

1,4-Dioxane Contamination Survey at River Estuaries and Wastewater Treatment Plants in Northern New Jersey

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Background/Objectives. 1,4-Dioxane (dioxane) is an emerging water contaminant that has been reported as a possible human carcinogen by EPA, WHO, European Union (EU), and International Agency for Research on Cancer (IARC). It is extensively used in the industry as a solvent stabilizer and manufacture additive. Moreover, dioxane has been found as the undesirable impurities in a variety of daily consumable products, such as shampoos, laundry detergents, cosmetics, and food preservatives. Though not regulated by the federal government, a number of states have highly stringent drinking water and groundwater criteria (e.g., 0.4 µg/L in New Jersey). For the measurement of dioxane in environmental samples, USEPA method 522 uses carbon-based absorption cartridges that are capable of concentrating up to 500 mL of water samples. This method is highly sensitive with the MDL estimated as low as 0.016 µg/L. However, the complex SPE procedures are time and labor consuming. To circumvent the laborious sample handling involved in SPE extraction, we developed a frozen microextraction (FME) method to process samples with relatively high sensitivity (i.e., MDL as 0.30 µg/L) and low sample volume (up to 3 mL). In this study, this FME method was improved and employed to investigate the contamination of dioxane at local river estuaries and wastewater treatment plants (WWTPs) in northern New Jersey.

Approach/Activities. With the assistance of Meadowlands Environmental Research Institute, water samples were collected at 14 sampling points along the Hackensack River. The water samples of influent, primary effluent, before disinfection, and final effluent were collected from five WWTPs. After FME, dioxane at parts-per-billion levels was detected by a Trace 1300 gas chromatograph (GC) equipped with an ISQ mass spectrum (MS) detector (Thermo, Waltham, MA). For the quantification of extraction and instrument recovery, deuterated dioxane and tetrahydrofuran were used as the surrogate and internal standard, respectively.

Results/Lessons Learned. Along the Hackensack River, all samples were positively detected with dioxane in a range of 1.21 to 5.98 µg/L. Similarly, dioxane concentrations in the water samples at five local WWTPs all exceeded the guidance level of New Jersey. No significant difference was observed between the influent and effluent samples, suggesting the conventional wastewater treatments are marginally effective to treat dioxane. Therefore, WWTPs may serve as point sources that consistently discharge dioxane to the aqueous environment. Compared to the EPA method 522, this FME method reduces the labor, time, reagents, cost, and only requires very small sampling volume, which achieves a MDL that is sufficiently low for screening dioxane contamination. Thus, FME is more feasible and cost-efficient for the analysis of dioxane in the contaminated ground water and wastewater. To sum up, our lab has established an integral and sensitive extraction and detection competence that is applicable for analyzing dioxane contamination in different aqueous matrixes. The survey shows that the dioxane contamination widely exists at least in northern New Jersey.