INVESTIGATIONS ON RELEASE OF NANOPARTICLES FROM WASTE AND SEWAGE SLUDGE INCINERATION RESIDUES DURING DEPOSITION AND AGRICULTURAL USE – COMPARISON OF PILOT SCALE SIMULATION AND LABORATORY TESTS

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Introduction

- Engineered nanomaterials (ENMs) used in products (e.g. textiles or paints) enter the waste (water) stream and thus waste incineration and waste water treatment plants.
- Residues from waste and sewage sludge incineration are either deposited in landfills or used in agriculture as fertilizer, where they possibly can be released to the environment [1].
- The aim of this project was to whether the possible release from both scenarios can be assessed by lab-scale column elution experiments.
- Comparison of the column experiments with pilot scale simulation reactors (Landfill simulation of ENP-amended incineration bottom ash and simulation of agricultural use of ashes from ENM-amended sewage sludge after application to soil).

Conclusions

- Release of TiO2-ENMs can be simulated using lab-scale column elution experiments according to DIN 19528.
- The reactors offer a realistic simulation of real scenarios and confirm results of column experiments.
- More release of TiO_2-ENPs in agricultural scenario than for landfill simulation.
- Spiking amount unrealistically high for improvement of detection limits, therefore no direct conclusions for real life scenarios possible.
- Additional studies with different ENMs and more soil types are needed to support the results, evaluate reproducibility and derive recommendations for regulatory action.

Experimental Setup

Municipal solid waste incineration ash

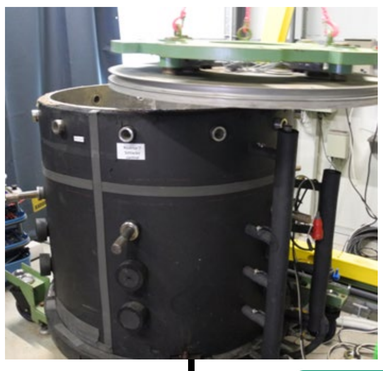
Column elution experiments

Pilot scale simulation reactors (1.5m³)

Sewage sludge + soil

(i) Landfill simulation

- **Watering (every 14 days, 36 L synthetic rainwater)**
- **Temperature control 20°C (determined in depth of 20, 30, 40 cm)**
- **Pressure 15 t/m²**



ICP-QQQ-MS (© Fraunhofer IME)

Leachates

Chemical analysis

Nanoparticle analysis

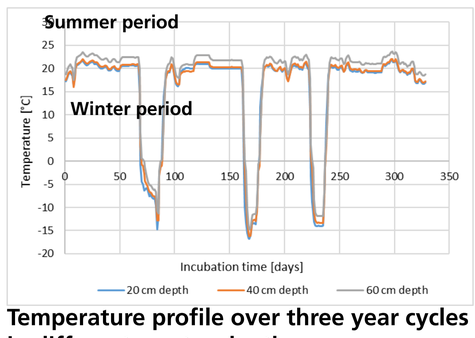
Total analysis

spICP-QQQ-MS

ICP-OES/-MS

(ii) Simulation agricultural use

- **3-year time-lapsed seasonal cycles (repeated freezing / thawing)**
- **Summer period watering (50 L synthetic rainwater)**
- **Temperature control (20, 30, 40 cm depth)**



Temperature profile over three year cycles in different reactor depth.

Results

- Domestic waste landfill simulation → no significant release of TiO_2 ENPs was observed compared to the reference simulation (Fig.1).
- Same results for lab-scale elution experiments.

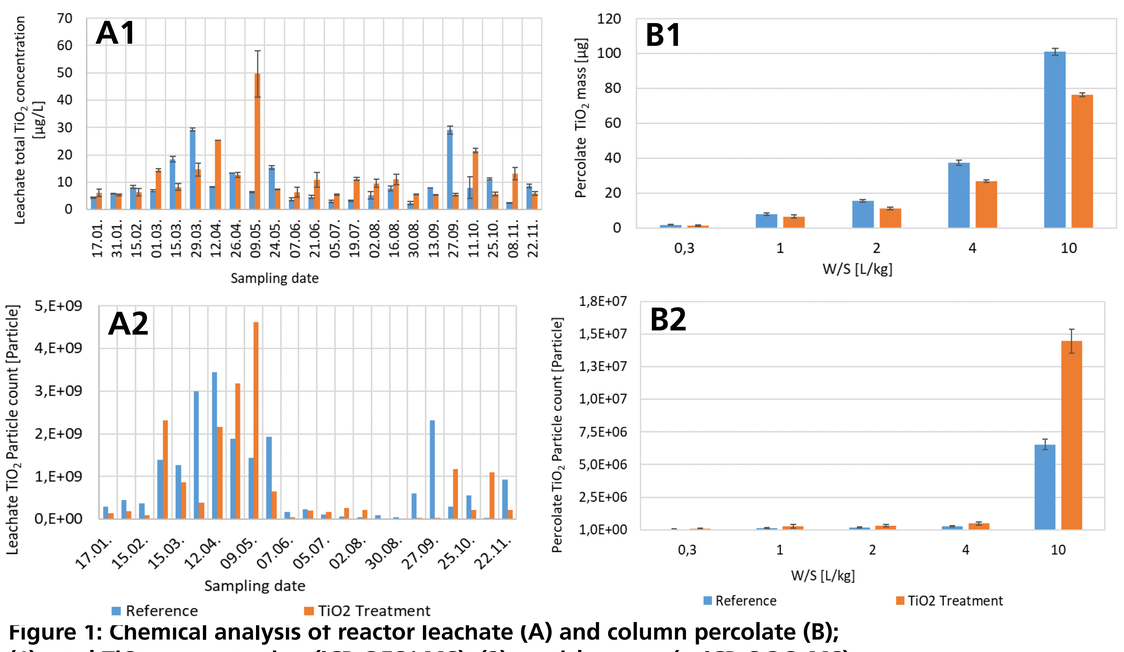


Figure 1: Chemical analysis of reactor leachate (A) and column percolate (B); (1) total TiO_2 concentration (ICP-OES/-MS), (2) particle count (spICP-QQQ-MS).

- Agricultural use simulation with spiked sewage sludge ashes → release of nanoparticles in comparison to the control simulation (Fig. 2).
- Same results for lab-scale elution experiments.

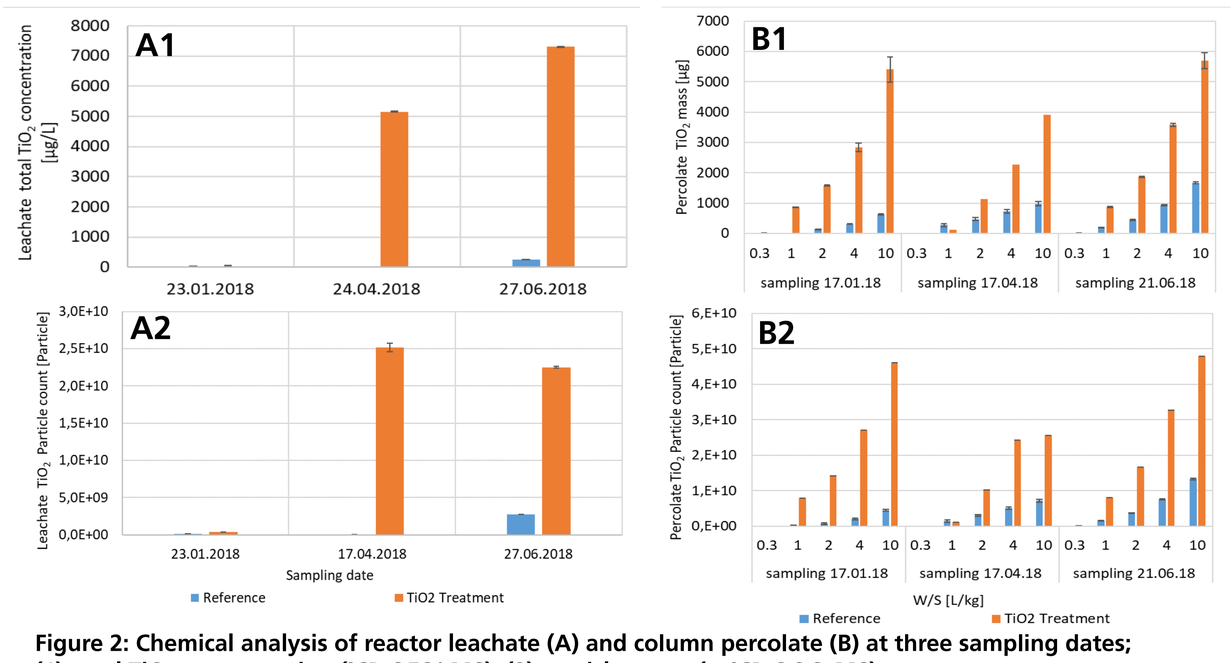


Figure 2: Chemical analysis of reactor leachate (A) and column percolate (B) at three sampling dates; (1) total TiO_2 concentration (ICP-OES/-MS), (2) particle count (spICP-QQQ-MS).

References: [1] Walser, T. et al, Nature Nanotechnology, 2012, 7, 520-524

Acknowledgments: The authors thank the German Environment Agency for funding this project.