This research focused on the fundamental requirements of stabilizing a mature landfill using three treatment approaches as well as the implications of discharging leachate organic matter (LOM) to wastewater treatment plants (WWTPs). Three treatment approaches aimed at removing releasable carbon and nitrogen from mature landfills including flushing with clean water, leachate recirculation with ex-situ chemical oxidation, and leachate recirculation with ex-situ chemical oxidation and in-situ aeration were evaluated. After extensive treatment of the waste in the flushing bioreactor (FB) scenarios, the overall biodegradable fraction was reduced relative to mature waste. Leachate quality improved for all FBs but through different mechanisms. Flushing was the most effective approach at removing biodegradable components and improving leachate quality. A mass balance on carbon and nitrogen revealed that a significant fraction still remained in the waste.

Solid waste and leachate samples from the anaerobic bioreactors and FBs were characterized using Fourier Transform Infrared (FTIR) to provide a better understanding of changes in waste characteristics when waste transitions from mature to stabilized. Organic functional groups associated with aliphatic methylene were present in leachate and solid waste samples during the early stages of anaerobic degradation and disappeared once these wastes underwent treatment. Once the waste was stabilized, the FTIR spectra of leachate and solid waste were dominated by inorganic functional groups (carboxylic acid/carbonate group, carbonate, quartz, and clay minerals).

Leachate is commonly co-treated with domestic wastewater due to the cost and complexity of on-site treatment. The organic constituents in leachate can be problematic for WWTPs as their recalcitrant components pass through conventional treatment processes, impacting effluent quality. Twelve leachates where characterized for total nitrogen (TN) and dissolved organic nitrogen (DON). The average concentration of TN and DON in leachate was 1,160 and 40.7 mg/L, respectively. Leachates were fractionated based on hydrophobic (recalcitrant; rDON) and hydrophilic (bioavailable; bDON) properties. The average concentrations of bDON and rDON were 16.5 and 18.4 mg/L, respectively. Multiple leachate and wastewater co-treatment simulations were carried out to assess the treatment of leachate nitrogen at historic nitrogen removal levels of four WWTPs and the effects on wastewater effluent quality for four WWTPs. The effluent quality exceeded typical TN limits of 3 to 10 mg/L at leachate volumetric contributions of 10%. The maximum calculated pass through concentrations of rDON and DON at 10% volumetric contribution for the twelve leachates was 4.77 and 9.71 mg/L, respectively.

The effects of LOM on wastewater effluent quality was further evaluated in the field. Results showed that leachate detection for each field study could be determined using UV254 nm absorbance. DON and dissolved organic carbon (DOC) concentrations increased at significant levels in leachate-impacted wastewater samples. The DON decreased through the treatment train, suggesting that this parameter was effectively removed, while DOC persisted. DOC pass through coincided with an increase in color and UV254 nm absorption. In effluents, the UV254 nm transmittance was just below the minimum 65% disinfection requirement at dilutions greater than 1%. Leachate-impacted wastewater showed a higher concentration of humic-like peaks during fluorescence measurements than wastewater without leachate.

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