Investigation of the release of engineered nanoparticles by waste incineration

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Keywords: engineered nanoparticles, waste incineration.
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The amount of consumer products containing engineered nanomaterials is constantly growing. As these products reach their end of life cycle they often end up in the waste incineration. Till now only few data is published concerning a possible release of nanoparticles (NP) into the environment (Walser et al., 2012).

In the Institute for Technical Chemistry (ITC) at the Karlsruhe Institute of Technology (KIT) this topic is analysed in fundamental investigations of NP behaviour in lab-scale flames (Lang et al., 2015), in technical investigations at a 3 MW combustion chamber in the KIT and in large-scale investigations at an industrial hazard waste incineration plant. A new project concerning the behaviour and possible release of NPs by incineration of polymer nanocomposites (ProCycle) started in 2015.

Fundamental research at a lab-scale burner with different nanomaterials shows that cerium dioxide is suitable for use as a tracer in experiments on pilot and industrial scale plants.

The pilot scale experiments are performed at the KIT combustion plant BRENDA. The tracer was dispensed into the post-combustion chamber via a two-phase nozzle. The tracer concentration along the furnace, boiler and flue gas cleaning system was analysed. The particle size distribution of the fly ash was measured by DLPI, ELPI+, SMPS and WELAS downstream of the boiler. To determine the concentration of the tracer material along the exhaust gas pipe, filter and impactor (DLPI) samples were analysed via inductively coupled plasma – mass spectrometry (ICP-MS). The mass concentration of the fly ash in the flue gas was varied by combustion of either natural gas or hard coal.

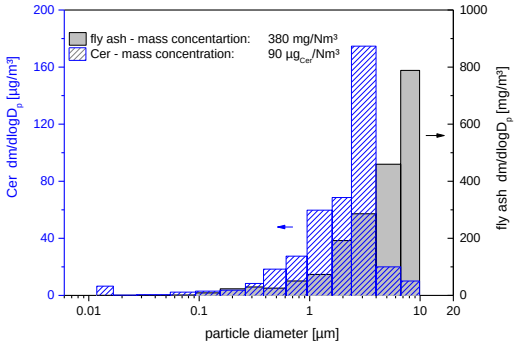

Figure 1. ICP-MS-analysis of the cerium concentration on the impactor plates for the combustion of a mixture of coal dust and switch grass.

The influence of the mass concentration of the fly ash on the size distribution of the nano sized tracer material was determined by analysing the different impactor plates via ICP-MS.

The results show that the CeO_2 tracer agglomerates with the fly ash and does not longer exist in nano sizes. The removal efficiency of the flue gas cleaning system for the injected tracer nanoparticles is in the range of 99.99 %.

At the industrial hazardous waste incineration plant the tracer material was injected as a suspension into the post-combustion chamber. The size distribution of the fly ash was measured by ELPI+ at the boiler outlet. To determine the concentration of the tracer along the exhaust path, filters were sampled inside the boiler, behind the boiler, behind the wet electrostatic precipitator and at the exhaust chimney and all samples were analysed via ICP-MS. Additionally all relevant material flows were sampled and also analysed via ICP-MS.

The mass balance of the injected tracer at the industrial waste incineration plant shows that over 80 % could be retrieved and the largest amount with roughly 70 % is found in the acid scrubber effluent.

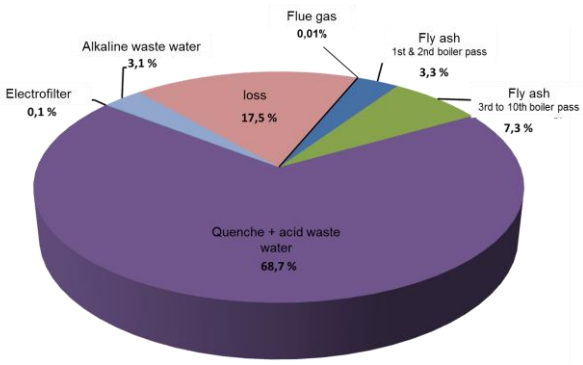

Figure 2. Mass balance of the injected tracer material.

Walser, T., Morawska, L. et al. (2012) *Nature Nanotech.* **7**, 520-524.

Lang, I.-M., Hauser, M., Baumann, W., Mätzing, H., Paur, H.-R., and Seifert, H. (2015b) in K.*J. Thomé-Kozmiensky and M. Beckmann (Eds.), Energie aus Abfall*, **12**, 347–370.