City of New Ulm Wastewater Treatment Facility Improvements

Class A Bio-solids Production

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Background

With a population of approximately 13,000, the City of New Ulm's wastewater strength is similar to that of a community of 100,000 due to several industries that operate within the city. The design parameters for the facility are provided in the table below.

Design Flows and Loads Wastewater Treatment Facility New Ulm, Minnesota	
Flow	**Loading**
ADW Flow = 2.28 MGD	CBOD5 = 24,166 lbs/day
AWW Flow = 6.77 MGD	
PHWW Flow = 9.40 MGD	

The City of New Ulm wanted to address their aging wastewater treatment facility and upgrade to newer technology where it would be beneficial. The wastewater treatment facility consists of pretreatment, two primary clarifiers, biological and chemical phosphorus removal, four activated bio-solids basins, three secondary clarifiers, and disinfection using chlorine. The bio-solids treatment consists of an aerobic storage tank, gravity thickening, pre-digester storage tank, four aerobic digesters, and four storage basins prior to land applying the bio-solids.

The city uses an Autothermal Thermophilic Aerobic Digestion (ATAD) system at their wastewater treatment facility to treat bio-solids and this system is one of only a few in the state. The ATAD system produces Class A bio-solids at the highest level of treatment available, allowing the city additional flexibility when land applying the final product. The design and equipment of the ATAD system, installed in 1996 as part of an upgrade project, was supplied by the German company, FUCHS. While the ATAD system was still producing Class A bio-solids, it was nearing the end of its useful life. The system consisted of four cast-in-place concrete tanks with a concrete roof and each tank contained one circular aerator, three spiral aerators, and eight foam cutters. Having 12 pieces of moving equipment in each tank and 32 total pieces of moving equipment in all 4 tanks, city staff spent considerable time replacing and repairing the equipment.

The city was also experiencing elevated hydrogen sulfide (H2S) and odor at their main lift station. Since it was vented and exhausted directly to the outside, the odor affected nearby residential and commercial properties. The ventilation air supplied to the dry well of the main lift station was upgraded in 2007 with a new make-up air unit and exhaust fan. Existing make-up air units and exhaust fans were also reconfigured to provide additional air exchanges in the operating space. Due to the age of existing ventilation equipment in the main lift station the city was interested in upgrading ventilation and addressing the hydrdogen sulfide levels and odors.

Proposed ATAD

Since the ATAD system was installed in 1996 there have been improvements to ATAD technology used for newer installations. These improvements have reduced the amount of equipment used in each tank, now with only a few major pieces, thereby reducing the amount of equipment requiring maintenance or eventual replacement.

There are two main manufacturers of ATAD equipment. FUCHS, the manufacturer of the city's 1996 system, and Thermal Process Systems (TPS). FUCHS has two systems, one with equipment similar to that currently installed in the New Ulm ATAD system, and the other a new-generation system using only a couple pieces of equipment. Unfortunately the new-generation system would not work in the existing tankage, so replacement with similar equipment was the only option available for FUCHS. The TPS system uses new-generation equipment utilizing a blower and mixing pump for each tank, greatly reducing the amount of equipment needed. Additionally, the equipment with moving parts (blower and mixing pump) are located outside of the tankage, allowing for easier operation and maintenance of the equipment.

An analysis was performed in order to compare the lifetime costs of the two prospective ATAD replacement systems supplied by FUCHS and TPS. The results of this analysis indicated the TPS system has a lower lifetime cost compared to the FUCHS system. Based on the lower lifetime cost along with the ease of maintenance with the new-generation system, the TPS system was proposed for replacing the existing system.

TPS ATAD Pumps

Proposed Lift Station

The main lift station was vented and exhausted directly to the outside. The higher levels of hydrogen sulfide in the lift station dispersed foul odor to the ambient air surrounding the lift station and nearby neighborhood. To deal with the odors, the city could install a new carbon air scrubber unit in an exterior location or inside a new building addition. The existing exhaust air streams would be ducted to the new air scrubber.

Both options required water and drain systems for the new scrubber system, regardless of location. It was also recommended to replace the existing 6,700 cfm roof-mounted make-up air unit and supply ductwork serving the existing screen room with new equipment and ductwork. The three existing exhaust systems needed to be routed over and connected to the new odor scrubber system. Due to concerns of freezing conditions, difficulty maintaining an exterior unit, and aesthetic concerns, installation of an odor scrubber in an exterior location with no

Lift Station Addition

building was not recommended. Therefore, the city decided to construct a new building adjacent to the main lift station and house the new odor control equipment in the new building.

Construction

The project was awarded to Rice Lake Construction Group for approximately $4.5 million in November 2016. Construction began in May 2017, the ATAD system was substantially completed by September 2017, with final completion of both sites in December 2017. The City of New Ulm desired to return to producing Class A bio-solids as soon as possible, therefore a tight project schedule was developed that would allow the city to return to Class A bio-solids production quickly. A shop drawing workshop was held between Bolton & Menk, Rice Lake Construction Group, and TPS in order to quickly and efficiently review the critical shop drawings for this project and achieve the aggressive schedule. Numerous issues and delays were avoided due to this workshop, as each party was able to review the design together and bring potential issues and conflicts to the attention of others. Timely delivery of equipment was critical to keep the project moving and ensure it was completed on time. Construction meetings were held every other week and communication between each party was established to ensure any issues or delays during construction could be resolved quickly.

ATAD Construction

The city wanted to maximize the amount of Class A bio-solids produced before construction began therefore, shutting down the old ATAD system had to be coordinated with the city and the contractor. While construction occurred on the existing tanks the city produced Class B bio-solids and stored in their existing holding tanks. The city has four bio-solids holding tanks, each approximately 867,500 gallons, for a total bio-solids storage volume of 3,470,000 gallons. The design bio-solids feed rate to the holding tanks is 18,100 gpd, which allows for approximately 180 days of storage. During construction the available bio-solids storage volume was extended by decanting the holding tanks as needed. The Class B bio-solids were eventually land applied to city sites approved for Class B bio-solids.

The source for the heat exchanger's water supply and location of the discharge was a construction challenge. The original plan called for using city water, but this would have been too costly for the facility. Alternatives included building a storage tank for city water to be cooled and reused by the heat exchanger and the use of the facility's non-potable water (NPW). The NPW was determined to be the most viable option but the existing service lines for the NPW system were in poor condition and had been shut off due to leaks and breaks. Evaluation of the existing NPW pumps and lines were completed and it was determined the existing pumps would be used and a new service line installed, to ensure that a reliable water source is available. This resulted in installation of approximately 1,050 feet of forcemain, mostly installed through directional drilling. The drain for the heat exchanger was connected to an existing forcemain from the bio-solids holding tanks that lead to the primary clarifiers.

The condition of two of the ATAD tanks had also deteriorated over the years and required concrete repair and a new interior coating. The existing wall and ceiling penetrations from all the previous equipment were in-filled and new openings for piping and equipment were core drilled. There was minor degradation of the exterior masonry that required resurfacing as well. The old biofilter that treated the off-gas was demolished and a new, larger biofilter was installed for the new system. This new biofilter contains haydite and root-wood media to filter the off-gas from the ATAD system.

ATAD Tanks

Lift Station Construction

It was known prior to construction that the lift station addition would require piles due to the poor soil, but it was unknown the original construction of the lift station was done with a step-excavation, resulting in poor soils directly next to the existing building for a greater depth than was expected. Additional pile lengths were required for the piles directly next to the existing building. The additional pile lengths were welded onto the existing piles that had been driven into the ground, but had not reached their design work loading capacity.

With the piles in place and the floor poured, the walls and air scrubber equipment could be installed. To transfer air from inside the main lift station to the addition containing the air scrubber, large fiberglass reinforced plastic ducts were installed to bring air from the lower levels up to ground level and into the addition. An overhead door was installed on the addition to allow for easier replacement of the activated carbon media in the air scrubber.

Lift Station Air Scrubber
Pictured: Jeremy Hillesheim, New Ulm Wastewater Chief of Maintenance (L) and Mitchell Swanson, Bolton & Menk Engineer (R)

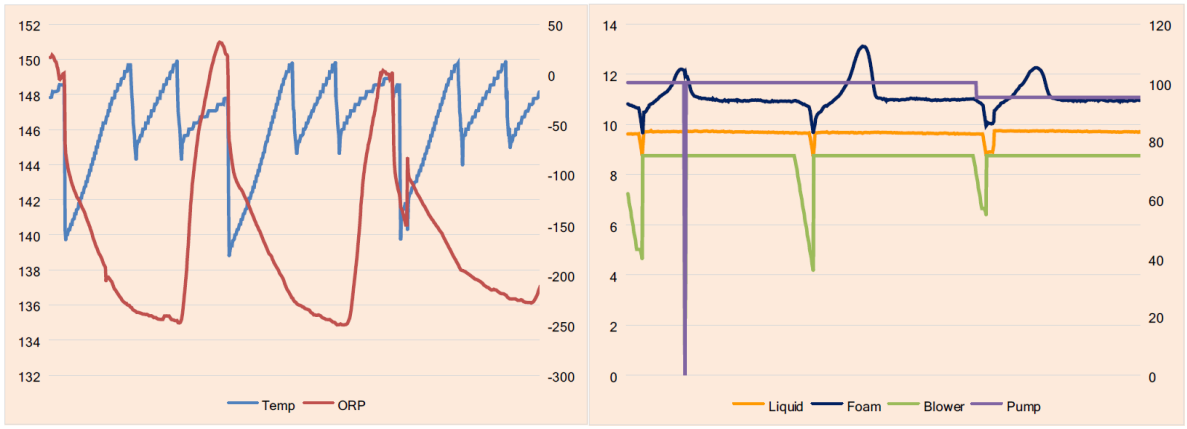
Operation

The ATAD system produces high-quality Class A bio-solids using a two-step digestion process. The first step involves thermophilic digestion designed to rupture cells, solubilize the food substrate, and remove a high percentage of biologically degradable material. The second step is mesophilic digestion designed to polish the material by reducing soluble COD, VFAs, and nitrogen compounds. Successful operation requires proper temperature control and oxygen transfer in all process steps. The system is semi-automated and controlled by the oxidation-reduction potential (ORP) in the ATAD tanks and pH/ORP in the storage nitrification denitrification reactor (SNDR) tank.

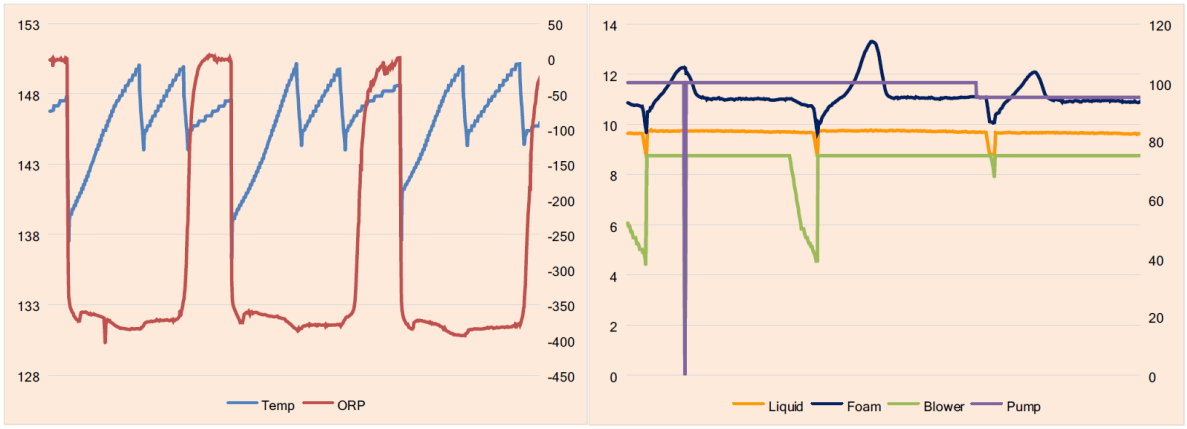
The ATAD tanks were brought online one tank at a time to allow proper environmental conditions to be established. The tanks were filled with water to check for leaks and test the equipment. Then most of the water was drained and bio-solids were mixed with the remaining water to obtain a three percent mixture of solids in Tank No. 1. This tank was then batch fed once per day to avoid overloading the system. The ORP and temperature were monitored closely to verify the initial startup was proceeding correctly. The temperature was allowed to climb until it reached 113°F (45°C), then the thermophilic bacteria would begin to dominate and the ORP would fluctuate. Tank No. 2 was brought online after Tank No. 1 reached its maximum liquid level. Tank No. 2 was initiated by emptying half of Tank No. 1 into it. These tanks were then batch fed every other day, on alternating days of each other. Once Tank No. 1 and Tank No. 2 were at their operating level, Tank No. 3 was initiated. Tanks No. 1 and No. 2 function in parallel then both feed, in series, into Tank No. 3. The ATAD tanks were brought online faster than anticipated, as the bacteria grew and heat climbed faster than estimated.

Tank No. 4, the SNDR, was initiated once all three ATAD reactors were at operational levels. The SNDR was fed slowly to ensure its contents remain below 100°F (38°C), in order to optimize the growth of Nitrifers and De-Nitrifiers.

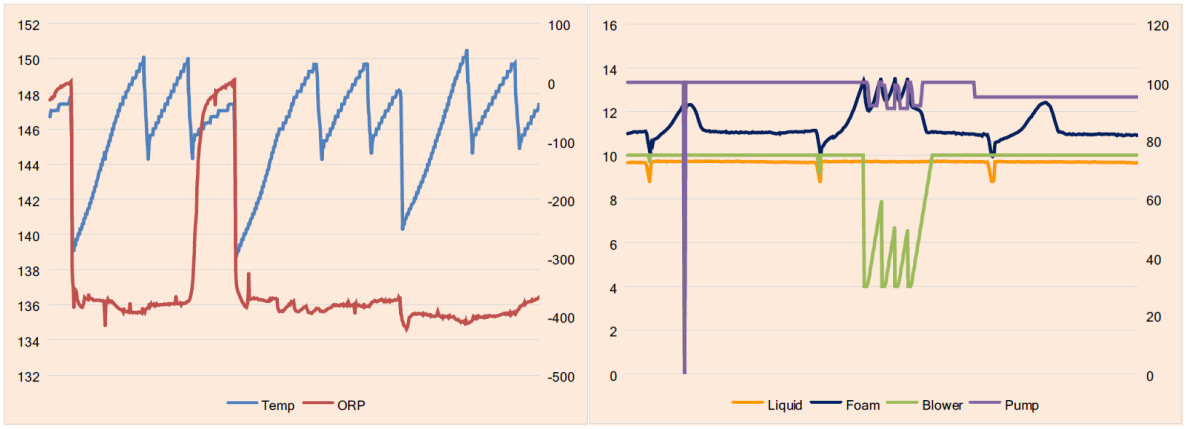
The following graphs show a days' worth of data for the ATAD and SNDR tanks. The ORP drops into the negative range during and after the feed and recovers when oxygen demand is reduced. Low ORP dips are an indication of high biological activity and high oxygen demand. High oxygen transfer results in high heat generation. As the ORP comes up toward "0 mV," the biological reaction rate and oxygen demand reduces. During the reduced demand, the pump and blower speeds are reduced to conserve heat in the reactor by reducing evaporative heat loss and energy to operate the equipment.



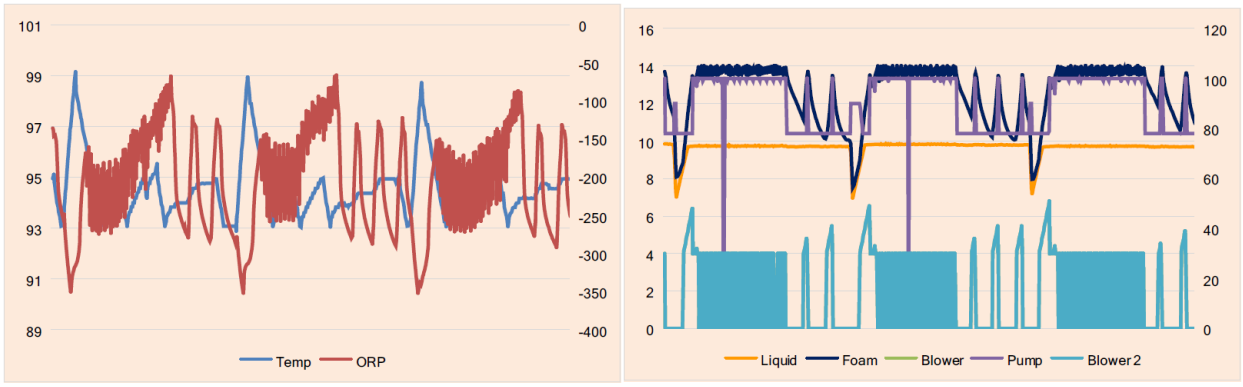
ATAD Tank No. 1



ATAD Tank No. 2



ATAD Tank No. 3



SNDR Tank

Outcome

Through effective and diligent communication this project was able to finish on time and within budget. The city was able to return to processing Class A bio-solids within five months. The four digester tanks available to New Ulm allow for greater flexibility in bio-solids processing, as they have ranged from 10,000 to 18,000 gallons daily. The new process allows for one touch transfer and the ability to hold temperatures within requirements to meet 503B bio-solids rules for Class A time and temperature requirements. In addition, odors from the ATAD system have been greatly reduced and there is flexibility in operating pump and blower speeds, allowing for energy savings. The new main lift station air scrubber has reduced hydrogen sulfide and odor in the lift station and surrounding neighborhood as well and provides a better working environment.

ATAD Blowers