Executive Summary

WERF

Using sludge produced from chemical P removal processes to further remove P from upstream processes

Solids Role in Tertiary Chemical Phosphorus Removal by Alum (NUTR1R06t)

This research examined the capacity and kinetics of P removal by chemical solids from wastewater and factors that affect the reaction.

The Central Issue

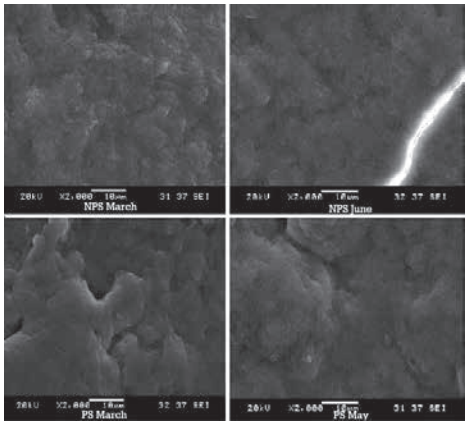
The need to control and remove phosphorus (P) in discharges from water resource recovery facilities (WRRFs) to prevent eutrophication of receiving waters is well known. Regulations encourage stringent P limits in discharge permits. Removal of P beyond the limits of biological or enhanced biological P uptake requires the use of chemical coagulants, most often alum.

This research examined the capacity and kinetics of P removal by chemical solids from real wastewaters and factors that affect the reaction.

Context and Background

The use of chemical coagulants to reach very low levels of effluent P, most often alum, produces large quantities of chemical sludge. The sludge is generally viewed as a waste product. Reducing the dose of precipitant (i.e., alum) added to achieve the desired P removal would reduce the amount of waste product.

The researchers investigated the influence of mixing, pH, contact time, precipitated solids concentration in the mixing tank, and feed secondary effluent (SE) characteristics when using chemical coagulants for tertiary P removal. An understanding of those influences could be used to enhance the process and optimize the operating conditions.



Results of SEM image showing that sludge is a porous surface.
NPS = Non Polymer Sludge; PS = Polymer Based Sludge.

The report presents full-scale and lab-scale investigations of some of the parameters previously listed on tertiary P removal with a specific focus on the role of precipitated solids in enhancing P removal and/or reducing the dose of precipitant to be added to achieve the desired P removal. The study was conducted at the Iowa Hill Water Reclamation Plant and Farmers Korner Wastewater Treatment Facility in Breckenridge, CO, and at the Illinois Institute of Technology.

Findings and Conclusions

The research demonstrated that sludge produced from chemical P removal processes can be used to further remove P from upstream processes, as well as in the chemical P removal process.

This full-scale investigation found that the age of the solids over a typical operating range has no effect on the performance of the chemical phosphorus removal (CPR) process as a whole, and that while a greater inventory of these solids may provide additional capacity for P removal, they spend the majority of retention time in the clarifier where minimal adsorption is taking place.

The point of addition of the recycled chemical sludge can be selected to improve the efficiency and stability of the CPR process. As alum dose is decreased, the particulate reactive P fraction increases. Thus the tradeoff between chemical dose and energy requirements for filtration should be considered, particularly in the case of tertiary membrane filtration.

Management and Policy Implications

New process flowsheets can be created to take advantage of the sorptive capacity of CPR sludges, leading to ultra-low effluent P concentrations at significantly reduced alum doses.

CPR sludges can return to the primary clarifier influent, the aerator, or secondary clarifier. These options take advantage of existing solids separation processes. It is reasonable that as alum doses are reduced in the coagulation/flocculation process, the capacity of the CPR sludge will also be reduced, until a balance is achieved.

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Related WERF Research

Project Title	Research Focus
Nutrient Management: Volume 1 – Regulatory Approaches to Protect Water Quality Review of Existing Practices (NUTR1R06i)	Provides a better understanding of key nutrient management issues and technical challenges that currently confront point source wastewater dischargers and regulators nationwide in setting and meeting low nutrient effluent limits.
Nutrient Management: Volume 2 – Removal Technology Performance & Reliability (NUTR1R06k)	Comprehensive two-year study of 22 real-world full-scale 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). Provides database for key decision makers about proper choices for both technologies and rationale bases for statistical permit writing.
Phosphorus Fractionation and Removal in Wastewater Treatment – Implications for Minimizing Effluent Phosphorus (NUTR1R06l)	Investigates wastewater treatment configurations to determine the various P fractions, and their fate and susceptibility to a range of different P removal processes in order to gain better insight into the removal efficiency and mechanism of different P fractions through various treatment technologies.
Striking the Balance Between Nutrient Removal in Wastewater Treatment and Sustainability (NUTR1R06n)	Provides a bench-top analysis on finding the balance between nutrient removal and sustainability in order to determine if a point of diminishing returns is reached where the sustainability impacts of achieving increased levels of nutrient removal outweigh the benefits of better water quality.
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: **http://www.chesapeake.org/stac/Pubs/eonreport.pdf, http://www.chesapeake.org/stac/DONWorkshop.html#materials**
Bioavailability of Phosphorus from Treated Wastewater Effluent in the Spokane River (NUTR4C09)	Uses algal growth to estimate the amount of bioavailable phosphorus in treated wastewater.

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