

Fate of Zinc Oxide Nanoparticles during Anaerobic Digestion of Wastewater and Post-Treatment Processing of Sewage Sludge

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The rapid development and commercialization of nanomaterials will inevitably result in the release of nanoparticles (NPs) to the environment. As NPs often exhibit physical and chemical properties significantly different from those of their molecular or macrosized analogs, concern has been growing regarding their fate and toxicity in environmental compartments. The wastewater–sewage sludge pathway has been identified as a key release pathway leading to environmental exposure to NPs. In this study, we investigated the chemical transformation of two ZnO-NPs and one hydrophobic ZnO-NP commercial formulation (used in personal care products), during anaerobic digestion of wastewater. Changes in Zn speciation as a result of postprocessing of the sewage sludge, mimicking composting/stockpiling, were also assessed. The results indicated that “native” Zn and Zn added either as a soluble salt or as NPs was rapidly converted to sulfides in all treatments. The hydrophobicity of the commercial formulation retarded the conversion of ZnO-NP. However, at the end of the anaerobic digestion process and after postprocessing of the sewage sludge (which caused a significant change in Zn speciation), the speciation of Zn was similar across all treatments. This indicates that, at least for the material tested, the risk assessment of ZnO-NP through this exposure pathway can rely on the significant knowledge already available in regard to other “conventional” forms of Zn present in sewage sludge.