European Commission

Science for Environment Policy

Nanoparticles present in residues of waste incineration plant

The use of nanomaterials in consumer goods is growing, as is their presence in waste. A new study is the first to follow the fate of engineered nanoparticles through the entire waste incineration chain. The results indicate current filter technology is effective in removing nanoparticles from flue gas, but that nanoparticles also bind to residues, such as fly ash and slag, which eventually end up in landfill.

6 December 2012
Issue 309

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Source: Walser, T., Limbach, L.K. Robert Brogioli, R. *et al.* (2012) Persistence of engineered nanoparticles in a municipal solid-waste incineration plant. *Nature Nanotechnology*. 7: 520–524 doi:10.1038/nnano.2012.64.

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Theme(s): Chemicals, Waste

The current trend in the use of engineered nanomaterials in consumer goods is expected to grow, which means their presence in our waste material will also be increasing. Although landfilling is still common practice, more than 100 million tonnes of municipal solid waste are incinerated worldwide each year and the use of thermal waste treatment is expected to increase. Engineered nanoparticles are often designed to be insoluble and stable when incorporated into consumer goods, so as not to be released during use, but this can cause problems if they enter the environment as they may reside for a long time.

Unlike previous research that analyses only sections of the waste incineration chain, this study was the first to follow the fate of nanoparticles through the entire chain. It focused on the nano form of cerium oxide (nano-CeO_2), which has a wide range of uses, for example, in ceramics and as a glass polisher.

The researchers added nano-CeO_2 particles to waste destined for a large-scale incinerator. The nanoparticles were introduced either directly onto the waste before incineration or into the gas stream exiting the furnace. Samples were then taken from the flue gas and the residues of the combustion process, such as the fly ash (flue gas residues from the boiler), slag (solid combustion residues from the furnace grate) and slag water (water used to cool the hot slag), and analysed for cerium content.

The results showed that the filter systems in the incinerator were highly effective, removing nearly 100% of the nano-CeO_2. This suggests that no significant nano-CeO_2 emissions can be expected from thermal waste treatment plants provided they have up-to-date flue gas cleaning systems.

The filters are effective because the nano-CeO_2 binds loosely to the solid residues from the combustion process, which can then be efficiently removed using the filter technology. As such, the nano-CeO_2 is still present in the residues of fly ash and slag and, moreover, its chemical and physical properties have remained unchanged. For example, when the nanoparticles were introduced directly onto the waste there was a measured cerium concentration of 835 micrograms (μg) per gram of slag.

This suggests that the problem of disposal is shifted to the handling of slag and fly ash residues in landfills and final deposits. Exposure to nanoparticles may occur during transportation or immediate storage, or if the slag or fly ash is treated for material recovery, for example, to recover copper, aluminium or zinc. The study strongly recommends the use of the precautionary principle in developing measures to control nanoparticle waste and further exploring development of degradable nanoparticles.