Start-Up and Operations of the City of Delphos MBR / ThermAer ATAD Wastewater Treatment Facility

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ABSTRACT

The City of Delphos, Ohio along with their engineers designed a new state-of-the-art wastewater treatment plant utilizing flat plate membrane (MBR) technology (Enviroquip/Kubota) coupled with an autothermal thermophilic aerobic digestion (ATAD) 2nd generation (ThermAer^{TM}) solids treatment system to address the current and future needs of the city as well as the Directors Final Findings and Orders (DFFOs) filed against the city by the Ohio Environmental Protection Agency (EPA). The city received funding for this project from the Ohio EPA's Division of Environmental and Financial Assistance (DEFA). The plant has a design average day flow of 3.83 MGD (14,500 m^3/day) with a peak 48-hour flow of 12 MGD (45,500 m^3/ day). The average dry weather flow is 1.5 MGD (5,700 m^3/day). The ATAD system is designed for a solids loading of 8,700 lbs/day (4,000 kg/day). The community has a 70% combined sanitary sewer system with seven permitted combined sewer overflows.

The entire project included the following: an addition to an existing equalization basin bringing the total storm equalization capacity of the system to 12 million gallons (14,500 cubic meters); a new pumping station with course screens at the existing plant with two 18-inch (450 mm) force mains to pump the flow to the new plant site; a headworks building with fine screening and grit and grease removal; a septage receiving station; a membrane bioreactor using flat plate technology; vertical ultraviolet (UV) disinfection system; ThermAer ATAD (Class A or exceptional quality) solids handling system with gravity belt/ belt press units; SCADA control system; new administration building with offices, laboratory and vehicle storage and demolition of the existing facilities.

This paper and presentation will briefly describe the design of this new facility and the decision process behind going with an MBR and moving from a Class B to Class A wastewater solids treatment process; however, it will focus mainly on the first 18 months of operations and maintenance at the facility. The author will discuss the basic operations of the MBR system and the detailed start-up and operations of the ThermAer ATAD system focusing on training, staffing requirements, and operational costs and benefits of utilizing these two treatment technologies to meet strict effluent limits for (carbonaceous biochemical oxygen demand 5 day (CBOD5), nitrogen ammonia and phosphorus brought on by a recent total maximum daily load (TMDL) study while producing an exceptional quality biosolids product that is being utilized within the community. The paper and presentation will include data associated with the ATAD system such as percent total solids and percent volatile solids destruction, and percent total solids of the exceptional quality cake product being utilized for land application. Polymer and alum dosage rates and associated costs for each system will also be discussed.

KEYWORDS

ATAD, ThermAer, Biosolids, Membrane Bioreactor, MBR, Operations and Maintenance, O&M, Start-up, digestion, Class A

INTRODUCTION

Beginning in 2005, the City of Delphos began the construction of a wastewater treatment improvement project that now allows the community to adequately treat its high organic loadings, improve the effluent quality being discharged into Jennings Creek and meet the Total Maximum Daily Loadings (TMDLs) for the Auglaize River Watershed.

The new (2006) state-of-the-art facility is the largest flat plate membrane bioreactor facility in North America. It is also the only flat plate membrane treatment facility in operation with an Autothermal Thermophilic Aerobic Digestion ThermAer (ATAD) solids handling system.

The City of Delphos, Ohio along with their engineers designed the new wastewater treatment plant utilizing Enviroquip / Kubota flat plate membrane bioreactor (MBR) technology coupled with a 2nd generation ATAD solids treatment system from Thermal Process Systems to address the current and future needs of the City as well as the Directors Final Findings and Orders (DFFOs) filed against the City by the Ohio Environmental Protection Agency (EPA). The use of this treatment technology to address peak flows was a unique application at the time of design of the facility. Start-up of the new facility occurred in October 2006. The City received funding for this project from the Ohio EPA's Division of Environmental and Financial Assistance (DEFA). The plant has a design average day flow of 3.83 MGD (14,500 m^3/day) with a peak 48-hour flow of 12 MGD (45,500 m^3/day) and an 8-hour peak flow of 18 MGD (68,000 m^3/day). The average dry weather flow is 1.5 MGD (5,700 m^3/day). The ATAD system is designed for a loading of 8,700 lbs/day (4,000 kg/day).

The project included the following: an addition to an existing equalization basin bringing the total storm equalization capacity of the system to 12 million gallons (45,000 m^3); a new pumping station with course screens at the existing plant with two 18-inch (450 mm) force mains to pump the flow to the new plant site; a headworks building with fine screening and grit and grease removal; a septage receiving station; a membrane bioreactor using flat plate technology; vertical ultraviolet (UV) disinfection system; ATAD (Class A or exceptional quality) solids handling system with gravity belt/ belt press units; SCADA control system; new administration building with offices, laboratory and vehicle storage and demolition of the existing facilities.

The treatment plant is designed to deal with two unique situations present in Delphos. The City of Delphos has a seventy percent combined collection system; thus, there can be large fluctuations in flow during wet weather events. The average dry weather flow for the community is 1.5 MGD (5,700 m^3/day); however, with just ½ inch (12 mm) of rainfall, the flow at the plant can increase to 12 MGD (45,000 m^3/day) quickly. The new plant is designed for an

8 hour peak sustained flow of 18 MGD (68,000 m^3/day) and a 48 hour peak sustained flow of 12 MGD (45,500 m^3/day). In addition to the peak capacity of the plant, the City of Delphos has 12 million gallons (45,000 m^3) of storm pond holding capacity connected to two interceptor sewers that collect water in excess of the capacity of the existing collection system.

The second unique situation in Delphos is the design loading for the facility. The plant is designed for 12,000 lbs./day (5,500 kg/day) carbonaceous biological oxygen demand (CBOD5) and 9,000 lbs./day (4,100) total suspended solids (TSS). The conventional loading to the facility is extremely high for a community of only 7,000 people. The population equivalent for the City of Delphos is in excess of 50,000 people. This is due to the high loading attributed to the food processing flows coming from three industries located in Delphos. These facilities manufacturer such products as mashed potatoes, sour cream based dips and desserts, gelatin products and soybean meal and oil. Based on production of particular product lines and varying with holidays, the loading to the plant can be highly variable. The membrane bioreactor treatment system lends itself to dealing with this variability much more easily than other types of conventional activated sludge facilities would have.

BRIEF SYSTEM DESCRIPTION

The flow to the new influent pump station arrives via two influent sewers: one 12-inch (300 mm) sewer servicing a small portion of the north end of town and one large 48-inch (1.2 m) sewer that takes the remainder of the flows from the community. There is very little fall across the City of Delphos; therefore, the city has 16 lift stations that force-main flow to gravity sewers that eventually make their way into the 48-inch (1.2 m) trunk line coming into the new influent pump station. The influent pump station is designed to pump the 12 MGD (45,000 m^3/day) peak capacity of the new plant from the site of the old plant over to the green site location of the new plant via two 18-inch (450 mm) force-mains.

The flow then enters one of two completely redundant Andritz 1/8 inch (3mm) fine screens. There is no mechanism by which the flow can bypass the fine screens. This screening is necessary as part of the pre-treatment of flows going to the membranes. The flow then enters a Schreiber aerated grit and grease removal system. From here, the flow falls over a small weir system and combines with the return activated sludge (RAS) flow from the membranes in the influent channel. The flow goes from the influent channel into the anoxic basins of the MBR system. The MBR system has five trains. The fifth train can either be utilized as a membrane bioreactor or a membrane thickener (MBT). The anoxic basins for trains 1 – 4 are combined via holes cored close to the base of each tank to make a common anoxic basin. Train 5 has a separate anoxic basin so that it may be utilized under low or normal flow conditions as a MBT, digesting and thickening solids to 3.0 – 5.0 % before further treatment in the ATAD system. As flows increase, the facility SCADA automatically brings all trains online to treat peak flows.

Once in the anoxic basins, the influent/RAS mixture is pumped utilizing RAS or feed forward pumps from the anoxic basins into pre-aeration basins. The RAS pumps have a maximum pumping capacity of 4,000 gpm (250 l/s). There are Flygt mixers in each of the anoxic and pre-aeration basins as well. From the pre-aeration basins, the flow falls over a concrete weir into the MBR basins. Each MBR tank contains 26 double-stacked flat- plate membrane cassettes. The permeate is pumped via one of 10 Gorman Rupp Super T Series pumps located in the basement of the operations building. There is a separate pump for the upper and the lower cassettes in each train with two shelf spares having been supplied as part of the project. The permeate then flows to a vertical IDI UV disinfection system, through Sanitaire fine-bubble post-aeration and out to Jennings Creek.

Using the concept of *biohydraulics*, the MBR System was designed to exceed biological treatment objectives over the range of expected operating conditions. Designed using the Storm Master™ configuration, the plant is also equipped with the SymBio® technology, which helps to promote simultaneous nitrification and denitrification (SNdN) in the supplemental aeration zone. Operating at low DO in SNdN mode can reduce operating costs and ensure optimum biological process performance. The Storm Master™ design is an important feature of the Delphos WWTP because it further reduces overall plant operating costs by putting offline membrane capacity to beneficial use. Utilizing the Storm Master™ design, Enviroquip and the City's engineers actually automated the plant to handle flows ranging from 300 gpm or 0.019 m^3/sec (0.4 MGD / 1,500 m^3/day) to a maximum net capacity of 8,328 gpm or 0.53 m3/sec (12.0 MGD / 45,425 m^3/day). As a result, the effective turndown ratio of the plant is 28:1. The plant has already experienced minimum recorded flows of approximately 400 gpm (0.025 m^3/sec) and peak flows in excess of 8,000 gpm (0.50 m^3/sec) during periods of high rainfall.

City of Delphos MBR / ThermAer ATAD Wastewater Treatment Facility

Back at the influent pump station, as flow starts to exceed the design capacity of the plant, the flow will then go over a concrete weir to a storm pond wet well. There are two pumps rated for 2,450 gpm (0.15 m^3/sec) each. These pumps send the flow to either of the two storm ponds; one pond is located just north of the park on North Jefferson Street that holds two million gallons (7,500 m^3) and one is located on North Franklin Street that holds just over ten million gallons (38,000 m^3). The pond at North Franklin Street was increased in size as part of this project from four million to ten million gallons (15,000 m^3 to 38,000 m^3).

The City also has two interceptor sewers that capture and convey flows in excess of the existing collection system. The Franklin Street Interceptor Sewer has a capacity of 400,000 gallons (1,500 m^3) and conveys storm flows to the Franklin Street Storm Pond pump station that sends the flows directly to the Franklin Street storm pond. The Jennings Creek Interceptor Sewer has a capacity of 323,000 (1,220 m^3) gallons and conveys water to the North Street pump station that pumps the storm water to the Jefferson Street storm pond. There is also an equalization line between the two ponds that allows the flows to equalize to either of the two ponds when open. The storm water from these ponds is returned to the influent pump station wet well once the flows at the treatment plant have decreased enough to begin to receive the storm water. The storm water then receives full treatment at the plant. If the wet weather event continues and the treatment facility is treating 12 MGD (45,000 m^3/day) and the ponds become full, the system will bypass from one of the seven approved points in the collection system. The entire system, according to our approved Long Term Control Plan (LTCP) is designed to reduce those bypasses to less than four events in a typical year.

Franklin Storm Lagoon – Increased from 4 to 10 million gallons in 2006

DESIGN AND PLANNING

The City had been issued DFFOs from the Ohio EPA in March of 2002 and the former superintendent retired in May 2002. In addition to beginning negotiations with the Ohio EPA on the Findings and Orders, the city was in the middle of negotiating a consent decree with one of their significant industrial users, Orval Kent / Chef Solutions. The first objective was to review the Findings and Orders and develop a game plan so that the treatment plant staff could get a handle on what was actually going on at the treatment plant, within the system with the industrial users and the pretreatment program and then assist the engineers and the city's environmental lawyer in responding to the Findings and Orders in a timely manner with the most up-to-date and valid information.

There were many issues facing Delphos and decisions needed to be made in order to begin laying out the plan for the future of wastewater treatment in Delphos. It was the job of the superintendent to help put forth the decisions and provide options and guidance to the city council and administration to assist them in ultimately deciding what the best options for Delphos were. The feedback from council members varied widely, to say the least. Several felt if the situation were simply ignored it would go away. Ultimately, after many hours of preparation, guidance and deliberations, city council agreed that the city ultimately needed to build a new treatment facility and while several were absolutely opposed, the majority ruled that the city would not make any of the industrial users install their own pretreatment equipment outside of what they already had and Delphos would size the plant to take the current loadings and plan for a small amount of growth for the future.

While Poggemeyer Design Group (PDG) had assisted in the planning phase of the project, the City advertised a Request for Qualifications (RFQ) and a new engineer (Floyd Browne Group and CT Consultants) was hired for the design phase of the wastewater project. It was imperative to have them review and concur with the concepts that had been presented to the Ohio EPA in the Wastewater Compliance Plan that was developed by PDG. This submittal was a facility plan combined with a Long Term Control Plan which was required as part of our DFFOs and NPDES Permit. The concept was to design a plant with a peak design flow that could handle the average daily flows as well as the storm flows for the city and bring Delphos into compliance with the required less than four CSO events per year. In the original plan prepared by Poggemeyer it was suggested that the city needed a facility capable of treating 19 MGD (72,000 m^3/day) for peak wet weather. WWTP staff worked with Floyd Browne and CT Consultants, the city's new engineers, to develop a tabletop model of the collection system and it was determined that the city needed a facility capable of treating 12 MGD (45,425 m^3/day) a day to get below the four combined sewer overflow (CSO) events per year. In the revised Compliance Plan as developed by Floyd Browne and CT, it was suggested that since the city did not have time to do a proper flow study, the facility would be built to treat 12 MGD (45,000 m^3/day) and that the city could add on to existing storm lagoons to capture an additional six million gallons (23,000 m^3) in the future, if it was necessary.

In addition, the original Compliance Plan indicated that the city would be constructing an oxidation ditch type treatment system at the City's existing facility site. Upon review of the conditions and other types of treatment (predominately MBRs), city administration wanted the engineers to consider looking at MBRs as an option. There were concerns voiced by the wastewater department staff that since the oxidation ditch would have been designed with conventional loadings as the limiting factor that the city could be in trouble if the ditch was sized to handle all of the loadings from the industrial users. In addition, since the oxidation ditch process would have provide almost two-thirds of the load to the facility if the industries left or reduced their production, Delphos could have a facility that was difficult to operate if it was designed without the estimated loadings. Since MBRs are designed based on peak flow, they would be more easily adapted to lower loadings at the facility. In addition, the MBR system eliminated the need for clarifiers which had the potential to cause problems with solids during peak wet weather events.

A cost analysis of construction was completed for both types of treatment and the costs were within $1,000,000 of each other; thus, MBRs looked like a viable option for the city. In addition, MBRs would provide the ability to treat to a lower effluent quality in terms of CBOD5 and TSS. This was important, as the TMDL study for the discharge stream was underway at the time of the new system design phase. The revised Wastewater Compliance Plan indicated that Delphos would construct a MBR system capable of treating a peak daily flow of 12 MGD (45,000 m^3/day) and that the city would consider the installation of additional storm water capacity, if necessary, to get to less than four CSO events per year. In the end, the city agreed to install the additional storm pond capacity as part of the overall wastewater project and the Wastewater Compliance / Long Term Control Plan was approved by the OEPA in December of 2004. During this time, the city continued to negotiate with the OEPA over the Findings and Orders that were finalized in 2004.

The City worked with DEFA to secure the loan for the project that was estimated to cost $29 million. The bids for the project came in at $31,890,000, and it was determined after working with the auditor, that the city would have to raise sewer rates 15% a year for four years beginning in February 2005 and ending in February 2008. The current sewer rate is $68.78 for the first 1,000 cubic feet/quarter (30 m^3/quarter) of wastewater and $6.87 for each additional 100 cubic feet of wastewater per quarter (3 m^3/quarter). This reflects just slightly over a 100% increase from the rates in 2004. Prior to that, the sewer rates had not been raised more than the consumer price index (CPI) increase each year for the past 15 years.

While for reasons mentioned above, the city was leaning toward the MBR process to treatment wastewater, we had the design engineer prepare a site layout and construction cost for the MBR and oxidation ditch processes. The costs were very comparable; however, the foot print was not. The MBR system took up approximately 60% of the new 14-acre site, (5.7 HA) while the oxidation ditch process required 90% of the same site. This, along with the release of the draft TMDL study for Jennings Creek and the Auglaize River Watershed, swayed the city administration to ultimately agree that the MBR process was going to be the best option for Delphos.

During the initial design phase, the city traveled extensively in Ohio, Indiana and Illinois looking at solids handling equipment and pumps, in addition to traveling to Georgia to visit several Enviroquip / Kubota MBR facilities. While no site visits were made to Zenon facilities, the design team and city administration met with Zenon representatives regarding their membrane system. We accepted proposals for both membrane systems and the engineers developed a 20-year cost analysis for each system. In the end, Kubota was the chosen MBR manufacturer for the project.

For the solids handling portion of the plant, it was decided to look at technologies capable of meeting Class A requirements without the use of lime or lime products. Due to the fact that the old facility was plagued with odor complaints, city council was extremely concerned with odor issues associated with the new facility. After attending a presentation on Thermal Process Systems' ThermAer 2nd Generation ATAD system, wastewater facility administration discussed this system as an option with the design engineer. The City staff decided to make several visits to existing facilities to ensure that this system met all of the city's criteria; little to no odor generation, and produce a small volume of biosolids which met Class A requirements. Site visits were also made to several RDP Class A En-Vessel Pasteurization facilities. However, since the process uses lime (that is difficult to handle) and some odors were observed at the toured facilities, this process was ruled out. Ultimately, Delphos chose to specify the Thermal Process Systems (TPS) ThermAer ATAD as the solids treatment system for the new facility. This system was chosen for design specifically for its ability to meet Class A criteria, its record of achieving at least 50% total solids reduction and 60 to 80% volatile solids reduction, and its lack of odor generation due to the integral 2-stage ammonia scrubber/biofilter odor treatment system.

The new Delphos Wastewater Treatment Plant (WWTP) project was estimated to cost $29 million dollars. The bids came in for the project at $31,890,000. The final cost of the project was just slightly over $30 million. The design took less than six months as was required by the Ohio EPA Director's Final Findings and Orders. All things considered, the planning and design phase went amazingly well considering it was a sharp learning curve and there was a very tight timeline dictated by the DFFOs.

With regard to staffing, there were minimal changes made during the course of this project. Initially at the old facility, there were four permanent positions: a superintendent and three operators. During the planning phase of the project, one of those operators was promoted to pretreatment operator which was a newly created position that would be trained on all laboratory work that was recently brought back in-house and assist the superintendent with the pretreatment program and all that it entailed. This created a vacant operator position which was shortly filled bringing the staff to 5 persons for the department: a superintendent, the pretreatment operator and 3 facility operators. Then during construction, it was determined that an additional staff person would be needed due to the amount of maintenance that would be required at the new facility with the increased number of pumps and associated equipment with the MBR system. In the end, the pretreatment operator was promoted to assistant superintendent and the pretreatment operator's job description was incorporated into that of the assistant superintendent minus the laboratory work and an additional operator was hired into the department. Thus, after a three year transition, the final staff count at the time of start-up included a superintendent, an assistant superintendent and four facility operators for a total of six staff members.

DETAILED ATAD START-UP AND OPERATIONS

The City of Delphos utilizes Autothermal Thermophilic Aerobic Digestion or a ThermAer ATAD system supplied by Thermal Process Systems, Inc. for solids treatment. As noted previously in design and planning, this system was chosen for its ability to provide a significant volume reduction and a stable Class A or EQ biosolids material that is effectively odor and pathogen free. While the Delphos facility is a newly constructed state-of-the-art facility, the

ThermAer system can also be easily utilized during a retrofit upgrade of an existing wastewater treatment facility when tankage is available and reduce the overall process footprint compared to conventional aerobic and anaerobic process that produce a Class B biosolids product. This reduction in new footprint or ability to increase capacity without adding tankage is achieved through the accelerated digestion that occurs in thermophilic reactors.

Specifically at the Delphos facility, waste activated sludge (WAS) can be pumped from the MBT (train 5) or directly from the RAS channel at the MBR system by either one of two 40 HP (30 KW) Moyno progressive cavity pumps located in the MBR basement. The WAS can be pumped directly into the ATAD reactors when utilizing the MBT, or to one of the two 2-meter Ashbrook combination gravity belt thickener/belt filter press units (GBT/BFP) located in the solids thickening building when wasting directly from the RAS channel. Polymer is utilized to produce a thickened WAS (TWAS) of approximately 3 to 6 percent solids with the gravity belt thickener. TWAS is pumped from the thickened solids hopper via one of two 20 HP (15 KW) Moyno progressive cavity pumps to one of the two ATAD reactor tanks. This portion of the system is operated at a design 12 day hydraulic retention time (HRT) and in the case of Delphos, is a batch process (feeding one reactor while isolating the other). The ThermAer system can also be run in a continuously fed operation mode depending on the preferences of the facility operation staff and design engineers and the level of automation provided.

From the ATAD reactors, the digested biosolids are pumped to the ATAD storage tank (storage nitrification denitrification reactor or SNDR tank). The addition of this tank to the system is important as it provides a method of biosolids cooling to reduce potential odor generation and BFP polymer consumption and reduces the ammonia concentration in the BFP filtrate that also reduces the aeration demands of the liquid treatment processes. From here, the biosolids are again pumped via another set of two 20 HP (15 KW) Moyno pumps located in the ATAD basement to the BFP units for dewatering. Polymer and alum are added and mixed into the biosolids prior to dewatering to promote phosphorus precipitation and coagulation. Dewatered biosolids fall onto a conveyor belt on the opposite end of the unit from the biosolids hopper and are conveyed through a wall into the biosolids storage building. Biosolids are stored in the biosolids storage building prior to utilization in fields by local farmers or in gardens by home owners. The end product is a Class A biosolids and meets all state and federal 503 biosolids regulations.

ThermAer jet and foam pumps with heat exchanger in the far right

During the normal operations of the gravity belt thickener, the units are operated at approximately 150 gpm (0.009 m^3/sec) or 9,000 gallons per hour (gph) (34 m^3/hr). This operation utilizes just slightly over 1 gph (0.004 m^3/h) of polymer. The thickened WAS is approximately 4 – 6% solids prior to being fed into the ATAD reactors. When the unit is being utilized for pressing, the system is typically operated at 115 gpm (0.007 m^3/sec) or approximately 6,800 gph (25.7 m^3/hr). When pressing approximately 3 gph (0.01 m^3/hr) of polymer and 46 gph (0.174 m^3/hr) of alum are utilized. The pressed product is approximately 25 -28% solids and is discharged from the conveyor system into the storage building. The system produces approximately 30 – 40 tons per month of biosolids for a total of 400 to 450 ton per year. The polymer and alum costs are approximately $75,000 per year.

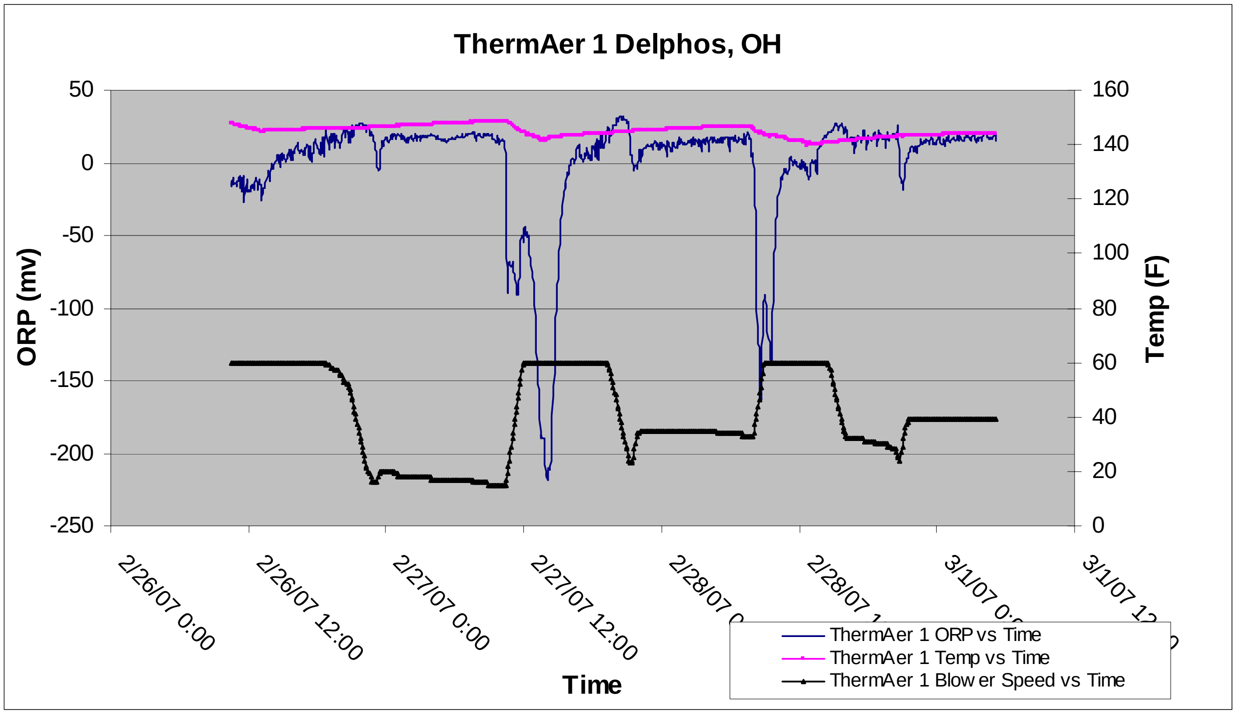
The ATAD system was designed to treat 8,700 pounds (4,000 kg) of dry solids daily. Each ATAD reactor holds approximately 162,000 gallons (613 m^3) and the SNDR tank holds approximately 360,000 gallons (1,360 m^3). The design feed rate to the ATAD reactors is approximately 120 gpm (0.007 m^3/s) at a solids concentration of 4 – 6% solids. Each reactor is equipped with a Sulzer recycle pump rated for 6,000 gpm (0.379 m^3/sec) and a Sulzer foam transfer pump rated for 1,500 gpm (0.095 m^3/sec). The SNDR tank is equipped with a Sulzer recycle pump rated for 4,026 gpm (0.254 m^3/sec). The design and current operational solids retention time is approximately 12 days which resulted in constructing much smaller tanks than many other options.

This digestion process has three basic steps: waste, feed, react. At the Delphos facility, the process is operated five days per week. In the morning, digested biosolids that have met the time and temperature criteria are wasted to obtain the optimal liquid depth and HRT. Once wasting is complete, the tank is then in "feed mode." Under current normal operating conditions, thickened biosolids are introduced to the fully enclosed reactor tanks. These tanks are operated in parallel. During start-up, these tanks were operated in series due to questions that arose during construction regarding the volatile solids content of the MBR solids and whether the volatile solids content would be high enough to bring the reactors up to a proper operating temperature. The reactors achieved an operating temperature of 150 degrees Fahrenheit (F) (65.6 degrees Celsius (C)) within two weeks of start-up and within 4 weeks, the temperature of reactor 2 was at 178 degrees F (81.1 C). At that time, the operations were switched to a parallel operation as originally designed and have remained on the parallel mode. The average operating temperature range of the two reactor tanks is now 140 – 155 degrees F (60 – 68.3 C).

When the tanks are being fed, the operating temperature of the tank begins to drop. Once the feed cycle ends and react mode begins, the temperature begins to rise as the thermophilic process destroys the solids. Air is continuously added to the process by 30 HP (25 KW) positive displacement blowers through a jet aeration header system. The blowers are variable frequency drive (VFD) driven and ramp up or down during treatment based on the ORP (oxidation reduction potential) in the reactor. This assists in the efficiency of the system, but also has another important role - the ability to vary the liquid flow and the air flow independently also aids in controlling the operating temperature of the reactor. This has been shown to be a cost effective operating method while still providing optimum digestion and metabolic conversion.

Four ThermAer ATAD blowers, 3 duty blowers with 1 stand-by

During the feed cycle, the oxygen demand increases. As oxygen demand increases, the ORP decreases, and the blower speeds up. The aeration system is designed and programmed with a maximum and minimum setting. The purpose of the maximum setting is to limit the drop in ORP as well as to limit the amount of time that the ORP remains low. By optimizing the ability of the blower to adjust to these maximum and minimum setpoints, the aerobic digestion efficiency is maximized and the odor potential and electrical costs are minimized. Please note the data in the inserted graph of operations at the Delphos facility. The decline in the blue line (ORP) denotes a feed cycle. The corresponding increase in the black line denotes an increase in the blower speed to provide the necessary oxygen.



The ThermAer ATAD system is also equipped with a foam control mechanism. The foam recycle pump and Foam SplashCone™ controls the thickness of the foam layer which acts as an insulation blanket in the reactor. The Delphos tanks are approximately 23 feet deep, so the foam blanket control is set for 22 feet above the tank floor to allow for four feet of foam at the design liquid operating depth of 18 feet and to eliminate the possibility of foam coming out of the top of the tank. The foam recycle pump allows for the foam to be mixed with a recycle stream, and then returned to the tank via spray nozzles that control the foam depth of the tank. The system is operated based on the foam radar transmitter located at the top of the reactor and the foam recycle pump is also utilized to transfer or waste the digested liquid to the SNDR tank.

Biosolids are also recirculated through the jet aeration system to mix the air with the recycled solids and enhance the oxygen transfer rate within the system. From the reactor, biosolids are pumped through a heat exchanger with a maximum flow of 200 gpm (0.013 m^3/sec), which provides for biosolids cooling, and then into the SNDR tank. While in the SNDR tank, the biosolids are furthered cooled via the heat exchanger to approximately 95 degrees F (35 C); thus, the temperatures drop from a thermophilic range to a mesophilic range. The cooling of the biosolids is important for odor control (re-uptake of the ammonia via the nitrification denitrification process) and acceptable solids dewatering. The greater than 50% TS destruction in the process had a significant impact on the project economics and was a major factor in the ultimate decision to utilize the TPS ThermAer ATAD system at Delphos.

A two-stage odor control system was also provided as part of this project. Off gas from the SNDR is also treated with a cooling/ammonia water scrubber to decrease the air temperature to assure mesophilic temperature conditions for the biofilter which is the second stage in the odor control system. In addition, the cooling/ammonia scrubber functions to remove a high percentage of any ammonia that may be contained in the off-gas. The ammonia is stripped from the system and removed in the water which is then returned back to the head of the plant via a plant drain system. The remaining off-gas, typically no higher in concentration than 300 ppm ammonia is then sent to the biofilter. The biofilter airflow distribution, temperature, humidity and pH are controlled by controlling various setpoints such as influent velocity, ammonia scrubber saturation and air temperature, and the washing of the media periodically with plant effluent water.

Under current operating conditions, the reactors meet time and temperature requirements in a matter of minutes to hours; however, the biosolids are not transferred out of the reactor and into the SNDR tank until the next day or approximately 24 hours later to provide mixing of the entire tanks contents. The average percent total solids destruction across the system is currently 53 – 60 percent and the average VS destruction across the system is approximately 65 – 75 percent (depending on how much industrial dissolved air floatation (DAF) skimmings the facility takes directly into the system from one of the industrial users). The more industrial flow, the higher percent TS and VS destruction Delphos experiences across the ATAD system. The biosolids are tested for fecal coliform utilizing the MPN method and metal requirements before being made available for land application. Metals have never been an issue for the community and have never affected the beneficial use of our biosolids product at either facility. The fecal coliform results for the ATAD biosolids product are typically non-detect or less than 10 MPN per gram of dry solids. The solids concentration of the dewatered biosolids product is typically in the range of 25 – 28%.

Biosolids Storage Area

The biosolids are currently being utilized by a local farmer who has in excess of 6,000 acres (2,500 HA) of available land. A small isolated pile of biosolids is kept on-site in the biosolids storage area to be able to supply the local residents with the biosolids product when they choose to utilize the product in their yards, gardens or flower beds. Currently, there is no charge for the biosolids product. The agreement with the farmer states that he will pay for the hauling and the city will provide the product and load his trucks.

CONCLUSIONS

The Delphos WWTP startup and operation has provided a unique set of circumstances, challenges and solutions. In conclusion, this successful project demonstrates that a community with help from their design engineer, Ohio EPA, equipment suppliers and contractors, can design and build a state-of-the-art treatment system capable of treating a highly variable wastewater and biosolids loading. The City administration and facility staff can not look past the importance of comprehensive planning, investigation and design; understanding the conveyance system; thorough training; proper, informed operations; and ultimately excellent communication among all parties involved. The Delphos facility, with a total installed cost of approximately $31M and a construction time of approximately 18 months, has set the bar high for new large MBR/ATAD facilities in the US and around the world. More importantly, the competitive cost and proven capabilities of the Delphos treatment system to produce reuse quality effluent and Class A biosolids with a broad range of loading conditions, demonstrates the ability of the MBR and ATAD systems to be competitive and reliable compared to conventional technologies.