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

ICARST 2017, Vienna, Austria
24 – 28 April 2017

presented by: Thorsten B. O. Jentsch
Department of Radiation Protection and Safety, Head
Helmholtz-Zentrum Dresden - Rossendorf
Germany
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.“
Extrinsic 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
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

$T_{1/2} = 13.8\text{h}$

$E_\gamma = 439\text{ keV}$

metal sheets (1 - 2 mm)

nearly non-volatile

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

$T_{1/2} = 12.7\text{h}$

$E_\gamma = 511\text{ keV}$

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)

- Plastics (10%)
- Urban waste wood (60%)
- Lava (30%)
Pilot plant incinerator

**Diagram Details:**
- **Input Material**
- **Tracer Tube**
- **Forward Acting Grate**
- **Bottom Ash**
- **Secondary Air**
- **Absorber**
- **Post Combustion Chamber System**
- **Exhaust Gas (to cleaning unit)**
- **Measurements:**
  - Detector (D)
  - Concentration (C)
  - Flow Rate (F)
  - Pressure (P)
  - Temperature (T)

**Text:**
Investigation of heavy metal release ..., ICARST 2017, Vienna, 24-28 April 2017
Thorsten B. O. Jentsch
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
Acknowledgement

The author thanks the following institutions and persons for the co-operation:

**Hahn- Meitner- Institut, Berlin**  (Dr. Alber, Dr. Buchert, Mr. Gatschke)
Preparation of radiotracers

**TU Dresden**  (Dr. Bätz, Dr. Zeuner)
Support at the measurements

**PSI**  (Mr. Schuler, Mr. Marti)
Support at the measurements, design and building of the tracer absorber

**Swiss National Science Foundation**
Financial support