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BEHAVIOR OF PERSISTENT BIOCIDES DURING WASTEWATER TREATMENT: MASS BALANCES AND META ANALYSIS

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ABSTRACT: Persistent biocides (PBs) are manmade chemicals commonly added to antimicrobial personal care products. Their halogenated aromatic structure suggests a high potential for particle sorption and reduced biodegradation potential. Upon down-the-drain disposal, these compounds readily partition into sewage sludge, which may render them partially inaccessible to degradation during municipal wastewater treatment.This nationwide study examined the fate of 10 PBs during conventional full-scale wastewater treatment. Samples (raw sewage, treated wastewater and digested sewage sludge) were obtained and analyzed from 12 wastewater treatment plants located across the United States. Cleanup of aqueous samples was performed by solid phase extraction, whereas solid samples were subjected to liquid extraction using organic solvents. All target compounds were analyzed by isotope dilution liquid chromatography electrospray ionization tandem mass spectrometry (ID-LC-ESI-MS/MS). Mass balances were conducted by multiplying measured concentrations with the aqueous and solid flow rates at the time of sampling. The extent of observed persistence during treatment was compound specific and plant specific. For example, whereas >50% of the influent mass of triclocarban were sequestered in sludge from all plants examined, the structurally-related compound triclosan showed much more variation with respect to mass persisting during wastewater and sludge treatment (range: 2-93%). No statistically significant correlation was observed between per-capita usage and plant size ($p>0.05$). However, the mass of PBs accumulating in digested sludge on a per-capita basis was positively correlated with plant size. Obtained data and published information were used in a meta analysis that explored the feasibility of using chemical properties to predict chemical behavior during wastewater treatment. A strong correlation between the fraction of the compound persisting in sewage sludge and its logarithmic octanol-water coefficient (Kow) was observed. This study showcased the utility of mass balances approaches for evaluating plant performance in terms of aqueous removal efficiency and degradation potential of halogenated organic compounds. Additionally, study results suggest that the sorptive behavior of the above compounds can be utilized to approximate the overall chemical persistence during conventional wastewater and biosolids treatment.

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