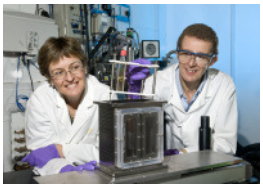
Managing nanoparticle waste in sewage

A new discovery about nanoparticle behaviour in sewage treatment plants could improve the environmental management of nanoparticle wastes from foods, cosmetics, medicines, cleaners and personal care products.



Helen Jarvie and Steve King
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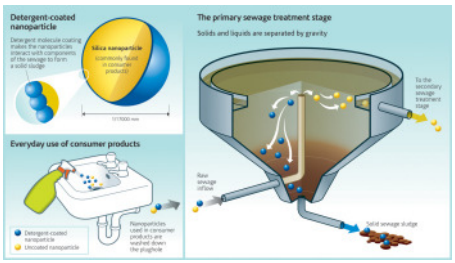
A team of scientists from ISIS and the Centre for Ecology & Hydrology (CEH), along with colleagues from King's College London and Oxford University, have studied how certain nanoparticles behave in wastewater and identified a way to potentially help remove them during primary sewage treatment. The scientists examined silica nanoparticles which are commonly found in consumer products and routinely discharged to wastewater.

The study, published in Environmental Science and Technology, simulated primary sewage treatment to show that coating silica nanoparticles with a detergent-like material (surfactant) made the nanoparticles interact with components of the sewage to form a solid sludge. This sludge can be separated from the wastewater and disposed of. The uncoated nanoparticles stayed dispersed in the wastewater and were therefore likely to continue through the effluent stream.



The journey of silica nanoparticles (commonly found in consumer products) through the sewage treatment system.
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Each year manufacturers worldwide use over one million tonnes of silica nanoparticles in consumer products. A large proportion of these are washed down the drain into the sewage system. This makes sewage treatment plants a major gateway for nanoparticles to enter the aquatic environment.

"Our research shows that primary sewage treatment may not be effective at removing some nanoparticles. However, we now know where those nanoparticles may go and how we might deal with them," said Dr Steve King from ISIS.

The scientists used ISIS to view the sewage at the nano scale. Nanoparticles are too small to be seen by the human eye. The neutrons easily penetrate the turbid sewage 'soup' and scatter strongly from the nanoparticles, allowing the aggregation behaviour of the nanoparticles to be measured through time.

> "Primary sewage treatment may not be effective at removing some nanoparticles"

Dr Helen Jarvie from the Centre for Ecology & Hydrology said, "The research proves that the surface chemistry of nanoparticles influences their likely removal during primary sewage treatment. By adding a coating which modifies that surface chemistry, it may be possible to re-route their journey through sewage treatment plants." She added, "Further work is now planned to examine the behaviour of a wider range of nanoparticles, with different classes of surfactants, in wastewaters."

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Instruments used

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- Dr Stephen King
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External Links

- Centre for Ecology and Hydrology (CEH)
- Environmental Nanoscience Initiative
- Department of Engineering Science, Oxford University
- Department of Physics, King's College London
- Pharmaceutical Science Division, King's College London

Experts agree that some nanoparticles might indeed have harmful effects on the environment or human health and so a great deal of research funding in the UK, Europe and wider afield is currently being directed at understanding the issues involved. The UK programme looking at nanoscience in relation to the environment is called the Environmental Nanoscience Initiative and involves the NERC, DEFRA, EA and also the US Environmental Protection Agency.

What are the next steps?

Wider studies of nanoparticle fate in wastewater treatment are to be carried out. Work begins shortly with a consortium of European partners under an EU-funded collaborative project (NanoFATE: Nanoparticle Fate Assessment and Toxicity in the Environment). NanoFATE will examine post-production life cycles of key nanoparticles from environmental entry as "used product," through the full range of waste treatment processes to their final fates and potential toxic effects. This will test the applicability of current fate and risk assessment methods and identify improvements required for assessment of nanoparticles at an early stage.

Helen P. Jarvie, Hisham Al-Obaidi, Stephen M. King, Michael J. Bowes, M. Jayne Lawrence, Alex F. Drake, Mark A. Green and Peter J. Dobson

Research date: November 2009

Further Information

Jarvie, H.P. *el al* (2009). Fate of Silica Nanoparticles in Simulated Primary Wastewater Treatment. *Environ. Sci. Technol.*, **43**, 8622–8628.