Executive Summary

WERF

BNR process very effective for trace organic compound removal

Holistic Assessment of Trace Organic Compounds in Wastewater Treatment (U3R11)

The Central Issue

Within the next decade, hundreds of municipal agencies will likely be facing decisions on upgrading plants for nutrient removal and some may also be required to achieve trace organic compound reduction. A field study of trace organics removal by conventional and advanced wastewater treatment processes was conducted to inform new plant design by providing information for both immediate nutrient reduction requirements and longer-term for trace organics reduction.

Context and Background

The occurrence of trace organic compounds in treated wastewater effluent is well documented. California leads the nation in considering permits dealing with trace organics. As part of the Sacramento Regional County Sanitation District's two-billion dollar treatment facility upgrade, a study of trace organics removal by to conventional and advanced wastewater treatment processes was conducted. The test facilities consisted of a demonstration-scale pilot with a biological nitrogen removal (BNR) activated sludge treatment process, parallel membrane and granular media filtration processes and a biologically active filter preceded by ozone treatment, and three parallel disinfection processes. Twelve trace organic indicator compounds were selected to represent the treatability of a breadth of compounds. Measurements of concentrations entering and exiting each unit process were made over a period of six months under a range of operating conditions to assess the treatability of each compound by each process. Comparisons were made to the existing full-scale plant, a high purity oxygen activated sludge (HPOAS) secondary treatment plant using chloramination for disinfection.

Findings and Conclusions

- The BNR process was more effective at removal than the HPOAS process, likely due to longer solids retention time (SRT) and higher mixed liquor suspended solids (MLSS) concentration in the BNR process.
- Eight of the 12 studied indicator trace organic compounds were reduced through the BNR process.

The Sacramento Regional County Sanitation District owns and operates the Sacramento Regional Wastewater Treatment Plant, a high purity oxygen activated sludge system (HPOAS) disinfected via chlorination/ dechlorination with permitted discharge to the Sacramento River.

- In general, membrane filtration provided no additional benefit when compared with conventional granular media filtration (GMF), in reducing the dissolved fraction of trace organic compounds. Neither membrane nor granular media filtration was effective.
- Many of the trace organic compounds were reduced by ozone treatment, however subsequent biologically active filtration did not result in further removal.
- NDMA was formed by reaction with ozone. Pre-ozonated GMF, conventional GMF, and membrane filtration did not provide removal of NDMA from secondary effluent, however it was reduced by the biologically active filter.
- Post-filtration disinfection processes had varying degrees of effectiveness in reducing the compounds with ozone being most effective, followed by chlorine and then UV.

Management and Policy Implications

As municipal agencies face treatment upgrades for nutrient removal now, and trace organics reduction later, results of field-scale treatment processes, both conventional and advanced, will be invaluable in informing new plant design.

The study results demonstrated the effectiveness of ozone and biological filtration in reducing some trace organic compounds. Based on that knowledge, the District is incorporating the flexibility to add pre-filtration ozonation and to convert conventional filters to biological filters into the design of its new tertiary treatment processes.

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Holistic Assessment of Trace Organic Compounds in Wastewater Treatment

Related WERF Research

Project Title	Research Focus
Fate of Pharmaceuticals and Personal Care Products Through Municipal Wastewater Treatment Processes (03CTS22UR)	Surveyed a list of 20 pharmaceuticals and personal care products (PPCPs) and assessed their removal through secondary treatment. The study data examined if the removal of these compounds is influenced by the solids retention time (SRT) – the master variable in the operation of activated sludge secondary treatment. PPCP removal through subsequent tertiary media filtration, disinfection, and membrane bioreactor processes were also evaluated.
Diagnostic Tools to Evaluate Impacts of Trace Organic Compounds (CEC5R08a, CEC5R08b, CEC5R08c)	Developed diagnostic tools for water quality managers to assess and monitor trace organics in their treatment processes and watersheds. Companion parts of this project include a trace organics prioritization method, a report on diagnostic approaches and types of analyses in aquatic systems used to identify causes of ecological impairments, seven case studies, and web-based database to help users search and evaluate trace organic data.
Nutrient Removal Workshop: How Low Can We Go & What is Stopping Us from Going Lower? (05CTS1W) **Bioavailability of Wastewater Derived Organic Nitrogen in Treatment Systems and Receiving Waters (NUTR1R06d)** **Maximizing the Dual Benefits of Advanced WWTP Processes: Reducing Nutrients and Emerging Contaminants (Chesapeake Bay STAC, MWCOG, WERF)**	Series of collaborative WERF-sponsored workshops (2006-2008), on nutrient removal, reduction, sources, bioavailability, impacts, and recalcitrance of various wastewater nitrogen species. As wastewater treatment facilities in the Chesapeake Bay implement enhanced nutrient removal and control technology strategies, they also help reduce endocrine disrupting compounds, personal care, and pharmaceutically active compounds. These workshops established what we know and do not know about the various fractions of nitrogen, and led to a coordinated, multi-year research agenda. Joint workshop reports are available at: www.chesapeake.org/stac/Pubs/eonworkshopreport.pdf
Nutrient Management Volume 2: Removal Technology Performance & Reliability (NUTR1R06k)	Comprehensive two-year study of 22 real-world nutrient removal plants designed and operated over three years to meet very low effluent TN and TP concentrations (as low as 3 mg/L TN and 0.1 mg/L TP). Focused on maximizing what can be learned from existing technologies in order to provide a database that will inform key decision makers for both technologies and rationale for statistical permit writing.
Demonstrating Advanced Oxidation/ Biofiltration for Pharmaceutical Removal in Wastewater (U2R11)	Developed and demonstrated design criteria for UV/H_2O_2 advanced oxidation process (AOP) followed by downstream biofilm-based treatment for removing biologically recalcitrant pharmaceuticals like carbamazepine from wastewater effluents. It builds on WERF study *Demonstrating Advanced Oxidation Technologies on Pharmaceutical Removal Downstream of Biological Treatment* (INFR6S609) which demonstrated that UV combined with hydrogen peroxide produces breakdown products that could be completely biodegraded.
Developing a Standardized Protocol for Assessing the Biodegradability of Trace Organic Compounds (U3R10)	Established a standardized approach for site-specific evaluations of trace organics removal and a protocol that outlines how to perform biodegradation tests under conditions that closely match the system being considered – biological technologies.

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