

# Web-Based Biosolids Reduction Roadmap Tool, Including Additional Testing on Effects of Aluminum and Iron Addition

## Evaluation of Aluminum and Iron Addition during Conditioning and Dewatering for Odor Control (03CTS9a)

## Effect of Aluminum and Iron on Odors, Digestion Efficiency, and Dewatering Properties (03CTS9b)

## Web-Based Biosolids Odor Reduction Roadmap Tool (03CTS9c)



**These studies provide valuable information on how strategic addition of metal salts can increase treatment efficiency and significantly reduce biosolids odors.**

**M**anagement of biosolids odors in local communities is important to the wastewater industry. To better understand how odors are generated from biosolids and what actions wastewater treatment plant (WWTP) operators can take to identify sources and control odors, WERF embarked on a comprehensive research effort. This research tested relationships between WWTP process parameters and biosolids odors in the laboratory and at full-scale. The goal was to develop effective techniques to minimize biosolids odors following anaerobic digestion.

WERF published the principal findings of this research, *Biosolids Processing Modifications for Cake Odor Reduction* (03CTS9T), in 2008. The following reports, *Evaluation of Aluminum and Iron Addition during Conditioning and Dewatering for Odor Control* (03CTS9a) and *Effect of Aluminum and Iron on Odors, Digestion Efficiency, and Dewatering Properties* (03CTS9b) provide additional information on metal salt addition at various points in the treatment process to improve odor reduction capabilities.

The 2008 report included a decision tree to help users apply the large body of research and supporting studies to the complex task of identifying sources and controlling biosolids odors at a wide range of treatment facilities. At the suggestion of subscribers, WERF developed an interactive, web-based version of the decision tree to further facilitate use of the suite of biosolids odors research products at individual treatment plants. *Web-based Biosolids Odor Reduction Roadmap (BORR) Tool* (03CTS9c) includes the complete text of all WERF reports related to biosolids odor reduction, a database with more than 100 abstracts related to wastewater biosolids odor reduction, in addition to the decision matrix tool. Highlights of the research are provided below. Projects 9a and 9b were conducted concurrently; Project 9c was conducted last, to integrate all the findings.

## Overall Findings

The two research studies provided valuable information on how strategic addition of metal salts can increase treatment efficiency and significantly reduce biosolids odors. The research also confirmed that the interactions of iron and aluminum are complex and at times competing. Appropriate onsite testing and monitoring are necessary to effectively achieve the desired results. Some key findings include:

## BENEFITS

- Provides an interactive decision tree tool and web-based resources for treatment plant personnel and engineers on research findings regarding biosolids odors.
- Provides guidance for applying metal salts in the field to control biosolids odors and reduce polymer demand.
- Provides a better understanding of the impact of shear at various points in the treatment process on odor production.
- Provides an understanding of the interactions of metal salts, biosolids, and shear, and the effectiveness of metal salt addition to reduce odorant production.

## RELATED PRODUCTS

*Identifying and Controlling Odor in the Municipal Wastewater Environment: Literature Search and Review* (00HHE5A)

*Health Effects of Biosolids Odors: A Literature Review and Analysis* (00HHE5C)

*Impacts of In-Plant Parameters on Biosolids Odor Quality* (00HHE5T)

*Biosolids Processing Modifications for Cake Odor Reduction* (03CTS9T)

## RELATED ONGOING RESEARCH

Wastewater Treatment Plant Design and Operations Modifications to Improve Management of Biosolids Odors and Sudden Increases in Indicator Organisms (SRSK4T08)

## AVAILABLE FORMAT

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# EXECUTIVE SUMMARY

- Monitoring iron and aluminum concentrations in raw sludges is necessary to optimize downstream addition of metal salts with regards to treatment efficiency and odor reduction. Higher concentrations of iron in raw sludges resulted in increased anaerobic efficiency, but also resulted in greater production odor-producing Total Volatile Organic Sulfur Compounds (TVOSC).
- Iron addition to sludges *immediately before* digestion improved treatment efficiency *and* lowered TVOSC.
- Addition of metals salts to digested solids prior to or during dewatering effectively reduces TVOSC production, but the shear applied during dewatering needs to be considered to optimize the chemical dosage and odor reduction achieved.
- Addition of metal salts directly to dewatered sludge cake was effective at reducing odor-causing TVOSC.

## Research Examined the Effects of Iron and Aluminum in Wastewater and Solids through Various Phases of Treatment (03CTS9b)

An example of the complexity of iron and aluminum interactions is that raw sludges with higher iron content digest more efficiently, but produce more odor related compounds. The research provided valuable insights on testing for iron and aluminum throughout the plant and ways to optimize chemical addition to control odors.

Three distinct locations for the iron and aluminum were studied. First, the impact of the iron and aluminum content in the raw sludges on digestion and organic sulfur compounds was evaluated. Second, the impact of the addition of iron or aluminum for phosphorus removal in the activated sludge process was studied. Third, the direct addition of iron to the feed to an anaerobic digester was evaluated. All studies were conducted in the lab using a variety of sludges collected from seven wastewater utilities. However, iron addition immediately before digestion improved treatment efficiency, but did not increase the production of odor compounds.

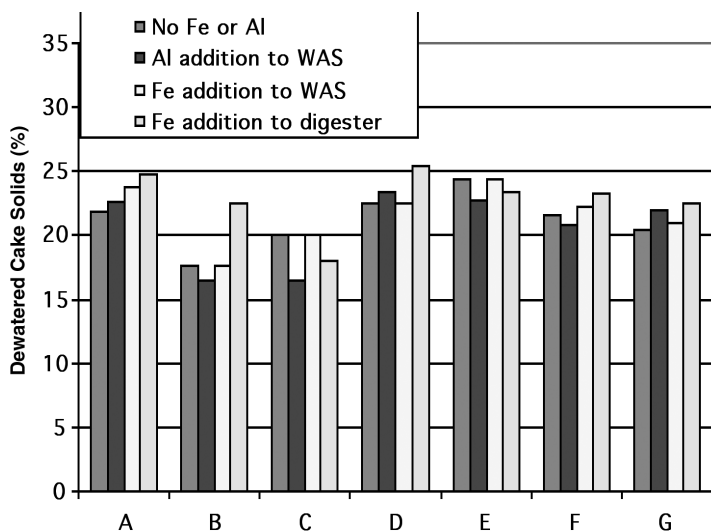


Figure 1. Effect of Chemical Addition on Cake Solids Comparing Seven Municipal WWTPs.

The study results indicate that both iron and aluminum in raw sludges being fed to anaerobic digesters impacted the volatile solids destruction, dewatering characteristics and total volatile organic sulfur compound (TVOSC) generation of anaerobically digested sludges. TVOSC is one of the principal contributors to biosolids odors. Higher concentrations of iron in the raw sludge generally improved anaerobic digestion efficiency and resulted in greater volatile solids reduction. However, as the iron content increased, generation of odor-producing TVOSC also increased. Furthermore, as the concentration of iron in the raw sludge increased, the polymer dose needed to dewater anaerobically digested sludge also increased. The implication is that sludges that digest better may also generate higher, more odor causing compounds and require more polymers for dewatering. For this reason, the iron and aluminum content in raw sludges should routinely be measured and compared to results measured in the field for solids destruction and TVOSC. This information can be used to evaluate the role of iron and aluminum in anaerobic digestion and odor production. Data from this study indicated that TVOSC concentrations in dewatered cakes increased as the concentration of iron increased. When the iron concentration was below 15 mg/gm TS, TVOSC was below 200 ppm (volatiles as sulphur), which is considered to be a low odor value. The results for aluminum were not clear.

With regard to iron and aluminum addition for phosphorus removal, little difference in volatile solids destruction by anaerobic digestion was seen for sludges that received iron, while a slight decrease in volatile solids reduction was seen for aluminum addition. Both iron and aluminum addition to activated sludge produced lower TVOSC generation from digested sludges in most cases. Iron addition immediately before digestion improved treatment efficiency and lowered TVOSC. Reductions in TVOSC were substantial for some sludges, reducing TVOSC concentrations by 90% or more.

Direct addition of iron to the combined primary and secondary sludges before anaerobic digestion resulted in greater volatile

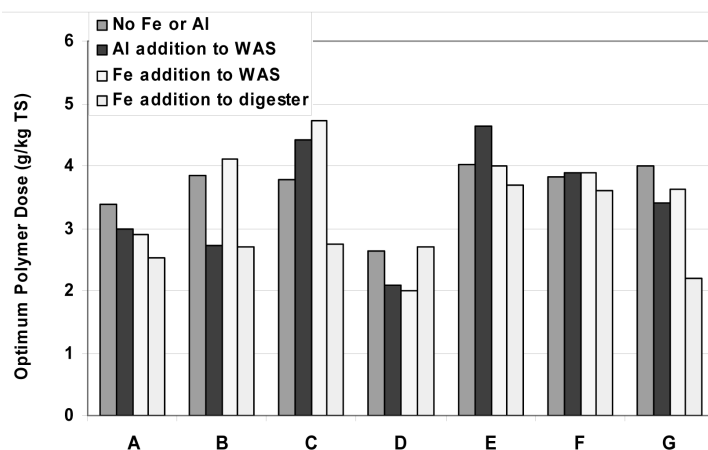


Figure 2. Effect of Chemical Addition on Optimal Polymer Dose Comparing Seven Municipal WWTPs.

solids destruction, much lower TVOSC generation, and higher dewatered cake solids. The benefits to TVOSC reduction were substantial enough that iron addition at 1.25% of TS to the digester feed should be considered as an odor reduction technology.

**Companion Research Examined Factors that Affect Chemical Addition for Odor Reduction during Conditioning and Dewatering (03CTS9a)**

This research corroborated that complex chemical interactions, in addition to physical properties of the solids and treatment systems, make it difficult to develop a “standard approach” for aluminum and iron addition for biosolids odor control. Solutions will be site-specific, but through laboratory and pilot testing procedures recommended by this research, reduction in effective odorant production can be achieved.

The objectives of this research were to investigate the factors impacting the effectiveness of metal salts in reducing the production of odor-causing TVOSCs in biosolids, with the goal of developing recommendations for applying metal salt addition in the field for odor reduction. The research examined a number of factors which could impact the effectiveness of metal salt addition which included chemical dosage, types of chemicals, location of the addition point, the shear applied to the solids, and different biosolids sources.

The results showed that metal salt addition can reduce VOSC production, but the effectiveness is especially impacted by the shear applied to the biosolids. Greater amounts of shear resulted in greater dosages required to achieve VOSC reduction. Little differences in odor reduction were found when comparing the chemical addition points during conditioning, before, with, or after the polymer. Although, from a dewatering perspective, the best application point is to add the metal salt prior to the polymer

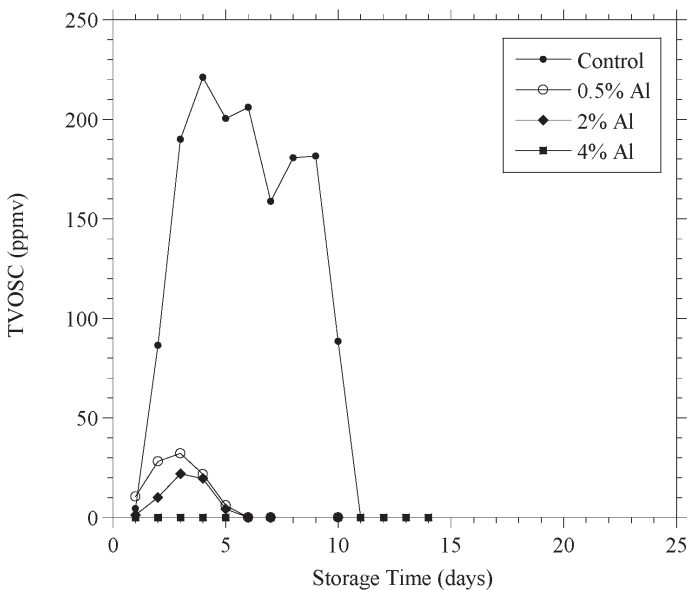
addition. Addition directly to the cake was also effective at reducing odors. The addition of metal salts can be applied to reduce the production of odorants, although laboratory and possibly pilot testing usually is needed to predict the dosage that will be required.

A series of experiments was performed to examine the impact of metal salt addition on the production of a key group of odor causing compounds. The objective was to investigate the factors which impact the effectiveness of the metal salt addition in reducing odorant production, with an overall goal of developing recommendations for practitioners that would like to implement metal salt addition for odorant reduction.

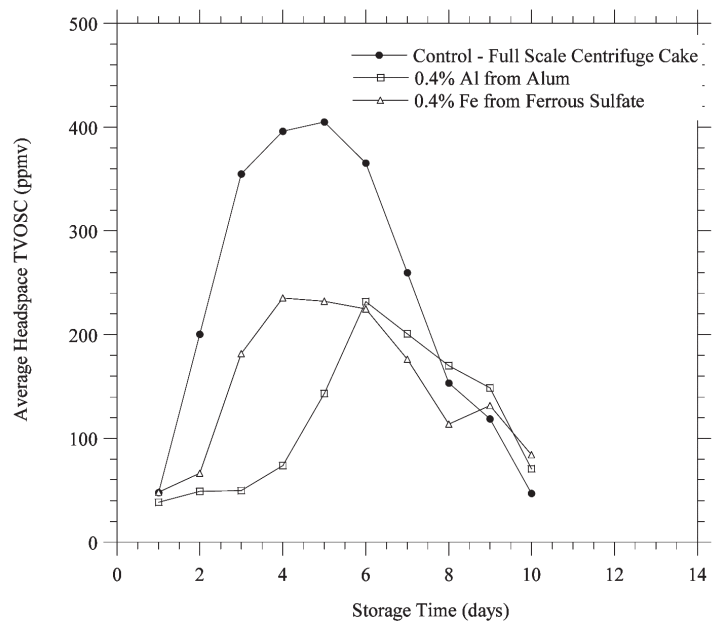
The results showed that metal salts could reduce VOSC production when added to biosolids either during conditioning and dewatering or directly to the cake after dewatering. Addition of metal salts before, after, or simultaneously with the polymer had similar effects on reducing VOSCs. However, addition of the metals after the polymer caused deterioration in dewaterability and increased the polymer demand, while addition prior to or with the polymer reduced the polymer demand. The results also showed that the chemical dosage required for odorant reduction varied based on several factors, especially the shear applied to the solids. For example lower dosages, considered up to 1% of the metal could be added for lower shear conditions, while moderate dosages between about 1-2% for moderate shear, and greater than 2% for higher shear conditions.

**Web-Based Biosolids Odor Reduction Roadmap Tool (03CTS9c)**

The biosolids odors reduction “roadmap” is a web-based decision tool that uses a treatment process-based schematic diagram of potential measures to identify and reduce odors from biosolids at different points in a typical wastewater treatment plant.



**Figure 3. Effect of Alum Addition on TVOSC Production in Laboratory Trial.**



**Figure 4. Effect of Fe Sources Added Directly to Cake on Methane Production.**

The web-based tool and resources include:

## Study Reports

The tool contains links to the full set of WERF research reports on biosolids odor identification and reduction. Each chapter from a report is linked to the table of contents, and the report's bibliography is in turn linked to a literature database. Each chapter of the study reports is provided to users as a downloadable PDF file.

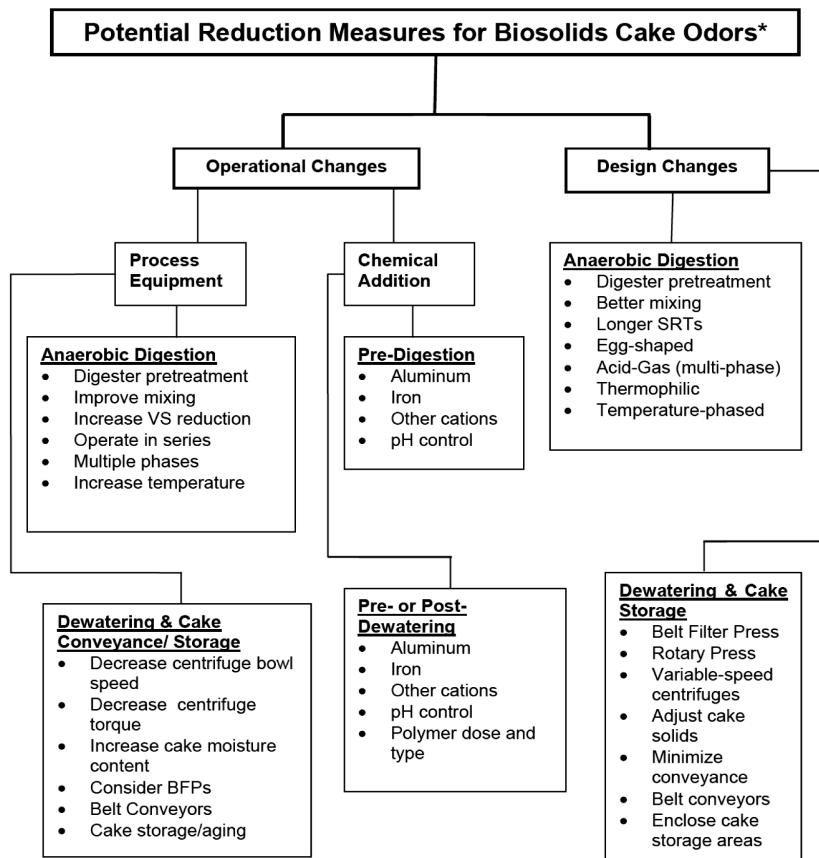
## Literature Database

The literature database feature contains an indexing function for searching and sorting each field of bibliographic data. Additionally, paper abstracts and reviews are keyword searchable.

## Decision Matrix

A key feature of the tool is a decision tree matrix to provide guidance for design, problem solving, and technology selection. It uses a logical structure to help users focus on approaches and issues pertinent to their specific problem. The decision matrix does not provide definitive answers or detailed design findings; rather, it directs users to the appropriate methods and technologies that should be considered. The decision matrix flags points in the decision-making process where additional data might be needed. The decision matrix also flags common pitfalls corresponding to the subject being queried and cautions against counterproductive actions. Each level of the matrix is linked to more-detailed information in the WERF reports and other tool resources.

The decision tool and resources are available to WERF subscribers through the WERF website ([www.werf.org](http://www.werf.org)). The tool is expandable and can be updated when additional ongoing biosolids odor reduction research results are available.



\*Note: None of these options should be considered independently of the others, and odor reductions in one area may impact treatment processes and odors in other areas. Therefore, an integrated and customized approach is required for each WWTP.

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