COMPARISON OF CLASS A SYSTEMS
SMALL DIGESTER FACILITIES

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ABSTRACT

In recent years there has been much more interest in 2-stage digestion systems, especially those that produce Class A Biosolids. Their popularity is in part due to their ability to treat more sludge than conventional digestion systems while achieving a Class A product. Another reason for their popularity is due to the variations in 2-stage digestion processes available.

This paper will review three treatment facilities, each with a wastewater treatment capacity of less than 15 MGD; that utilize variations of the 2-stage digestion process. The 2-stage process for each plant includes a thermophilic first stage process followed by mesophilic anaerobic digestion to produce Class A Biosolids. The three facilities are:

- Franklin Township, PA
- Lakeland, FL
- London, OH

Each of these facilities underwent a plant upgrade that included an upgrade of the digestion facility. Each had a goal to achieve Class A Biosolids while utilizing a land application program. Adding digester capacity was also important to the overall upgrade at each plant.

In considering their options, each plant determined the most cost effective method for achieving Class A Biosolids was to install a first stage thermophilic process. However, each used a different approach to the overall 2-stage process. The systems chosen include pasteurization, 2-stage thermo-meso anaerobic digestion and 2-stage anoxic thermophilic-mesophilic anaerobic digestion. Each process provides Class A pathogen reduction in the first stage and relies on a mesophilic anaerobic digestion in the second stage for volatile solids reduction.

Information contained within this paper will focus on the facility design for each plant and the operating data.

KEY WORDS: anaerobic digestion; 2-stage digestion; pasteurization; anoxic thermophilic-mesophilic digestion; Egg-Shaped Digesters; pathogen reduction; volatile solids reduction

INTRODUCTION

In recent years there has been much more interest in systems that produce Class A Biosolids. There are various methods for achieving the Class A pathogen reduction requirements, even within the anaerobic digestion arena. One of the more popular methods is a 2-stage digestion process. The popularity of this method of digestion is in part due to the various options available for 2-stage digestion.

Many of the 2-stage digestion processes include options for either thermophilic or mesophilic operation in the first stage process. These options are also available in the second stage, although most process designs utilize mesophilic anaerobic digestion in the second stage. Benefits to the 2-stage process include:

- Class A pathogen reduction
- Improved digester performance
- Higher solids loading
- Improved gas production
- Increased digester capacity

This paper we will concentrate on three processes that utilize a thermophilic first stage process followed by mesophilic anaerobic digestion. The processes reviewed in the paper include:

- Pasteurization followed by anaerobic digestion (Franklin Township, PA)
- 2-stage anaerobic digestion (Lakeland, FL)
- Anoxic thermophilic-mesophilic anaerobic digestion (London, OH)

Each of the processes listed above are somewhat different in their approach yet similar in achieving Class A Biosolids. The process used at each facility was selected based on what was considered best for their situation. The upgrade for each facility also included the use the Egg-Shaped Digester technology for either the first stage or second stage process.

A brief summary of each plant including the upgrade to the Digester facility is described within to provide the reader with background information.

FRANKLIN TOWNSHIP DIGESTION FACILITY

Franklin Township Municipal Sanitary Authority, located in Pennsylvania, began to do future planning for their solids handling and disposal at the treatment plant in 1995.

Up until the mid-1990's the Authority land applied solids from their existing digester complex. Then they began to landfill their solids. It was decided to produce an Exceptional Quality Class A Biosolids and revert back to a disposal program that incorporated the beneficial use of their solids.

The process selected was a 2-stage digestion process, utilizing the Roediger pasteurization process for the first stage to achieve Class A pathogen reduction. The second stage is a mesophilic anaerobic digestion process. To ensure that the municipality could meet the needs of the community it was determined that a new Egg-Shaped Digester (ESD™) would be needed to allow the existing digesters to be converted to storage.

By choosing a first stage pasteurization process, the Authority was providing a process that would comply with the USEPA criteria for Class A pathogen reduction under Alternative 1. The 70ºC operating temperature also allowed the Authority to meet the USEPA's time-temperature requirements while operating a nearly continuous feed operation to the digester complex.

Construction of the new digester facility began in 2001 with process startup completed in 2004. New components required for the 2-stage process included:

- (3) 2,100 gallon first stage vessels
- Heat Recovery System
- (1) 750,000 gallon ESD Vessel
- Unconfined Gas mix - ESD Vessel
- Liquid recirculation for ESD Heating
- 50,000 CF Dry Seal Gasholder
- Integrated Control System
- Access Tower (Future Elevator)

Pasteurization as a Class A process is based on heating up untreated sludge to 70ºC and maintaining the temperature for 30 minutes to comply with the USEPA requirements for a Class A process. The process design for the Franklin Township Facility is designed to allow flexibility in the system operating temperature, which is advantageous when not operating at full capacity. This allows the plant staff to adjust the operating temperature and dwell time of the first stage process based on the sludge being processed on a given day, which also allows the staff to save energy.

The first stage process consists of three vessels. This allows the plant to fill and empty two tanks simultaneously while maintaining the isolation required by the USEPA. A spiral sludge-sludge heat exchanger is used for the heat recovery system. The heat recovery system provides the transfer of heat from the pasteurized sludge to the untreated cool sludge during the transfer of pasteurized sludge to the mesophilic digester. This minimizes the heat input required for achieving pathogen reduction in the first stage. It also cools down the pasteurized sludge prior to introduction to the anaerobic digester, which is operated at a mesophilic temperature range.

The preheated untreated sludge is then heated up to a temperature designed to meet the USEPA time-temperature requirements using a second spiral exchanger prior to entering one of the three pasteurization holding vessels. The heated sludge is stored to meet the USEPA required retention time. Figure 1 is provided to show the process schematic for the Pasteurization process with heat recovery.

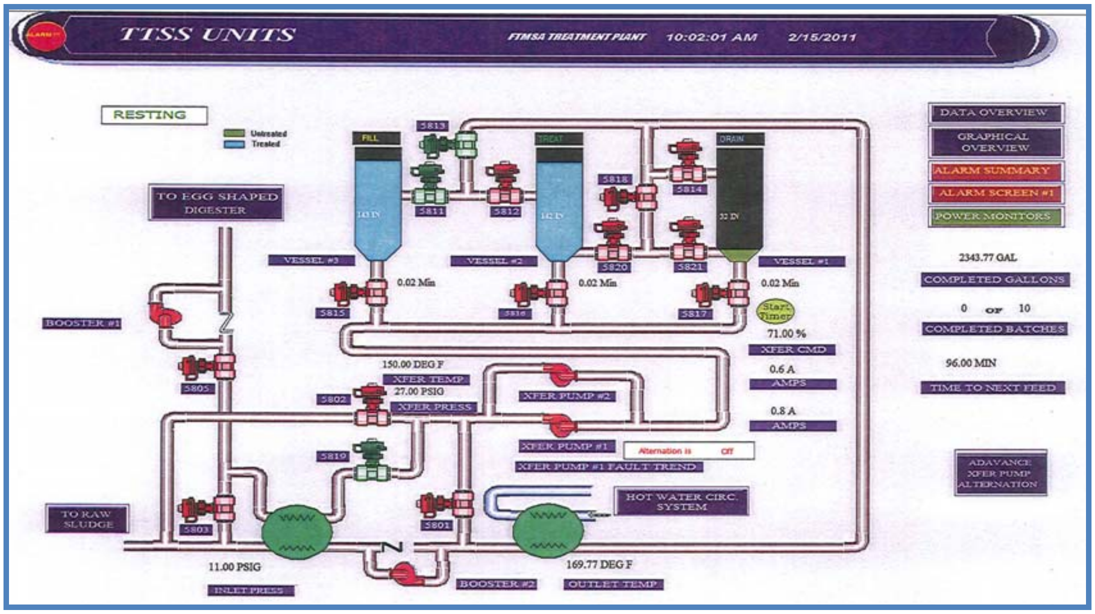

Figure 1: Pasteurization Process Control Screen

The schematic above depicts the three pasteurization vessels and related equipment necessary to maintain process control including the heat recovery system and the transfer of treated sludge to the anaerobic mesophilic ESD vessel. The primary mixing system of the ESD vessel is an unconfined gas mix system. The gas mix system includes a series of gas injector nozzles in the upper area of the bottom cone section of the vessel. The gas injection nozzles are arranged to allow the mixing to be separated into four separate segments. This allows the operator to vary the segments being mixed and improve the mixing capability of the system.

An external liquid recirculation system is also provided for use with the ESD heat exchanger, which is a tube-in-tube style exchanger. The exchanger is designed to operate with either hot water or plant effluent to allow the system to maintain an operating temperature within the 36-37°C range. The current operation of the system utilizes the ESD exchanger with plant effluent to cool down the vessel when it exceeds the operating temperature range.

The existing facility remained in operation as originally designed during construction until completion of the startup of the new 2-stage digestion facility. Once the new facility was in operation the existing facility was converted to storage.

Startup of this facility followed a more traditional approach to start up, which began by filling the ESD vessel with plant effluent and seeding the vessel with a small volume of sludge. The startup of an anaerobic digester under this approach may 3-6 months before the system achieves steady state operation. Once the startup was completed the plant began to work with local authorities for receiving their permit as an Exceptional Quality Class A Biosolids. Data was collected with respect pathogen reduction, metal concentration and other pollutants listed in the USEPA guidelines for Exceptional Quality Biosolids. Information was also provided to verify the process operation, as required, in achieving the time-temperature requirements set forth in the USEPA 503 Regulations. Figure 2 is the Control Screen used to monitor the pasteurization process operation.

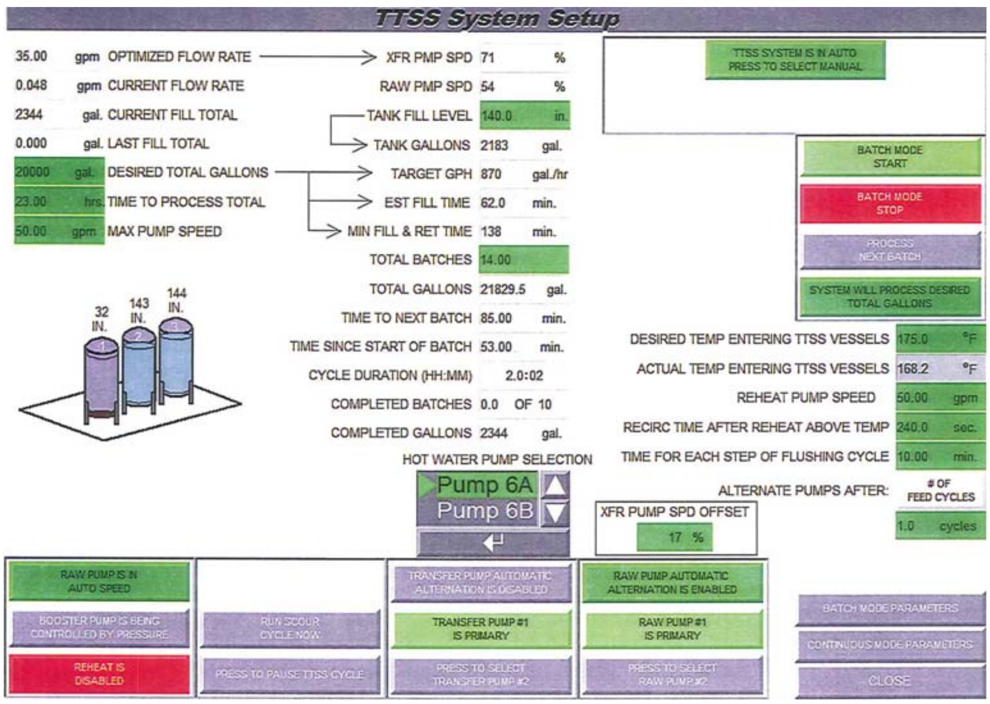

Figure 2: Pasteurization Process Control Screen

Franklin Township received their permit from state of Pennsylvania in 2011 as an Exceptional Quality Class A Biosolids. The permit is extended through 2016.

LAKELAND DIGESTION FACILITY

In 2006, the City of Lakeland contracted to upgrade and improve its' existing biosolids processing facilities at their Glendale WWTP with a goal of producing Class A biosolids utilizing the IDI 2-Pad anaerobic digestion process. This process is a 2-stage process involving a first stage Acid Reactor followed by mesophilic anaerobic digestion.

The construction project included the addition of an Acid Reactor and an untreated sludge storage tank, also referred to as a Feed Sequencing Tank (FST) and rehabilitation of the existing digesters. The Acid Reactor is a modified Egg-Shaped Anaerobic Digester (ESD). Components of the upgrade include the following:

- (1) 49,000 gallon FST
- (1) 268,400 gallon modified ESD Vessel
- ESD feed and transfer pumps
- Heat Recovery system
- New mixing for exist'g digesters
- New heating system
- Integrated Control System

The construction schedule implemented required one digester to remain in operation at all times. To meet these requirements construction of the FST and ESD vessel were done simultaneous with the cleaning and rehab of one of the existing digesters. Once work was completed and the vessels put in service, the second existing digester could be taken out of service for cleaning and rehabbed with the new mixing system.

The FST is provided to allow the plant to waste solids to the digester complex independent of the operation of the 2-stage process. This is very important because the 2-stage process design only allows 3-4 transfers per day of untreated sludge to the Acid Reactor. This is to meet the requirements of the IDI system as a Class A process. The FST is also used for the transfer of gas from the Acid Reactor to the gas handling system. Gas from the Acid Reactor and the existing digesters is utilized in the heating system or flared through a waste gas burner.

The IDI 2-stage digestion process required the first stage Acid Reactor to be sized to operate at 2.1 days detention time followed by mesophilic anaerobic digestion. The operating temperature in the first stage Reactor is 55°C. This temperature is to be maintained for 3 hours prior to discharge to the mesophilic digester. Discharge of the treated solids to the mesophilic digester is to be completed prior to introducing new untreated solids to the Acid Reactor. The FST allows the plant to maintain isolation of the Acid Reactor contents with respect to the untreated solids during the transfer of treated solids to the mesophilic digesters. A Heat Recovery system is incorporated to recover heat from the Acid Reactor solids and transfer it to the untreated solids. The cooled down treated solids are fed to the digester at a temperature that should minimize the need for additional heat in the second stage mesophilic digesters.

The operation of the ESD vessel requires a varying liquid level for maintaining the 2.1 day detention time with respect to the volume of sludge being treated at any given time. Liquid level varies with the changes in daily feed while maintaining a well mixed Reactor vessel. This required a simple and effective mixing system that would allow mixing under current day design flows up through the ultimate design capacity. An external liquid recirculation system with dual internal draft tubes, developed by CB&I and marketed as the Dual Zone Mixing System, was provided for this project. The dual zone mixing system allows the operator to maintain an effective mixing system that also allows the tank volume to vary between 60% and 100% capacity. The controls for the system ensure that the vessel is well mixed and that the operating temperature is maintained for achieving the process results. Figure 3 is the Stage Process Control Screen, which provides an overview of the first stage process.

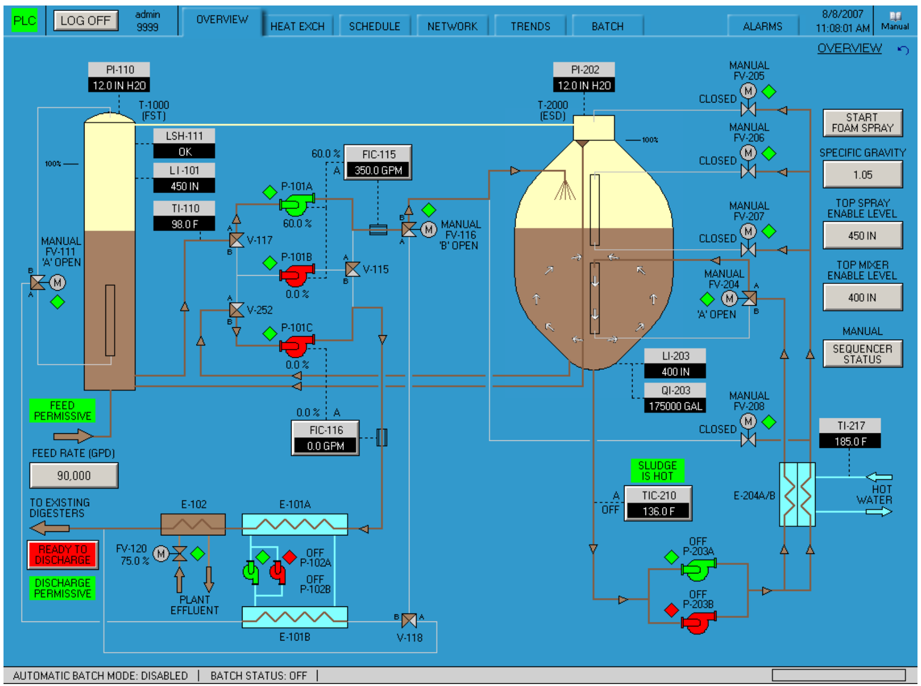

Figure 3: Process Control Screen

Due to the vessel size, a single recirculation pump was provided for the external recirculation system. Contents from the vessel are pumped with a single pump to a pair of heat exchangers that are operated in parallel mode. The split flow is then recirculated back into the vessel through the upper and lower draft tubes, when the vessel is at full capacity. When the operating level in the tank is less than 100% full, flow may be diverted from the upper draft tube to another mixing mode. Level control is provided to ensure that the mixing system operates properly with respect to the operating level of the vessel. The level control also provides a means of ensuring that the system is operating within the 2.1 day detention required by the process.

The second stage mesophilic digesters consist of two existing conventional digesters. These digesters were cleaned and provided with new draft tube mixing. The draft tube mixers utilize gas for the means of mixing and are provided with water jackets to be used in heating the digester contents should the digester drop below the 38°C operating temperature. The tank covers were also inspected when the modifications were made to the tanks.

Startup of the Lakeland facility utilized a variation of the micro-digester approach, commonly used in the startup of Egg-Shaped digesters due to the gas tight design of the vessel. This approach involves receipt of digested sludge from a nearby anaerobic digester facility to be used as seed sludge for the digester vessel, which allows the plant to establish a mini-digester that can be kept heated and mixed. Utilizing this approach at Lakeland required the ESD Acid Reactor to be initially operated as mesophilic anaerobic digester with a 15-20 detention. As the Acid Reactor achieved full capacity half its contents were sent to the existing mesophilic digester. The seed sludge from the ESD Acid reactor was blended with plant effluent to ensure that the existing digester vessel maintained its gas seal with the cover in its lowest position. The ESD Acid Reactor and existing digester were operated in parallel then until the ESD Reactor reached full capacity, where again half its contents were transferred to the existing digester.

Once both digesters were at full capacity the ESD vessel was converted to an Acid Reactor allowing the system to be operated as a 2-stage mesophilic process until the second existing digester was cleaned and received the new mixing system. Startup of the second existing digester was accomplished by transferring contents from the existing operating digester and then the ESD vessel was converted to a thermophilic reactor. During this time the plant staff monitored the 2-stage process for pathogens as well as volatile solids destruction. Once at full plant capacity the ESD was converted to a thermophilic Acid Reactor.

LONDON DIGESTION FACILITY

The London, OH facility embarked on a major expansion of their wastewater plant in 2006. The expansion included a new biosolids processing facility to replace existing conventional digesters. The existing conventional digesters had not been operated as anaerobic digesters for several years due to issues with equipment including the covers, which needed to be replaced. The new digestion system was designed as a two phase, Class A system with CB&I's ATP/ESD process.

The ATP process used as a first stage thermophilic process provides Class A pathogen reduction while also enhancing the sludge prior to the second stage mesophilic digester. The process was granted a Class A designation, as an alternative technology, by the USEPA in 1989. By achieving the Class A designation, the ATP Process has been able to obtain state recognition with minimal effort on the part of the Owner. It also relieves the Owner of special testing requirements in many cases.

The construction of the two phase digestion facility included:

- Blend Well (Primary + TWAS)
- (1) 33,000 gallon ATP Reactor
- Isolation Tank
- Heat Recovery System
- (1) 450,000 gallon ESD vessel
- (1) 1000 FT^3 Dry Seal Gasholder
- Heat Recovery System
- New Heating System
- Integrated System Control

Design of the new digestion facility utilized one of the existing digesters as a digested sludge storage tank. This was to allow the plant personnel to operate their dewatering operation as needed. The new 2-stage digestion facility would include new tanks for each phase of the process as well as a Blend Well for storage of primary and thickened waste activated sludge.

The first stage ATP Reactor is an anoxic thermophilic reactor designed to operate at 65° C with a series of feed cycles over a 24-hour period. Air is introduced to the process as part of the recirculation system. The air volume is limited to prevent the process from going anaerobic, thus anoxic. Operating at 65° C, the ATP Reactor can meet the USEPA's time-temperature requirements within one hour. As a result the system can be fed 10-12 times per day, meet the USEPA Class A pathogen reduction requirements while also performing heat recovery and transfer between the two process vessels. The system design allows the number of feed cycles to be varied based on the amount of sludge to be processed each day. Feed cycles are distributed throughout the 24-hour period. Sludge treated in the first stage reactor will achieve Class A pathogen destruction and enhance the sludge for the second stage mesophilic anaerobic digester.

ATP treated sludge is cooled down through a Heat Recovery System. The Heat Recovery System includes a set of tube-in tube exchangers with an Isolation Tank. The Isolation Tank is provided with two chambers to maintain isolation of the ATP treated sludge from the blended sludge at all times in the process, as required for meeting the USPA requirements for a Class A process. The Heat Recovery System also preheats the Blended Sludge before its entry into the ATP Reactor. Heat for the Blended Sludge comes from the cooling down of the ATP treated sludge.

The second stage mesophilic anaerobic digester for this project is an ESD vessel that operates at 36-38° C. The ESD vessel mixing system includes and external liquid recirculation system with internal draft tube. The external liquid recirculation system includes a tube-in-tube heat exchanger designed to operate with either hot water or plant effluent. This was done to assist startup of the facility and to ensure that the ESD vessel operates within the preferred operating temperature range.

For the London Facility, the cooled down ATP treated sludge temperature exceeds the operating temperature of the ESD vessel. This is done to ensure that the ESD operating temperature stays at or above the preferred operating temperature range. The heat loss in the ESD vessel is minimal compared to conventional digesters. Monitor of the ESD vessel temperature is accomplished through its external liquid recirculation system. When the temperature exceeds the preferred operating temperature of the digester, plant effluent is sent to the digester's exchanger to cool down the vessel contents.

Figure 4 is the ATP/ESD Process Control Screen. It provides an overview of the 2-stage digestion system including feed to the system, heat recovery, transfer between the two processes, ESD discharge to digested sludge storage and control of the ESD mixing system.

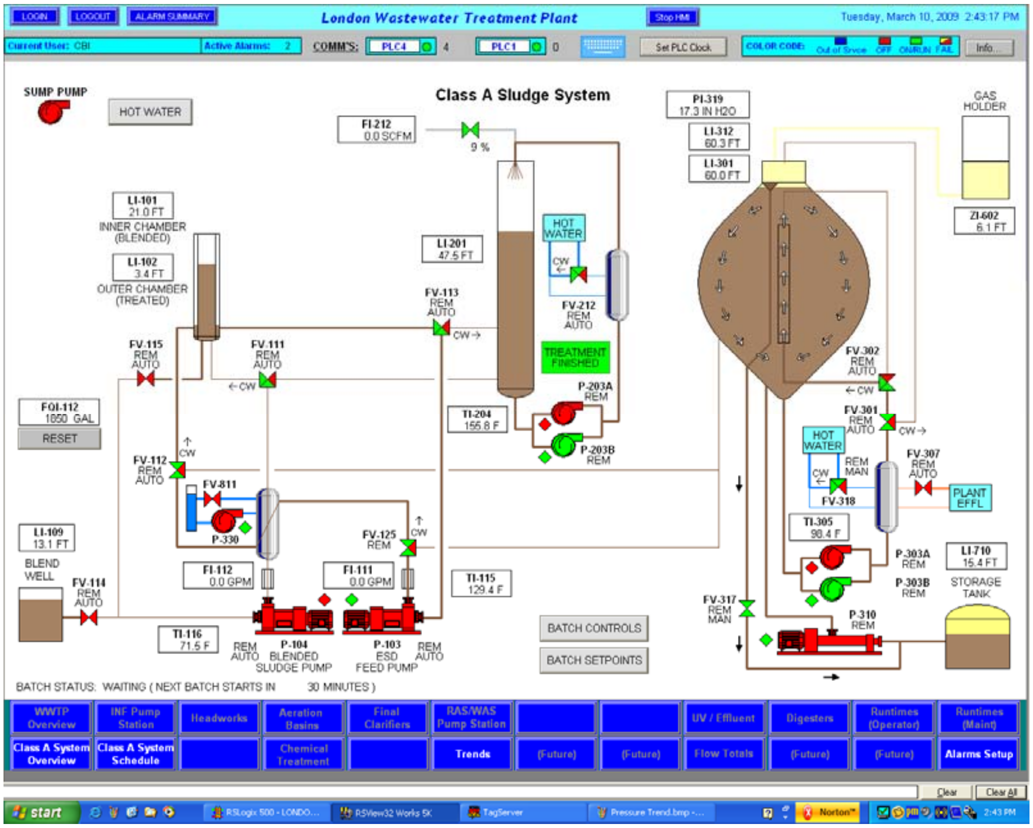

Figure 4: Process Control Screen

The original design of the 2-stage digestion process was to receive primary sludge 7 days per week and thickened waste activated sludge (TWAS) 5 days per week. This was done to accommodate the staff at London, which works on a 5-day 8-hour per day work schedule with one operator coming in for four hours on Weekends. During startup, CB&I with the assistance of the plant staff developed a means of controlling the volume of the Blend Well to allow the feed rate to be the relatively the same all 7 days of the week. This was accomplished by automated control of the transfer of thickened primary and TWAS to the Blend Well. Control included maintaining a certain volume of sludge in the Blend Well at the end of each day and prior to the weekend to ensure that the system has sufficient feed sludge throughout the period of time when the plant is left unattended.

Startup of this facility utilized a micro-digester approach to first start up the ESD Vessel. Anaerobically digested sludge was received from a nearby facility and introduced to the ESD vessel. Untreated sludge from the London WWTP was then fed daily to the ESD vessel establishing an active digester population while increasing the digester volume. After two weeks of operation the ESD vessel was half full and stabilized and producing gas to be used in the digester heating system. Contents from the stabilized ESD vessel were then transferred to the ATP Reactor. Lab tests were taken prior to the transfer of ESD vessel sludge to the ATP Reactor to evaluate the pathogens in the seed sludge. Pathogens were monitored through lab testing within both the ATP Reactor and ESD vessel until the ESD vessel achieved full volume.

Upon startup of the ATP Reactor, the 2-stage digestion process was operated as designed and the ESD vessel's heat exchanger was converted from a hot water system to a cooling system as noted earlier. The facility has operated in this manner throughout summer and winter operation.

Process startup was completed with a full ESD vessel within 45 days after startup of the facility. Although all aspects of the 2-stage digestion facility, including digester gas utilization were in full operation within the first few weeks of operation. During that time the system was monitored to ensure that the end product provided Class A pathogen reduction results.

PROCESS COMPARISON

In comparing the three facilities it is important to consider the process associated with each plant, including the benefits associated with each process. The design of the Franklin Township process is based on providing a first stage process to accomplish pathogen reduction in an efficient manner. It is not a process designed to enhance the sludge prior to the second stage anaerobic digester, as touted by other 2-stage processes.

All three facilities feed untreated sludge to the digester facility at a set number of cycles per day. The Lakeland facility feeds and transfers sludge from the Class A process 3 times per day. This number is based on meeting a 3 hour time-temperature requirement as stated in the IDI process. The London facility is capable of treating 10-12 cycles per day and Franklin Township 18 batches per day while still achieving USEPA mandated time-temperature requirements for the system. London is currently operating at 4 feed/transfer cycles per day while Franklin Township operates a minimum of 10 batches per day. The table below is provided to compare the design of each of the processes:

Description	**Franklin Township**	**Lakeland**	**London**
Sludge Feed Design - gpd	40,000	120,000	31,000
% Solids	3-5%	3-5%	3-5%
1^{st} Stage Process	Pasteurization	anaerobic	anoxic
1^{st} Stage Detention (design)	NA	2.1 days	1 day
1^{st} Stage Temp (design)	62-68° C	55° C	65° C
Time-Temp (design)	55 minutes	3 hours	1 hour
2^{nd} Stage Process	Anaerobic	anaerobic	anaerobic
	New	Exist'g	New
	ESD	Conv'l	ESD
2^{nd} Stage Det'n (design)	13 days	12 days	13 days
Digester Temp	37ºC	37ºC	37ºC

In reviewing the information above, both the Franklin Township and London Facility operate within the USEPA's time-temperature requirements for a Class A process. The elevated temperature in the first stage of these two facilities allow a more continuous feed operation than the Lakeland Facility that requires a 3-hour dwell once the temperature is achieved between feedings. As a result the Lakeland Facility is fed 3 times per day. Franklin Township can be feed each of their first stage vessels as much as 6 times per day. London can feed their first stage reactor up to 12 times per day. All three facilities allow the operator to adjust the process based on the daily volume of sludge to be treated at the facility

Each process includes a heat recovery system to reduce the temperature of the sludge being transferred from the first stage process to the mesophilic anaerobic digester. Franklin Township and Lakeland utilize a once pass thru design in the heat recovery system. Franklin Township uses a sludge-sludge spiral exchanger. Lakeland utilizes a series of heat exchangers with a closed loop water recirculation system for transferring heat from the ESD Acid Reactor discharge to the untreated sludge that is stored in the FST. The untreated sludge is circulated through the exchanger and back to the FST until the ESD sludge has been transferred to the existing digesters. An extra cooling exchanger, using plant effluent, is provided downstream of the heat recovery system to ensure sludge is sufficiently cooled prior to introduction in the existing digesters. Once ESD transfer is completed the ESD is then fed from the FST.

The London heat recovery system includes an Isolation Tank that is used to store both untreated plant sludge and treated sludge from the ATP Reactor. The Isolation Tank allows the system to be varied with respect to number of cycles and volume while also allowing the heat recovery system to be maximized. Heat Recovery is accomplished by recirculating each chamber of the Isolation Tank thru an auxiliary heat exchanger. The recirculation of sludge is continued until the system achieves the desired temperature or it exceeds the allowed time. Each chamber of the Isolation Tank is recirculated thru two cycles of heat recovery. This staggered approach to heat recovery optimizes the heat transfer between the untreated and ATP treated sludge. Utilization of the Isolation Tank allows for the Isolation mandated by the USEPA while also maximizes the heat recovery efficiency.

Regardless of the means used for heat recovery careful consideration should be given to the sludge characteristics as well as the type of exchangers used for the process. Spiral heat exchangers are very efficient but may require screening or grinding to minimize the potential for plugging. Spiral exchangers may also limit the flow rate for transfer, which can impact other aspects of the process design. Tube-in-tube exchangers are less susceptible to plugging and allow a higher transfer flow rate. Other exchanger designs may utilize tight bends within the exchanger for providing the required surface area in a compact design. Regardless of the type of exchanger it is very important to carefully consider the type of sludge and potential for plugging.

All three of the digester facilities have designed the second stage anaerobic digester for less than 15 day detention under maximum design conditions. Both Franklin Township and London are utilizing an Egg-Shaped anaerobic digester for the second stage digester. These tanks are operated at a constant liquid level. The Lakeland Facility is utilizing existing digesters, which includes floating covers allowing flexibility in operating level of the digester.

PROCESS RESULTS

The table below is provided to compare process results between the three facilities:

Description	Franklin Township	Lakeland	London
Plant Design Flow - MGD	16 Peak	13.7	5.8 Peak
Actual Plant Flow - MGD	4.9	7.0	2.0
Actual Sludge Feed - gpd	29,900	80,950	8,100
% Solids	2.95	*	5.7
Acids, mg/l	NA	*	2810
Alkalinity, mg/l	NA	*	1307
pH	NA	*	5.5
Primary - gpd	*	58,673	5,500
% Solids	*	2.4	2.5
pH	*	5.8	5.8
Secondary - gpd	*	22,277	2,600
% Solids	*	4.0	3.5
pH	*	6.5	6.95
1st Stage - Temp	65° C	55° C	65° C
Time-Temp actual	3 ½ hours	3hours	3 hours
Acids, mg/l	690	1012	4825
Alkalinity, mg/l	2200	2072	1669
VS Reduction	NA	28%	13%
Gas production, cfd	NA	28,557	NA
2nd Stage – Detention	29 days	19 days	56 days
Digester Temp	36ºC	38ºC	37ºC
Acids, mg/l	156	146	960
Alkalinity, mg/l	2775	2908	4711
VS Reduction, Overall	53%	44%	52%
Gas production, cfd	26,010	66,423	6,722
Dewatered Cake	18.5%	NA	17%

* Refer to discussion

DISCUSSION:

In looking at the process data compiled on each of these facilities please note that the data obtained is based on the reporting requirements for each facility as well as their lab capabilities. Note also that the IDI process does not operate within the time-temperature parameters set forth in the USEPA's 503 Regulation. IDI had received conditional approval for their process as a Class A process at the time of the construction of the plant. As a part of the conditional approval, testing was done prior to verify that each vessel was well mixed. Other conditions including 5 years of testing for pathogens as well as monitoring the time-temperature requirements outlined in the IDI process design. Lakeland also monitors each phase of the digestion process with respect to pH, TSS, VSS, volatile acids and alkalinity and gas production. However they do not sample the sludge in the FST.

The London facility, as noted earlier, works with a relatively small staff. This limits some of their sample collection and testing although they do test each stage of the digestion process allowing for a comparison of the operation of the system other 2-stage processes. Note also that the acidification that takes place in the first stage process enhances the digester operation. This includes increasing the methane content of the ESD vessel gas, which is routinely in the 65-68% range.

Each of these facilities includes a common storage tank where primary and secondary sludge can be accumulated prior to entering the digestion process. Both London and Franklin Township test their blended storage tanks for total solids and volatile solids. London also tests for pH, volatile acids and alkalinity as a means of monitoring the acid reactor process. Note that the pH of the blended sludge at London is below 6.0 and the ESD pH, volatile acids and alkalinity are within the typical range for a healthy anaerobic digester. Note also that the ATP Reactor pH is similar to the untreated sludge even though the volatile acid concentration is increased in the first stage process.

Benefits of the pasteurization process are primarily pathogen reduction. Not much is published with respect to other benefits associated with the anaerobic digestion process. Note also that the tanks for this process are filled and drained with each feed cycle. As a result there is probably little benefit to testing the pasteurized sludge for TSS, VSS, volatile acids and alkalinity. The process does not generate gas.

Each facility meets or exceeds the USEPA pathogen reduction criteria for Class A Biosolids. Due to their loading also meet the criteria for Exceptional Quality Biosolids. Testing is done on a regular basis to ensure they are achieving the pathogen reduction requirements based on fecal coliform. Volatile solids reduction exceeds the 38% requirement established in the USEPA's 503 Regulation. Both Franklin Township and London exceed 50% overall reduction in their facilities, although the detention time in their second stage digester is much higher under current loading conditions than the Lakeland facility.

Gas yield for all three facilities is similar. However, of the three facilities, only the Lakeland facility operates in an anaerobic mode in the first stage, as a result it is the only facility producing digester gas in the first stage reactor. Lakeland's first stage reactor will convert feed sludge into volatile acids. This conversion process produces higher CO_2 content than methane content, as is evident with Lakeland. They produce nearly 60% CO_2 in the first stage process. Gas from the Lakeland 2-stage process is combined and used for the heating of the system or flared to the atmosphere. The combined gas contains 40% CO_2, yielding less than 60% methane content. Franklin Township yields nearly 62% methane contents while London, as previously noted, exceeds 65% methane. This is primarily due to the second stage digester being the only methane producer in their 2-stage processes.

Lakeland utilizes a liquid application for its land application program. As a result there is no data available for comparing the dewaterability of the treated Biosolids. Both London and Franklin Township dewater their Biosolids. Franklin Township uses their existing storage tanks to store and thicken treated Biosolids prior to dewatering their product. London stores their treated Biosolids in an existing storage tank that is kept mixed prior to dewatering. There is no means for supernatant removal or thickening of the product. The belt press used for London's dewatering is an existing unit that was not replaced during construction.

Both the Franklin Township and the London facility have the capacity to add feed to their digestion facility from other sources. London has begun to receive waste solids from the County as well as grease from a nearby hauler. The additional food source provides a source for revenue and additional gas production. The material from these sources can be introduced to their TWAS storage tank where it can be mixed with plant sludge prior to introduction to the 2-stage digestion process. This will greatly enhance their ability to rely on digester gas only in the future for the heating system.

CONCLUSION

This paper describes three facilities, each choosing a different 2-stage process for their digestion facility with the end goal to produce Class A Biosolids. The process chosen by each facility differed based on the objectives of the plant and what the Owner felt best suited their needs. Each process has demonstrated an ability to achieve the goal for Class A Biosolids while also producing a very stabilized end product. Process parameters vary for each plant with respect to the feed solids to the digestion facility.

Regardless of the process chosen, it is important that the Owner and his staff feel comfortable with the selection and try to best match the process to their situation. There is no one process that is better than another just one process that may be better suited for your application.

ACKNOWLEDGEMENTS

CB&I and Biogas would like to take this opportunity to thank the plant personnel at the three facilities discussed in this paper. Their efforts in provided data on their plant operation were valuable in the development of the information. We also wish to thank Jim Brucker with Franklin Township (PA), Dan Leavitt with London (OH) and Scott Lewis with Lakeland (FL) for agreeing to commit their time and personnel. Their assistance in the writing and review of this paper was extremely valuable.

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