APPLICATION OF A CALCIUM HYDROXIDE SLURRY WITH METABOLIC MODIFIER FOR CONTROL OF HYDROGEN SULFIDE ODORS AT THE SIESTA KEY WASTEWATER TREATMENT PLANT

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ABSTRACT

In April 2016, Sarasota County Utilities investigated odor complaints from the Siesta Key WWTP. It was determined that the complaints were due to hydrogen sulfide odors from the effluent of the plant's existing odor control scrubber. This scrubber processes foul air from the headworks and equalization tank. The Siesta Key WWTP has been in operation since the late 1960s, and is slated to be decommissioned within a year and a half and converted to a master pump station. However, the aging wet chemical scrubber has been struggling to handle increased hydrogen sulfide loadings, resulting in several complaints from the surrounding neighborhoods. A solution was necessary to mitigate these odors.

Due to the short life span of the facility, improvements to the vapor-phase system were deemed cost-prohibitive. Therefore, a liquid phase treatment method was necessary for this application. Due to the nature of the upstream collection system, it was preferred to feed chemical directly into the force main discharge at the headworks. This feed configuration resulted in a detention time on the order of seconds, meaning any viable technology must be fast acting with rapid dissolution.

Upon evaluating the conditions of the application, it was determined that a pH shift technology using a calcium hydroxide based slurry with a metabolic modifier would be excellent for controlling odors at the headworks and EQ tank, reducing the loadings on the chemical scrubber. Furthermore, this alkaline calcium hydroxide slurry rapidly dissolves in wastewater, providing an almost instantaneous effect at the application point. As a result, the calcium hydroxide slurry could be fed directly into the force main discharge at the headworks and have a significant impact on hydrogen sulfide concentrations at the plant.

Hydrogen sulfide (H_2S) is a partially soluble, volatile gas notorious for causing offensive odors and corrosion in collection systems and treatment plants. While in an aqueous solution, H_2S exists in equilibrium with two ionic forms: hydrosulfide (HS-) and sulfide (S=). These ionic compounds are completely non-volatile, and are unable to escape into the vapor phase or result in any offensive odors or corrosion issues. (WEF, 2001)

At a neutral pH of 7.0, approximately 50% of the sulfide in solution will be in the H_2S form, and can escape to the atmosphere causing odor and corrosion problems. By shifting the pH of the solution to nearly 8.3, more than 95% of sulfide will be trapped in solution as non-volatile ionic sulfides (EPA, 1985).

Prior to chemical treatment, H_2S loadings at the inlet of the scrubber averaged 75 ppm, while the outlet of the scrubber averaged 3.4 ppm with peaks up to 24 ppm. Based on the plant's current flow rate of 4.9 ML/d (1.3 MGD) and an untreated pH of 7.4, approximately 757 L/d (200 GPD) of the calcium hydroxide slurry was fed into the headworks force main discharge. The solution was applied using an advanced dosing controller to match dose-to-demand and maintain a relatively constant wastewater pH. Once optimized, an average pH of 8.2 was achieved. H_2S loadings to the inlet of the scrubber were reduced to 5.8 ppm, with 0 ppm from the scrubber outlet, effectively eliminating odors in the surrounding area.

This paper describes the investigation methods used to quantify the problem, the implementation and optimization of the resultant solution, and presents the results of the optimized process.

KEYWORDS: Chemical Treatment, Headworks, Odor / Air Emissions

INTRODUCTION

Siesta Key, a barrier island located off the coast of Sarasota, has often been ranked as one of the nation's most beautiful beaches, making the island a popular tourist destination for Sarasota County and the State of Florida. The island is home to many high-end neighborhoods, shopping and tourist districts, as well as the Siesta Key Wastewater Treatment Plant located in the middle of the island within proximity to these high profile areas. The Siesta Key WWTP was constructed in the late 1960s, and has been in operation since then. Due to the age of the plant and the sensitivity of the area, the Siesta Key WWTP was scheduled to be decommissioned in 2018 to be replaced by a master pump station, which would convey sewage from the island to a treatment facility located on the mainland.

In early 2016, Sarasota County Utilities started receiving complaints from the neighborhoods surrounding the Siesta Key WWTP regarding wastewater odors. These odors were characterized as having a "rotten egg" smell, typically associated with hydrogen sulfide (H_2S). At the time, the WWTP only utilized a packed tower scrubber for odor control, which treated foul air from the headworks and equalization tanks.

The initial response to these odor complaints was to ensure that the headworks covers and equalization tank was completely airtight, preventing arrant releases of foul air from the plant. In addition the wet chemical scrubber was air-balanced to make sure that proper airflow was processed from the desired areas of the plant. Despite these improvements, odor complaints persisted. It was concluded that the plants aging wet chemical scrubber was processing foul air with sulfide loadings higher than its original design conditions. As a result, the scrubber was unable to effectively remove H_2S, and residual hydrogen sulfide from the scrubber outlet propagated into the islands surrounding neighborhoods.

METHODOLOGY

Aside from completely replacing the wet chemical scrubber with a new adequately sized unit, or making drastic rehabilitations to the system, Sarasota County Utilities required a method for mitigating the odors from the soon to be decommissioned plant that was not cost-prohibitive and

could be mobilized quickly to resolve the odor complaints. Because of this, liquid phase odor control treatment with a temporary feed system was deemed the most economical method for reducing hydrogen sulfide loadings to the scrubber during the remaining life of the plant. As one of the County's primary suppliers of Odor Control Technologies and Services, the County worked alongside Evoqua Water Technologies to determine an appropriate chemical solution.

Many liquid phase odor control technologies exist for reducing H_2S odors, including but not limited to; Nitrate salts, Iron salts, Oxidizers and pH shift technologies. Due to the configuration of the collection system upstream of the wastewater plant and site limitations, many of these technologies were not applicable for this scenario. As can be seen from Table 1, retention times upstream of the plant were only on the order of minutes, with the average retention times on the island being approximately 0.5 hours:

Table 1 – Siesta Key Wastewater Treatment Plant Primary Sulfide Contributors

Upstream Lift Station	Flow (ML/d)	Length (m)	Size (cm)	Avg. RT (hrs)
Avenida Del Norte LS	0.999	604.4	15.2	0.3
Oyster Cove LS	0.625	430.7	15.2	0.3
Stickney Point LS	1.110	976.6	20.3	0.7
Mangrove Point LS	0.814	958.6	15.2	0.5
Baytree Club LS	0.625	430.7	15.2	0.3
Turtles LS	0.386	1003.1	15.2	1.1
Average				**0.5**

Furthermore, the upstream lift stations either lacked physical space for the installation of a chemical feed system or were located in highly sensitive tourist /residential areas where a chemical feed system would not be aesthetically pleasing.

Because of these constraints, the only applicable chemical feed point was the Siesta Key WWTP itself. Chemical would need to be fed directly into the force main as it breaks to gravity at the plant headworks. Applying chemical in this manner would only provide a mixing time on the order of seconds.

Nitrate salts typically require 1.5 hours for complete removal of H_2S, and would have required to be fed upstream of the plant, making this an inviable technology. Additionally, Oxidizers such as 50% hydrogen peroxide normally need 30 minutes for complete removal to occur, meaning this could not have been fed at the plant and provide reliable control. Iron salts are faster acting (~5 minutes), however chemical safety was a major concern, meaning both Iron salts and Oxidizers could not be used.

Of the technologies evaluated, increasing the wastewater pH using a calcium hydroxide slurry and metabolic modifier was the only method capable of providing a rapid dissolution of product and reduction of sulfide in the order of seconds. As such, calcium hydroxide pH shift could potentially be achieved by feeding product at the plant headworks. Magnesium hydroxide, another pH shift product was considered, however could not be used due to its slow dissolution time. Sarasota County decided to proceed with a trial of this calcium hydroxide slurry with metabolic modifier in order to determine the efficacy of the product at the Siesta Key WWTP.

Summary of the Study Site

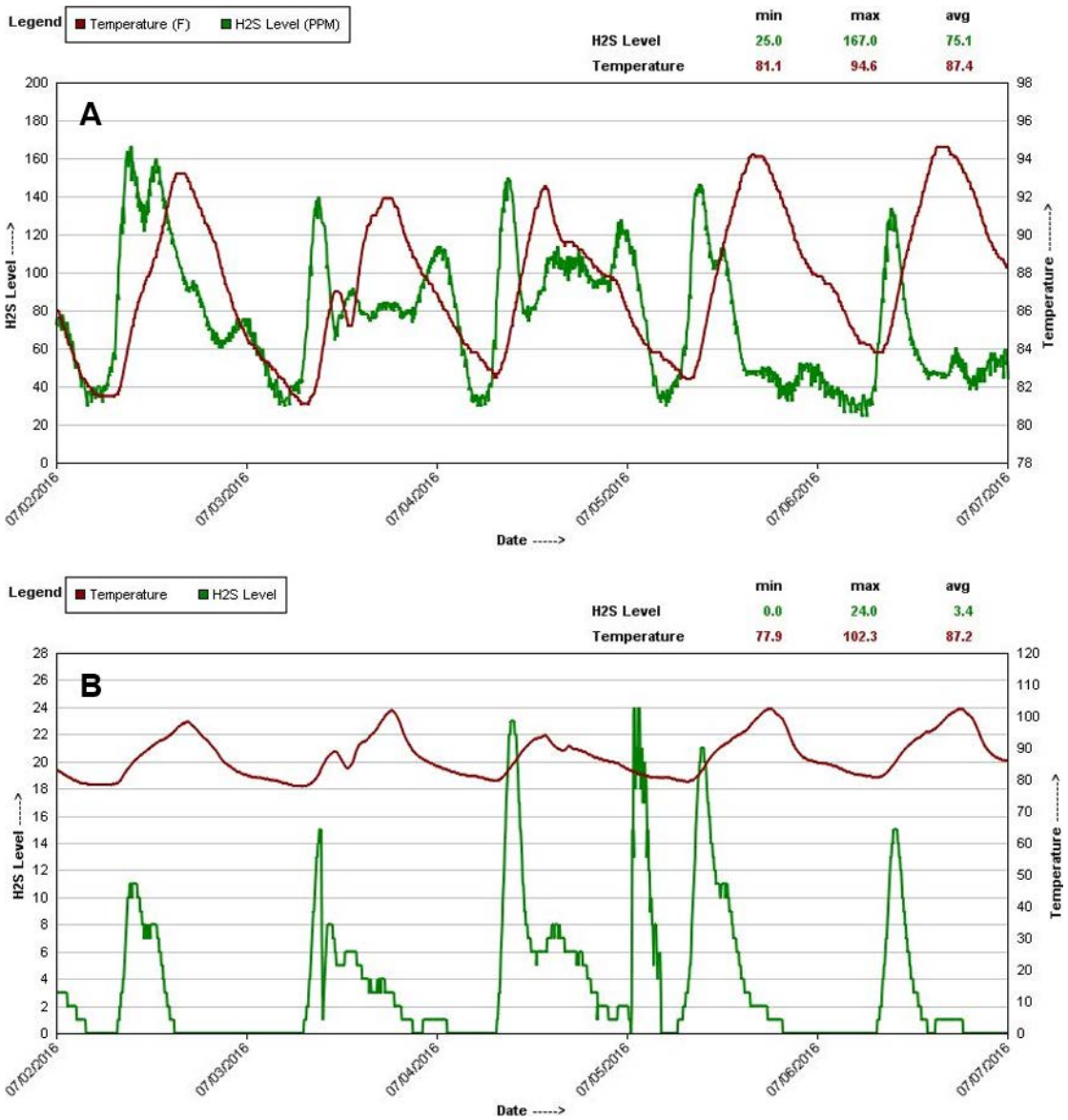

Figure 1 – Untreated Atmospheric H_2S. A) Scrubber Inlet, B) Scrubber Outlet.

At the time of this study, the Siesta Key WWTP handled an average of 4.9 ML/d (1.3 MGD) (+/- 5%) of sewage per day. Prior to feeding chemical, the influent pH of the plant averaged 7.4 based on liquid grab sampling. Atmospheric H_2S concentrations were recorded using continuous data loggers equipped with cellular modems for remote monitoring.

While untreated, atmospheric hydrogen sulfide concentrations from the Siesta Key WWTP Chemical Scrubber Inlet averaged approximately 75 ppm. Atmospheric hydrogen sulfide levels from the outlet of the Chemical Scrubber were originally measured at an average of 3.4 ppm, with peaks up to 24 ppm. This untreated H_2S data is represented above in Figure 1.

The following treatment objectives were established by Sarasota County Utilities for the trial:

- Average Atmospheric Sulfide (Scrubber Inlet): ≤ 10.0 ppm
- Average Atmospheric Sulfide (Scrubber Outlet): ≤ 0.50 ppm
- Average Wastewater pH: 8.3 – 8.5

Dose Estimation and Impacts on Hydrogen Sulfide

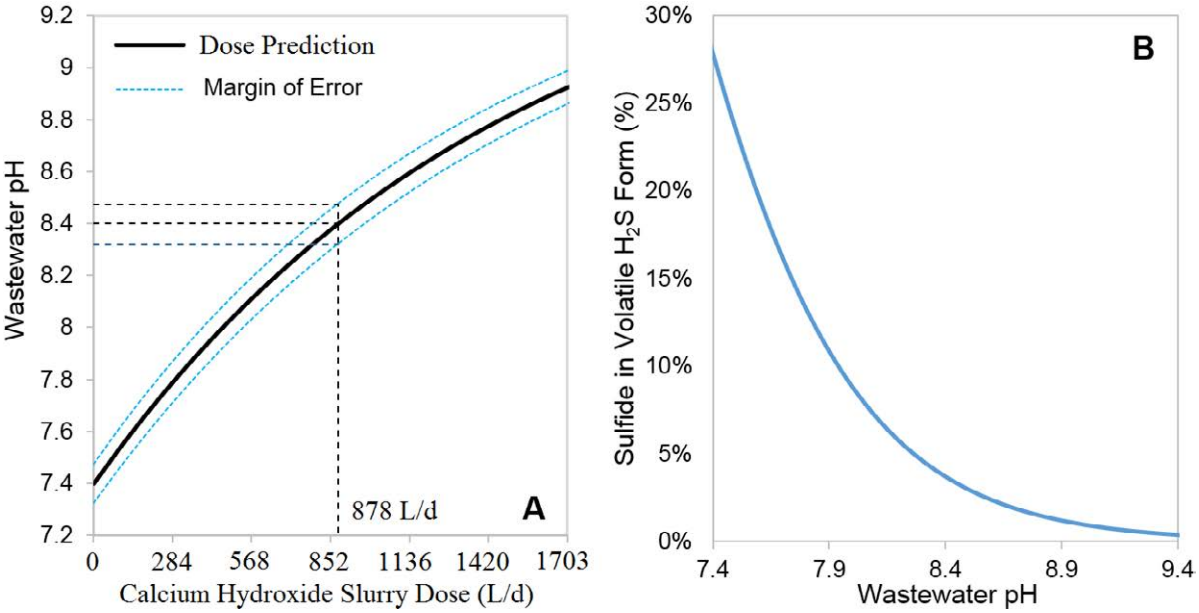

Figure 2 – Calcium Hydroxide Slurry Dose A) Dose Predictions B) pH Sulfide Relationship

In order to predict the necessary dose of calcium hydroxide slurry, Evoqua used model relationships derived from titration data performed using Sarasota County wastewater and samples of the calcium hydroxide slurry. This relationship is shown in Figure 2 (a) above. Based on the average daily flow rate of 4.9 ML/d (1.3 MGD) (+/- 5%) and the untreated pH of 7.4, the dose required to shift the pH to 8.3 – 8.5 was estimated at approximately 878 L/d (232 GPD).

While in an aqueous solution, volatile malodorous hydrogen sulfide (H_2S) exists in equilibrium with two non-volatile ionic forms: hydrosulfide (HS-) and sulfide (S=). These ionic compounds are unable to escape into the vapor phase and cannot result in any offensive odors or corrosion issues. (WEF, 2001) At a pH of 7.4, approximately 28% of the total sulfide would exist in the volatile H_2S form. By shifting the pH with the calcium hydroxide slurry, the total sulfides existing as volatile H_2S should reduce to nearly 5 – 3%, meaning an overall reduction of free volatile H_2S at the plant by 82 – 89%. This relationship is demonstrated above in Figure 2 (b).

Due to the hourly variation in flow entering the Siesta Key WWTP, an advanced dosing platform with hourly dose curves was required. By implementing a dose curve, the County would be able to feed precise volumes of chemical to achieve a nearly consistent pH throughout the entire day.

RESULTS

The calcium hydroxide slurry feed system was installed on August 15th and began dosing on August 18th, 2016. The chemical discharge line was run approximately 25 feet into the influent

force main in order to allow for sufficient mixing before wastewater entered the plant headworks. Photographs of the installed system, and chemical discharge line as well as the odor control scrubbers and draw points have been provided in Figure 3.

Following installation of the chemical feed and storage system at the Siesta Key WWTP, calcium hydroxide slurry feed rates were set at about 890 L/d (235 GPD) and incrementally reduced. During this process, atmospheric H_2S concentrations from the Chemical Scrubber Inlet and Outlet were continuously monitored using remote H_2S cellular data loggers.

Initially the 24 hour Dose Curve was adjusted in order to eliminate fluctuations in the hourly H_2S levels entering the Scrubber. Once these fluctuations were mitigated, a global modifier was used to reduce feed rates and determine the optimum dose rate. The final adjusted feed rate for the Siesta Key WWTP feed system was 757 L/d (200 GPD). At this feed rate, H_2S levels exiting the chemical scrubber consistently remained 0 ppm. Feed rates lower than 757 L/d (200 GPD) resulted in occasional spikes in concentration up to 1 ppm. Due to the sensitivity of the area, the feed rate was left at 757 L/d (200 GPD) in order to efficiently eliminate all H_2S odors from the Scrubber outlet. The final optimized Dose Curve is shown in Figure 4 (a) below.

Figure 3 – Calcium Hydroxide Slurry System at the Siesta Key WWTP A) Feed system and storage tank, B) Chemical discharge line, C) Odor control scrubbers, D) Odor control scrubber draw points.

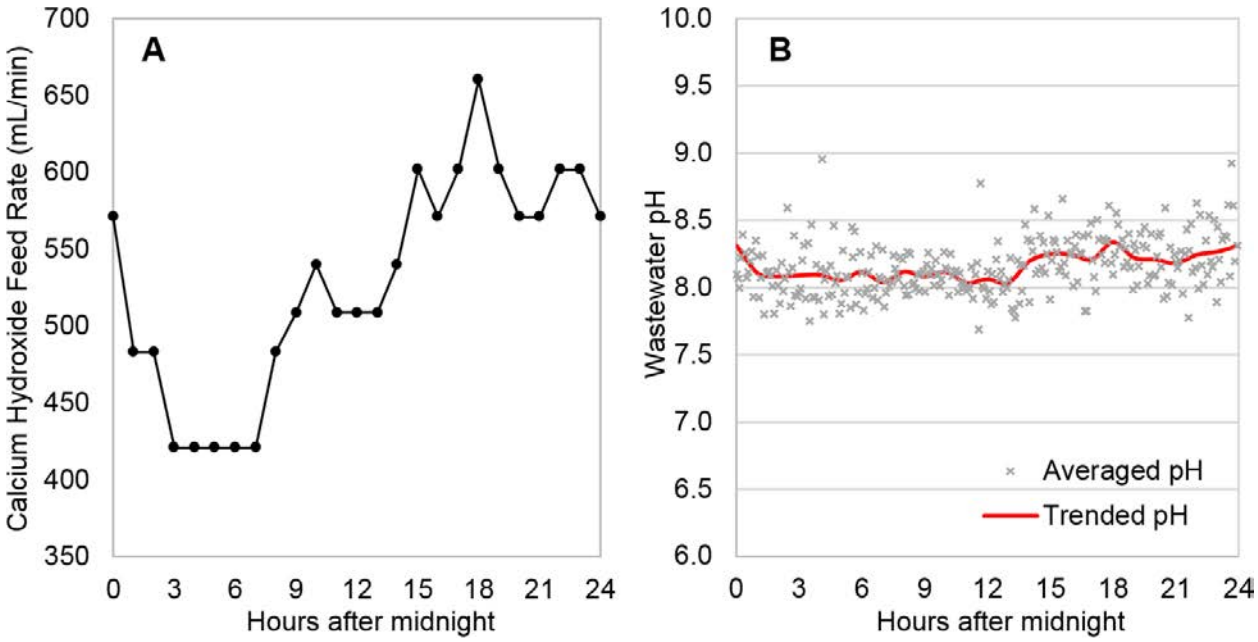

Figure 4 – Siesta Key WWTP Optimized Configuration A) Daily Dose Curve B) Treated Wastewater pH

In addition to monitoring H_2S data, shown in Figure 5, Evoqua deployed a continuously logging pH probe, to monitor the pH of the wastewater while the calcium hydroxide slurry was fed at 757 L/d (200 GPD). The pH probe was hung at the discharge of the force main on the headworks. This pH data, shown in Figure 4 (b), was recorded between the dates of September 4th – 9th, 2016, and averaged over each hour to determine trended pH values. From Figure 4 (b) it can be noted that the trended pH averages approximately 8.2 with a slight level of fluctuation throughout the day. However, the consistency of the pH values can be directly attributed to the effectiveness of using 24 hour daily dose curves to match dose to demand in this application.

The final optimized sampling data for the control point was found to be:

- Average Atmospheric Sulfide (Scrubber Inlet): 5.8 ppm
- Average Atmospheric Sulfide (Scrubber Outlet): 0 ppm
- Average Wastewater pH: 8.2

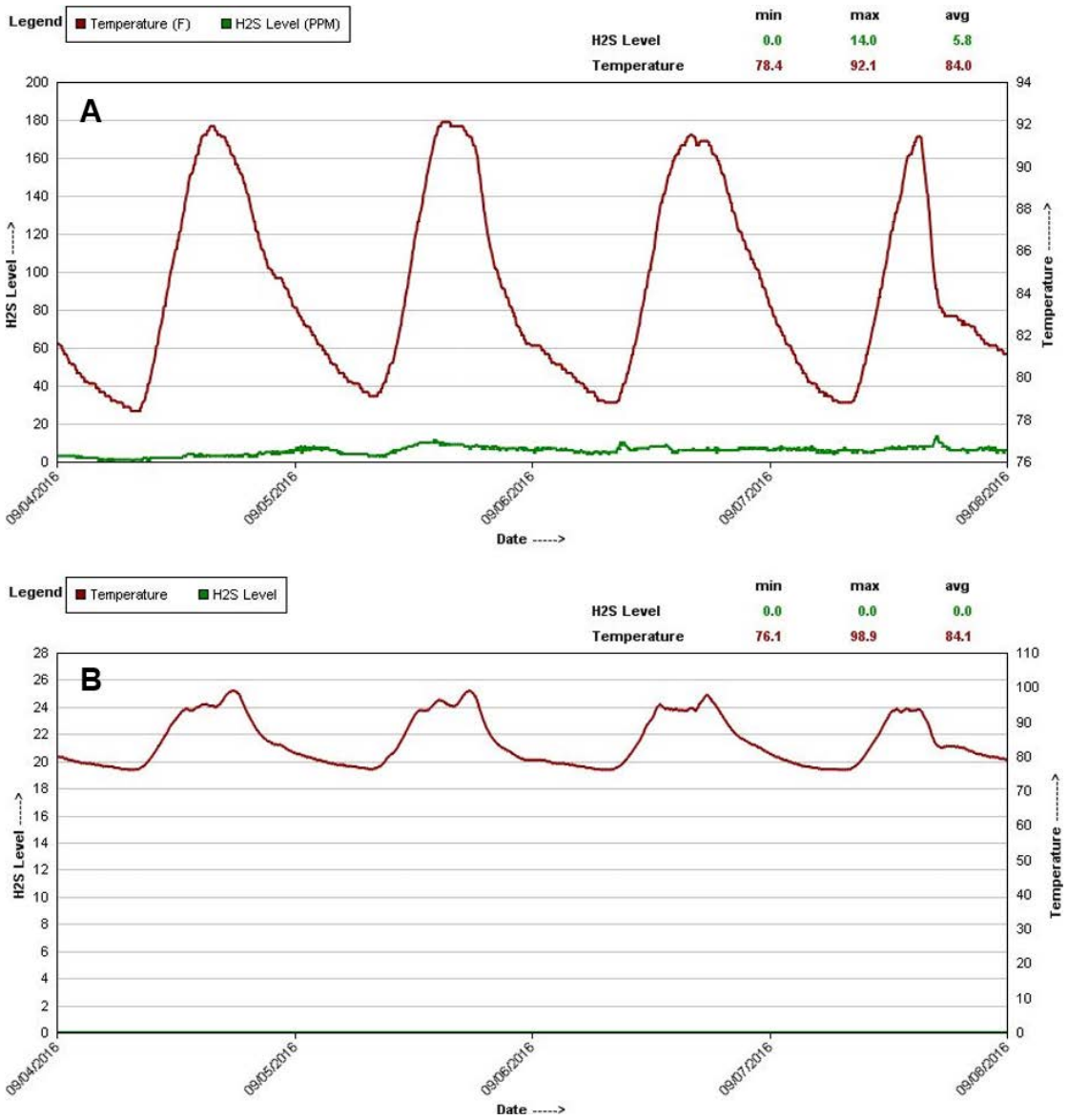

Figure 5 – Treated Atmospheric H_2S. A) Scrubber Inlet, B) Scrubber Outlet

DISCUSSION / CONCLUSIONS

By using a calcium hydroxide slurry with a metabolic modifier, Sarasota County and Evoqua were capable of reducing the hydrogen sulfide loadings at the Siesta Key Wastewater Treatment Plant to a level that could be easily handled by the plants aging wet chemical scrubber. The calcium hydroxide slurry was applied directly into the influent flow before the headworks, and due to its ability to rapidly dissolve, was capable of achieving an effect on the H_2S with only seconds of available mixing time.

Average wastewater pH was elevated from 7.4 (untreated) to approximately 8.2 by feeding 757 L/d (200 GPD) of the calcium hydroxide slurry. In doing so, average atmospheric H_2S at the inlet of the plants scrubber was reduced from 75 ppm to 5.8 ppm. Furthermore, the atmospheric

H_2S at the scrubber outlet was reduced from an average of 3.4 ppm with peaks up to 24 ppm, down to an average of 0 ppm. By utilizing the advanced dosing platform and 24 hour dose curves, the county was able to effectively reduce overfeeding and underfeeding of the calcium hydroxide slurry. This is supported by the continuously monitored pH data collected, which demonstrates only slight variation of pH around the average of 8.2. Following successful completion of this trial, Sarasota County Utilities decided to remain treating the Siesta Key WWTP using the calcium hydroxide slurry, and is continuing to feed product to date.

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