Executive Summary

WERF

New Findings on Engineered Nanomaterials Accumulation and Impacts in the Environment

Fate of Engineered Nanomaterials in Wastewater Biosolids, Land Application, and Incineration (U1R10)

Titanium-containing personal care products such as toothpaste, sunscreens, shampoos, deodorants, and lotions are widely used and disposed of down the drain, eventually leading to treatment plants.

The Central Issue

Engineered nanomaterials (ENMs) are increasingly common and used daily by people everywhere. ENMs are found in many household items, including such things as chewing gum and toothpaste. Their exact disposition after being flushed down toilets and into drains to wastewater treatment facilities, or water resource recovery facilities (WRRFs), is not known.

Context and Background

Concern has arisen among water professionals regarding whether ENMs could concentrate in biosolids. This WERF-funded research sought to develop tools to quantify and understand ENMs, including:

- Whether they accumulate in biosolids and the environment.
- How they undergo biosolids treatment.
- How they are disposed of.

The findings can help municipal and industrial WRRF owners, biosolids land application professionals, and consulting engineers manage any risks associated with ENMs in wastewater. The findings can also help regulators, academics, and manufacturers identify solutions to reduce any risks associated with ENMs in wastewater.

Findings and Conclusions

The study found that ENMs can, and do, accumulate in biosolids. However, at currently observed levels, ENMs in biosolids do not appear capable of significantly impacting biological soil processes during land disposal of biosolids.

Although the concentration of ENMs in wastewater effluents and biosolids is low, the most common ENM observed was titanium dioxide. Other metallic particles of micrometer size were also identified in biosolids, including precious metals such as gold and silver. Procedures to extract, isolate, or purify ENMs from liquid or biosolids would help assess their general composition.

Management and Policy Implications

The research team demonstrated analytical techniques suitable for full-scale monitoring of ENMs at WRRFs. However, the research team believes there is a need to develop more rapid screening tests for assessing the presence or absence and general composition of ENMs. Such rapid screening tests could help identify their points of entry into the sewage system. Then policy could focus on the source with the greatest potential to reduce risk, whether that source were to be residential, commercial, or industrial.

Moreover, current understanding of how metals accumulate in biomass and biosolids may need to be revisited to assess the presence of ionic metals or colloidal-sized metals. Removing them may have implications. Identifying and addressing toxicity of these compounds may also be needed and have additional implications, including source control and material substitution.

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Related WERF Research

Project Title	Research Focus
Fate of Pharmaceuticals and Personal Care Products Through Municipal Wastewater Treatment Processes (03CTS22UR)	Surveys a list of 20 pharmaceuticals and personal care products (PPCPs) and assessed their removal through secondary treatment. The study data examined if the removal of these compounds is influenced by the solids retention time (SRT) – the master variable in the operation of activated sludge secondary treatment. PPCP removal through subsequent tertiary media filtration, disinfection, and membrane bioreactor processes were also evaluated.
Impact of Silver Nanoparticles on Wastewater Treatment (U3R07)	Provides several experimental methods and tools to quantitatively determine the risk of accumulation and impact in activated sludge wastewater treatment and anaerobic sludge digestion processes. The findings suggest that accumulation of silver in activated sludge may have a detrimental effect on nitrification and nutrient removal if the concentration reaches threshold levels beyond 0. 1 mg/L.
Use of Nanoparticles for Reduction of Odorant Production and Improvements in Dewaterability of Biosolids (U3R08)	Provides preliminary information on the interactions of nanoparticles with sludge constituents, odorants, and their precursors. The findings suggest that nanoparticles improve the dewatering characteristics of lower and medium charge density polymers more than the high charge density polymers.
Holistic Assessment of Trace Organic Compounds in Wastewater Treatment (U3R11)	Sacramento Regional Sewer District is designing an upgraded $2 billion treatment facility to comply with a new discharge permit. This WERF study of trace organic treatment performance demonstrates testing of biological nutrient removal (BNR), filtration, and disinfection treatment technologies. The project outcomes provide a roadmap for agencies considering upgrading for nutrient removal now and trace organics reduction later.

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