Synthetic nano-waste does not disappear

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Non-degradable nanoparticles bind to solid residues resulting from the incineration of waste and thus can find their way into the environment. Depicted: the waste incineration plant Emmenspitz. Credit: Tobias Walser

(Phys.org) -- Tiny particles of cerium oxide do not burn or change in the heat of a waste incineration plant. They remain intact on combustion residues or in the incineration system, as a new study by Swiss researchers from ETH Zurich reveals.

Over 100 million tons of waste are incinerated worldwide every year. Due to the increasing use of nanoparticles in construction materials, paints, textiles and cosmetics, for instance, nanoparticles also find their way into incineration plants. What happens to them there, however, had not been investigated until now. Three ETH-Zurich teams from fields of chemistry and environmental engineering thus set about finding out what happens to synthetic nano-cerium oxide during the incineration of refuse

in a waste incineration plant. Cerium oxide itself is a non-toxic ceramic material, not biologically degradable and a common basic component in automobile catalytic converters and diesel soot filters.

Unknown danger?

Experts fear that non-degradable nanomaterials might be just as harmful for humans and the environment as asbestos. As yet, however, not enough is known about the properties of nanomaterials. One thing is for sure: they differ greatly from larger particles of the same material. Nanoparticles are more mobile and have a different surface structure. Knowledge of these properties is important with the increasing use of nanomaterials as, as they are transferred through incineration plants or sewage, and as they are absorbed by people in food and perhaps even through the skin and respiration, and can thus enter the body.

Consequently, the scientists sprayed ten kilograms of cerium oxide particles measuring eighty nanometers in diameter onto refuse to be incinerated in a waste incineration plant in Solothurn, thus modelling refuse that is rich in nanoparticles. Up to eight tons of waste is incinerated at the Solothurn plant per hour. It has modern filters and fly-ash separation systems based on electrostatic filters and a wet scrubber.

In a second experiment, the particles were sprayed directly into the combustion chamber, thereby simulating a future “worst case scenario” with massive nanoparticle release during incineration. The study was backed and approved by the SUVA, the Federal Offices of Public Health and the Environment, and the State Secretariat for Economic Affairs.

Nanoparticles stick to surfaces

The researchers' tests revealed that cerium oxide does not change significantly during incineration. The fly-ash separation devices proved extremely efficient: the scientists did not find any leaked cerium oxide nanoparticles in the waste incineration plant's clean gas. That said, the nanoparticles remained loosely bound to the combustion residues in the plant and partially in the incineration system, too. The fly ash separated from the flue gas also contained cerium oxide nanoparticles.

Nowadays, combustion residues – and thus the nanoparticles bound to them – end up on landfills or are reprocessed to extract copper or aluminium, for instance. The researchers see a need for action here. "We have to make sure that new nanoparticles don't get into the water and food cycle via landfills or released into the atmosphere through further processing measures," says Wendelin Stark, head of the study and a professor of chemical engineering at ETH Zurich. Moreover, the fact that nanoparticles that could be inhaled if inadequate protection is worn might be present in the incineration system needs to be taken into consideration during maintenance work.

Degradable nanoproducts the goal

But how can such problems be avoided in the long run? "Eventually, all nanoproducts will need to be degradable, otherwise the problem of spreading will keep cropping up," says Stark. "Persistence is the basic problem with asbestos, pesticides in our food chain and environment, the ozone-depleting agents in early aerosol cans and the accumulation of plastic in the ocean or environment." In order to avoid this problem in nanoparticles, the scientists see developing degradable nanoproducts as the only way that makes sense in the long run. This is not always easy from a technical point of view and the university and industrial development labs still face some major challenges ahead.

More information: Walser, T et al.: Persistence of engineered

nanoparticles in a municipal solid-waste incineration plant. *Nature Nanotechnology* (2012) doi:10.1038/nnano.2012.64

Provided by ETH Zurich

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