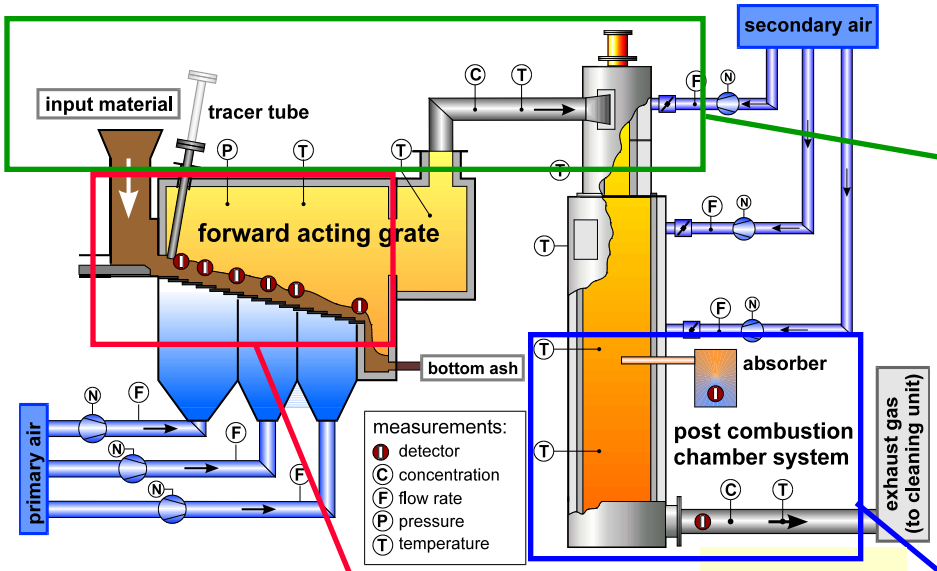


25 cm

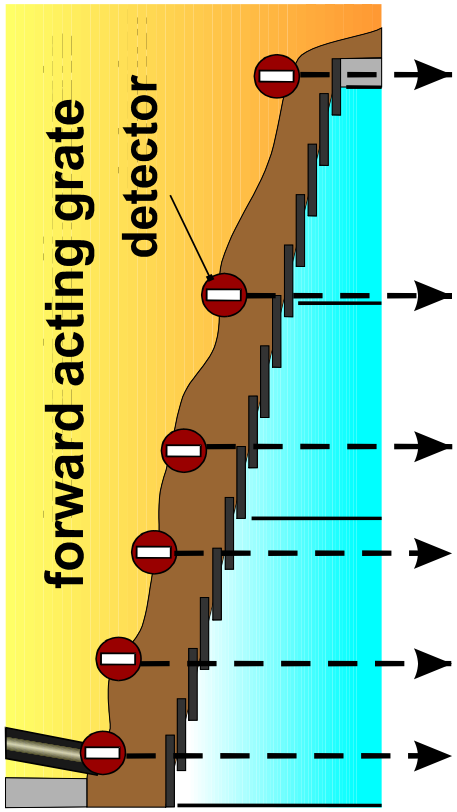
Pilot plant incinerator

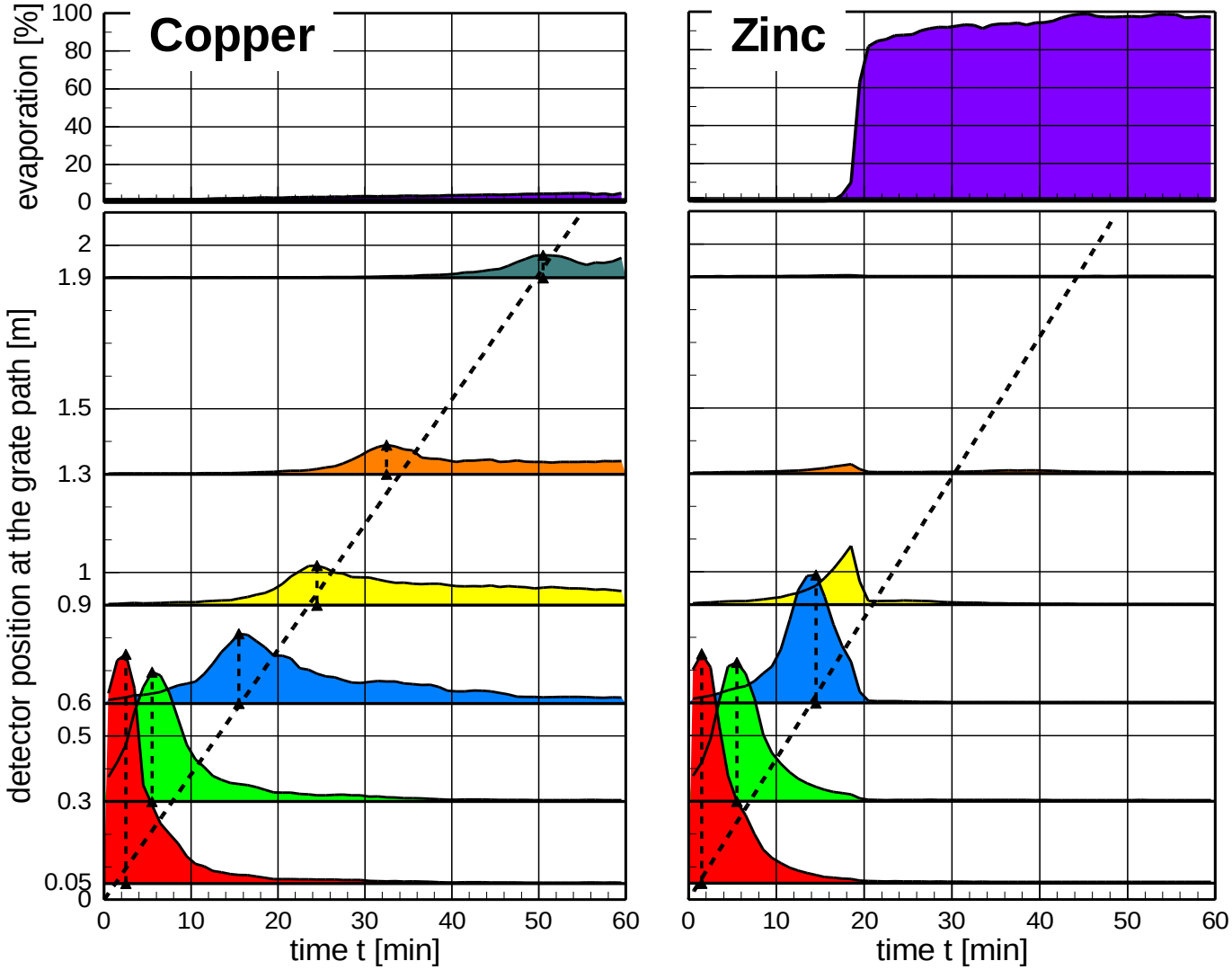


Installation for the radio tracer measurements



Typical data of the radiotracer measurements





Conclusions

- Methodology
  - Localization of the heavy metal evaporation is possible
  - Results of radio tracer measurements are more consistent than the results got from mass balance method
  - Radiotracer method is applicable also on MSW incinerators

- Volatility of Zn & Cu
  - A good zinc evaporation occurs at:
    - High temperatures &
    - Reducing conditions
  - Copper is negligibly evaporated

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