Integrating Foam Fractionation into the Activated Sludge Process for Per- and Polyfluoroalkyl Substances Removal from Landfill Leachate

An Energy-Efficient Approach

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4.07.A.T-04 Integrating Foam Fractionation into the Activated Sludge Process for Per- and Polyfluoroalkyl Substances Removal from Landfill Leachate: An Energy-Efficient Approach

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Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals known for their persistence, bioaccumulation, and toxicity. Landfill leachate is a major source of PFAS contamination in the environment. However, conventional wastewater treatment plants (WWTPs) are not designed to effectively remove PFAS, highlighting the need for specialized treatment technologies. Foam fractionation (FF) has shown promise in removing PFAS from landfill leachate, achieving removal efficiencies up to 60%. FF is considered a sustainable method, as it does not require chemical reagents or adsorbents. However, energy for aeration impacts its cost and energy efficiency.

This study investigates integrating FF into the activated sludge (AS) process, offering a more energy- and cost-efficient approach to mitigate PFAS emissions. AS processes already rely on aeration to treat nutrients and organic matter, and foam formation frequently occurs due to the presence of surfactants and filamentous bacteria. While foam formation is typically suppressed to avoid operational challenges, this study investigates its potential use for PFAS removal.

Laboratory experiments were conducted using a bench-scale activated sludge reactor treating landfill leachate. In the first phase, foam formation was suppressed with an antifoam agent to mimic conventional operations. This ensured that PFAS removal could occur solely through sorption to sludge. In the second phase, no antifoam was added, allowing natural foam formation and its subsequent removal. The analysis involved the general chemistry and the concentrations of 32 different types of targeted PFAS, in the

influent, effluent, and foam. The PFAS analyses were performed using Solid Phase Extraction (SPE) followed by LC-MS/MS.
Results indicated negligible PFAS removal during the first phase, while the second phase achieved removal efficiencies comparable to standalone foam fractionation. However, also solids were enriched in the foam, potentially impacting the microbial population in the bulk solution. Preliminary observations suggest no significant difference in biological performance between the two phases. These findings offer promising insights for WWTP operators seeking cost-effective strategies to mitigate PFAS emissions. Given the widespread use of activated sludge reactors in municipal and industrial wastewater treatment plants, integrating foam fractionation into these processes presents a potential scalable solution.