DEP Pretreatment Program Requirements

Frederick Bloetscher, Lisa Meday-Futo, Whitifeld R. Van Cott, and Robert Fergan

Hollywood's WWTP utilizes an ocean outfall and reclaimed water for treated effluent disposal. As a part of its ocean outfall permitting requirements, Hollywood must sample for lead, copper, cyanide, silver, and mercury on a monthly basis. In addition, because of the potential for environmental concerns associated with industrial pollutants, the city is required to prosecute an acceptable pretreatment program for its industrial and commercial users. As a part of NPDES delegation, the pretreatment requirements are now significantly more rigid than those imposed by EPA in the past, but at the same time yield a much more detailed understanding of the wastewater collection system for the permittees.

General Pretreatment Program Requirements

DEP, via FAC section 62-625.110, requires the city to implement the pretreatment standards set forth in FAC 62-625. The objectives of the FAC 62-625 pretreatment standards are:

- To prevent discharges that will interfere with the operation of a wastewater facility, including interference with its use or disposal of domestic wastewater residuals;
- To prevent discharges that will pass through or otherwise be incompatible with wastewater facilities; and
- To improve opportunities to beneficially use domestic wastewater residuals.

FAC 62-625 identifies the requirements for industrial pretreatment programs. They must be based on legal authority and include, at a minimum, six requirements outlined in the code. Authority and procedure must, at all times, be fully and effectively exercised and implemented. Each of the six requirements must be evaluated to determine whether future action is needed on the part of the treatment.

The six requirements are as follows:

- A comprehensive user database
- Proper legal authority
- Technical industrial effluent limits
- A compliance program
- Administrative procedures
- Operating resources

Each requirement is discussed in detail in the following sections.

Comprehensive User Database

A POTW's management cannot make informed decisions concerning potential problem discharges in the absence of a comprehensive database on industrial contributions to its systems. Therefore DEP requires POTWs to establish and maintain a complete Industrial Waste Survey (IWS), including data derived from each business. All industrial users, including commercial users such as dry cleaners and gas stations, should be included in the IWS. The IWS is invaluable for the identification of previously unknown industrial users and their discharges; to evaluate slug loading potential; in estimating raw waste loadings of pollutants for which analytical methods are unavailable; and for planning a logical monitoring/sampling strategy that ensures the efficient use of POTW resources.

The IWS should contain the following information for each industrial user:

- Name
- Address
- SIC Code
- Wastewater flow
- Types and concentrations of pollutants in discharge(s)
- Major products manufactured and/or services rendered
- Location of wastewater discharge points
- Process diagram and/or descriptions
- Chemical inventory
- Inspection results, documentation of spills, compliance history and general practices
- Treatment processes and management practices such as spill prevention plans and solvent management plans
- Discharge practices such as batch vs. continuous, variability in waste constituent concentrations and types, discharge volumes
- Pollutant characteristic data (i.e. carcinogen, volatility, biodegradability)

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Legal Authority

An industrial pretreatment program's overlying governing body must have the authority to:

- Place limitations on the amount of pollutants that can be discharged into the system
- Approve or deny additional contribution of pollutants to the system
- Approve or deny the changes in the nature of the pollutants discharged to the system
- Require compliance with pollutant discharge limitations and requirements
- Require compliance with pretreatment standards and technology
- Develop a compliance schedule for industrial users who fail to comply with pretreatment standards
- Develop an administrative procedure for monitoring, compliance, and for dealing with violations
- Carry out inspection surveillance and monitoring procedures without the permission of the industrial users, at such time that may be convenient or thought desirable to determine potential contributions
- Enact penalties for non-compliance
- Force conditional industrial limitation requirements and make appropriate technical decisions on the wastewater system and users as part of the pretreatment program
- Provide relief from industrial users that endanger the public health or the operation of the facility

Technical Limits

Pretreatment programs exist to regulate the introduction of pollutants from non-domestic sources into POTWs, thereby incurring opportunities to reclaim municipal and industrial wastewaters and sludges and reducing effluent toxicity. To accomplish those objectives, pretreatment programs rely on a pollution control strategy with three elements:

- National Categorical Standards
- Prohibited Discharge Standards: general and specific
- Local limits

National Categorical Standards are national, technically based standards that set industry-specific effluent limits. General and Specific Prohibited Discharge Standards are also national prohibitions against pollutant discharges from any non-domestic user that cause pass-through or interference with the treatment process, or could cause fires, explosions, corrosive structural damage, flow obstruction, or interferences due to heat, flow rate, and/or flow concentration at the POTW. Local limits are site-specific protections developed by the POTW to address federal standards, as well as state and local standards.

Steps in Local Limit development include:

- Identifying concerns to be addressed:
  - Water quality protection
  - Sludge protection
  - Operational problems
  - Worker health and safety
  - Air emissions
- Characterizing industrial discharges
  - Industrial user discharges
  - RCRA hazardous wastes
  - CERCLA hazardous wastes
  - Hauled wastes
- Review of environmental protection criteria and pollutant effects data
- Monitoring of IU discharges, collection system, and the treatment plant to determine pollutants of concern
- Toxicity testing
- Development of maximum allowable headworks loadings
  - Based on prevention of pass through NPDES limits
    - State DEP limits
    - Local ordinance-based limits
  - Based on interference with POTW operations
    - Prevention of process inhibition
    - Protection of sludge quality
  - Comparison of allowable headworks loadings
  - Representative removal efficiency data
- Allocating maximum headworks loadings
  - Safety factors
  - Domestic/background contributions

Compliance Monitoring Program

Monitoring of industrial users is the primary tool a pretreatment program has to determine compliance of the industrial users' wastewater with applicable regulations. Compliance monitoring by the industrial user also serves as a reminder to the industrial user that compliance with Local Limits is its responsibility. Compliance monitoring is specified in each industrial user's permit. The following should be included in compliance monitoring for each user:

- Sampling location
- Pollutants to be monitored
- Sample collection method
- Monitoring frequencies
- Analytical methods
- Reporting requirements of the industrial user and the control authority
- Duration of effluent limit (instantaneous maximum, daily maximum, monthly average, etc.)
- Effluent limit per parameter (limits may be derived from categorical standard, may involve flow-weighted averaging)

Basic factors that affect sampling location, sampling method, sampling frequency and reporting frequency are identified below. These factors must be carefully considered as they can lead to inaccurate compliance determination or misapplication of federal, state and/or local standards:

- Applicability of categorical pretreatment standards
- Effluent and process variability
- Flow and/or pollutant loading
- Type of pollutant

Monitoring frequencies are, in large part, at the discretion of the control authority. FAC 62-625.600 requires a minimum of one control authority sample and two self-monitoring samples every 12 months taken during specified times for categorical industries, and at least one sample every six months for significant industrial users. Reporting for categorical industries must be conducted to satisfy baseline reporting requirements, 90-day compliance report and repeat noncompliance monitoring requirements pursuant to FAC 62-625.600. Sampling performed by the industrial user that indicates a violation requires an additional sample be taken and submitted to the control authority within 30 days of becoming aware of the violation. Additionally, th e control authority must submit a report on an annual basis to DEP summarizing the pretreatment program's activities.

The primary task in establishing monitoring frequencies for the control authority is to achieve a reasonable balance between the need for sufficient representative data to assess compliance, and the expense and/or burden of obtaining such data. Factors to be considered by the control authority as it develops its own compliance monitoring program and industrial user self-monitoring requirements are as follows:

- The frequency necessary to obtain representative data of the nature and volume of an industrial user's wastewater
- Amount of historical data available to characterize the industry's discharge
- Actual or potential impact of an industrial user's wastes on the operation of the POTW, collection system, or residuals
- Types of pollutants contained in the facility's wastewaters and the concentrations or loadings discharged
- Regulatory requirements of any existing industrial user permits
- Seasonal variations of an industrial user's operations and wastewater flow
- Length of industrial user's operating day
- Industrial user's history of upsets, accidental spills, or lack of spill prevention plans
- Reliability of industrial user's pretreatment facilities
- Any unscheduled discharges of unusual or extraordinary strength and/or volume
- Compliance history of the industrial user
- Expense of monitoring imposed on both the industrial user and the control authority and the resources available

Administrative Procedures

A consistent, credible industrial pretreatment program that meets DEP standards must develop and implement administrative procedures addressing all elements of the pretreatment process. The procedures necessary for an effective pretreatment program include the following:

- Permitting
- Handling of confidential information
- Administrative enforcement response
- Judicial enforcement response
- Administrative defenses to discharge violations
- Sampling protocol

Operating Resources

FAC 62-625.500(3) states that public utilities required to develop a pretreatment program must have sufficient resources and qualified personnel to carry out the authorities and procedures set forth in 62-625.500(2). Those procedures include:

- Exercising of legal authority
- Control through permit of industrial user contributions to the POTW

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Thermophilic Aerobic Digestion to Achieve Class A Biosolids

Ronald Eyma, Berrin Tansel and Chris Helfrich

In 1995, the city of Sunrise, located about 15 miles west of Fort Lauderdale, authorized an engineering study[1] of available options to treat and dispose of its wastewater biosolids. The biosolids stabilization methods discussed in the study included lime stabilization, aerobic digestion (the city's old method), anaerobic digestion, and autothermal thermophilic aerobic digestion (ATAD). ATAD was recommended by the engineer and ultimately selected by the city based on cost and air quality considerations, as well as its ability to yield Class A biosolids. Sunrise's new biosolids stabilization process, joining other Florida municipalities such as Lakeland and Titusville, is the largest in the world.

Biosolids Stabilization and Disinfection

Several processes are used to stabilize the biosolids that are inevitably generated as byproducts of biological wastewater treatment. Biosolids are stabilized to reduce (or inactivate) pathogens, eliminate objectionable odors, and minimize the potential for septicity. Conventional methods of biosolids stabilization include lime addition, anaerobic digestion, aerobic digestion, composting, air drying, and heat treatment. Innovative methods include irradiation, pasteurization, and autothermal thermophilic aerobic digestion (ATAD).

ATAD, as the name implies, is fundamentally an aerobic digestion process that provides the stabilization mechanism. It is also commonly referred to as "liquid composting," since a significant portion of the process takes place under thermophilic conditions to provide the disinfection mechanism. In addition, since the biosolids in an ATAD system can achieve a sustained (i.e., ≥30 minutes) temperature of 70°C, it can also be referred to as a pasteurization process. The desired end product is a re-usable, high-quality biosolid that can be applied to land without further treatment.

Biosolids Regulations for Land Application

The growing popularity of ATAD may be due to its ability to stabilize and disinfect wastewater biosolids faster than conventional biosolids management methods. However, the decision to implement a particular biosolids management program is inevitably based upon regulatory requirements. That is, does the proposed management program provide reasonable assurances that its selection will lead to compliance with all applicable regulatory disposal criteria? For conventional systems, the answer to this question is relatively straightforward. For new and emerging technologies, such as ATAD, there is a great deal more review and analysis involved in the final selection.

Currently, the city of Sunrise disposes of wastewater biosolids by land-spreading following (mesophilic) aerobic digestion. Land-spreading of municipal sewage biosolids utilizes the available nutrients, trace metals, and organic material to fertilize and condition soils for agricultural and non-agricultural applications. Since the city's biosolids are applied to land, its biosolids management practices are, therefore, dictated primarily by EPA 40 CFR 503. This Code has been adopted by DEP under Chapter 62-640, FAC, with minor modifications.

The 503 Rule establishes standards for the final use or disposal of wastewater biosolids. It covers biosolids applied to land, placed on surface disposal sites (e.g., landfills), and fired in biosolids incinerators. These standards consist of (a) general requirements; (b) pollutant limits; (c) operations and management practices; (d) pathogen and vector attraction reduction requirements; and (e) monitoring frequency, recordkeeping, and reporting requirements. Under the 503 Rule, a thermophilic aerobic digestion system qualifies as a process to further reduce pathogens (PFRP) for Class A biosolids if "Liquid sewage sludge is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time (MCRT) of the sewage sludge is 10 days at 55 to 60 degrees Celsius." In contrast, a mesophilic aerobic digestion system can only qualify as a process to significantly reduce pathogens (PSRP) for Class B biosolids; to achieve this classification (with respect to pathogen reduction), the mesophilic aerobic digestion system must maintain an aerobic environment for up to 60, but not less than 40 days (MCRT). Note that the application of Class B biosolids imposes land use limitations on the receiving properties. Application of Class A biosolids imposes no site use restrictions. EPA has published a land application process design manual[2], which is an invaluable source of information. Unfortunately, some of the regulatory information is already out-dated, so the most current version of the 503 Rule, as well as proposed rules, should be reviewed concurrently.

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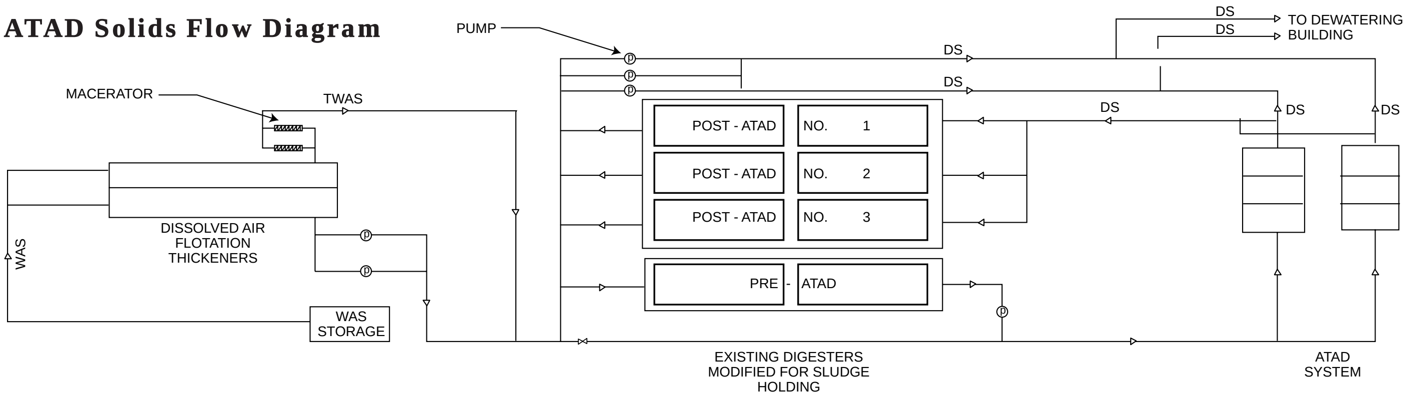
Generic ATAD Process Description

The ATAD process has undergone significant development in Germany since the 1960s and has been in general use throughout Europe since the 1970s. In aerobic digestion systems, the organic material contained in biosolids is mineralized through a series of microbiological processes. As the amount of available nutrients declines in a batch system, and with the continuous application of excess oxygen, endogenous microbial decay begins. In the endogenous phase, microorganisms consume their own protoplasm for sustenance, and cell tissue is oxidized aerobically to carbon dioxide, water, and ammonia. ATAD systems are typically two-stage aerobic digestion processes, operating within the thermophilic range (55 – 75°C). Normally, the heat released by the digestion process is the primary heat source used to achieve the desired operating temperature. The operating temperature is self-regulating because of the decrease in digestion rate with increasing temperature; hence the term "autothermal." Although aeration continues after the formation of ammonia byproducts, the nitrogen cycle does not proceed to completion, since thermophilic conditions inhibit the production of nitrates. This phenomenon prevents nitrification from imposing an oxygen demand on the system.

EPA[3] reports typical biological heat production of about 14,000 kJ/kg O_2 supplied, and carbonaceous oxygen demand of about 1.42 kg O_2/kg volatile suspended solids (VSS) oxidized. According to Metcalf & Eddy[4], over 6 kJ/L of heat energy are released during the aerobic digestion of primary and secondary biosolids containing between 2% and 5% solids. This quantity has been shown to be sufficient to raise the temperature of a wet slurry (containing 3% to 5% solids) to the thermophilic range, provided that sufficiently high oxygen-transfer efficiencies can be obtained without significant heat loss. Therefore, the ATAD process requires a steady source of adequately thickened (≥3% solids content) biosolids feed, insulated reactor infrastructure, thorough mixing, and an efficient oxygen delivery system that does not result in significant heat stripping. Grady and Lim[5] indicate that heat losses from a digester may be reduced through the use of pure oxygen, since a smaller quantity of gases pass through the

ATAD Solids Flow Diagram



digester, thereby reducing heat loss by evaporation. Further, by using pure oxygen in systems containing high solids concentrations, heat is conserved so efficiently that digesters can operate in the thermophilic range using microbial activity as the sole source of heat. The ATAD process offers short reactor detention times (in the order of 5 to 8 days) and great reduction of bacteria and viruses.

In 1990, no ATAD systems were operating in the U.S. Today Krüger, Inc., alone is responsible for delivering at least 15 Krüger/Fuchs ATAD units all over the U.S., including two in Florida (Lakeland and Titusville). The largest Krüger/Fuchs installation to date (15 MGD) is currently under construction in Camp Lejuene, North Carolina. Dayton & Knight and Jet Tech/ U.S. Filter also compete in the U.S. market.

Description of Original System

Currently, wastewater treatment at Sunrise's facilities includes pretreatment followed by activated sludge processing and secondary settling. Primary settling is not practiced. Biosolids management at the Springtree WWTP originally included aerobic digestion. At the Park City WWTP, biosolids processing included dissolved air flotation (DAF) thickening, with chemical conditioning by polymer feed followed by aerobic digestion. The Sawgrass WWTP also utilized DAF and aerobic digestion. At all three plants, Class B biosolids were removed and hauled away by private contractors for spreading onto agricultural lands under DEP permits.

Since the promulgation of the 503 Rule in 1993, compliance with regulatory requirements using current biosolids management methods for agricultural land spreading has become increasingly difficult from an operations and cost point of view. Furthermore, site restrictions imposed on Class B biosolids, which was the best classification that could be achieved, limited the city's land disposal options. For these and other reasons, the city's engineering consultant[6] recommended significant improvements to the biosolids management program.

Biosolids Quantities and Characteristics

Historically, the city has been generating biosolids at a rate of about 280 dry metric tons per month from the Springtree and Sawgrass WWTPs combined. Recent records indicate a maximum week to average month ratio of 1.3, or 90 tons per week, combined. New biosolids facilities may be sized to accommodate a monthly average production rate, if the quantity of wastewater treated remains relatively constant, and pre-digestion storage is provided to equalize biosolids feed. Otherwise, the more conservative weekly production rate should be used for equipment sizing.

The 503 Rule prohibits land application of biosolids that exceed ceiling concentration limits for nine regulated metals. Included are arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. Restrictions on land application of biosolids that exceed pollutant concentrations, cumulative pollutant loading rates (CPLRs), or annual pollutant loading rates (APLRs) are also imposed. Based on the results of regular quarterly biosolids sampled at the city's WWTP's, none of the CPLR nor APLR limits are expected to be exceeded[9].

The city previously met the pathogen reduction requirements for Class B biosolids by aerobically digesting biosolids in compliance with PSRP operational standards. Vector attraction reduction requirements were also met, as the City consistently produced digested biosolids with a specific oxygen uptake rate (S.O.U.R) of about 0.5 mg O_2 per hour per gram of total suspended solids (TSS), dry-weight basis, at 20EC; the allowable S.O.U.R. limit is 1.5 mg O_2 /hr/g-TSS.

New System Description

As called for in the original design for construction documents, waste activated sludge (WAS) from the Sawgrass WWTP is polymer-conditioned prior to entering the existing DAF units. The resulting 5 - 7% thickened wastes (TWAS) are then conveyed into two Pre-ATAD holding tanks, in which similarly thickened wastes transported from the Springtree and Park City WWTPs will be blended. Existing aerobic digesters were converted into the Pre-ATAD holding tanks. Following storage, the TWAS will be pumped into the new three-stage ATAD reactors. After thermophilic aerobic digestion, the biosolids are again stored in six Post-ATAD units, where they will be cooled before being conveyed to the new belt filter presses for dewatering. The flow diagram (a modified Fuchs ATAD system) is presented in the accompanying figure.

Based on the metals concentrations (from quarterly sampling) and the anticipated levels of stabilization and vector attraction reduction, the processed biosolids are expected to meet "exceptional quality"[2] (EQ), or Class AA, requirements, per F.A.C. 62-640.850. Class AA biosolids, like Class A biosolids, have no land restrictions, and can be marketed and distributed to the public at large as a common fertilizer or soil amendment to virtually any type of land.

The accompanying table lists basic design criteria for the city of Sunrise ATAD system in a traditional format. Following are additional design criteria and guidelines for the major ATAD equipment.

Design Criteria for Major ATAD Unit Processes

General Considerations

1. Equipment and material composition must be selected to secure against erosion/corrosion problems associated with high heat and aggressive liquids.

2. Follow standard industry guidelines and criteria (e.g., EPA-430-99-74-001 — Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability, 1973).

Pre-ATAD Holding Tanks

1. Thicken raw residuals to 4-6% total solids (TS), and provide

2.5% volatile solids (VS) to assure autothermal conditions in ATAD reactors. If a 2.5% VS fraction can not be attained, then heat exchangers should be used to provide supplemental heat.[3,1]

2. Tankage sizing will be based on monthly average flows.[1] To offset hydraulic variations in the absence of Pre-ATAD holding tanks, peak week loadings should be used to establish minimum volumes for the desired hydraulic residence time.[8]

3. Re-use existing concrete aerobic digestion tanks after insulation.

4. Material: Concrete will provide longer life; steel tanks should be glass-lined.[7]

ATAD Reactors

1. Meet EPA 40 CFR Part 503 requirements for Class A PFRP and 38% VS reduction. Sixty percent of VS reduction occurs in the first reactor.[3]

2. 503 Rule: When the percent solids of the sewage biosolids is less than 7%, the reactor temperature is 50°C or higher, and the retention time is 30 minutes or more, the temperature-time function shall take the form:

$$D = 50{,}070{,}000 / 10^{0.1400t},$$

where D = time (days) and t = temperature °C).

3. Manufactured, proprietary, or prepackaged ATAD systems would require excessive tankage and equipment. Dayton & Knight (West Vancouver, B.C., Canada) was retained by the city to design a custom facility.[7;11]

4. ATAD digesters will be constructed of rectangular concrete reactors, insulated on the inside and completely enclosed[7]. According to Krüger[9], however, a circular aerator is especially effective at preventing solids from settling on the bottom center of the reactor, but are more expensive to build. Also, steel is more commonly used due to heat stress concerns in concrete and costs[10].

5. ATAD tanks may be insulated with mineral wool (approximately four inches thick) around the tank walls, and styrene foam on the cover.[3] Coal tar epoxy is also used to coat the inside and outside of ATAD tanks.[9]

6. First-stage feed solids content should be in the range of 4-6%. Slurries with less than 3% solids may have difficulty achieving thermophilic temperatures because of too much liquid mass. Slurries with more than 6% solids are difficult to mix, aerate, and convey.[10]

7. Feed second-stage reactors once per day within 30 minutes. The displaced volume should be adjusted such that the average residence time will vary by about 20% or less to avoid thermal shocks that may disrupt the system.[3]

8. Total ATAD retention time has been reported as 5 - 7 days[7], EPA[3] reports 5 - 6 days, and Krüger[9] reports 6 - 8 days.

9. Minimize tankage and oxygen requirements. ATAD can accomplish this through improved oxygen transfer efficiency (i.e., using membrane diffusers or aspirating mixers), and inhibition of nitrification at temperatures above 40E C.[1]

10. According to CDM[1], ATAD is associated with lower capital and O&M costs, relative to more conventional biochemical stabilization technologies. Vik and Kirk[10] compared ATAD with anaerobic digestion and N-Viro AASSAD (a PFRP process) and reached the same conclusion.

City of Sunrise ATAD Design Criteria

Parameter			1999	Buildout
Plant Flow AADF		mgd	22.7	29.0
Solids Production	Average annual	lb/d	28,400	36,200
	Peak week	lb/d	37,800	48,300
ATAD	Trains		2	3
	Reactors each train		3	3
	Length x Width	ft	30 x 30	30 x 30
	Max. operating depth	ft	18	18
	Available volume each	gal	121,000	121,000
Operation	Number of reactors used		6	9
	Avg. annual operating volume	gal	565,000	848,000
	Organic loading	kg/m^3-d	5.1	4.4
	Total HRT	days	9.8	11.5
	Degree-days	deg C	490	575
	Volatile solids reduction	%	44	49
	Peak week operating volume	gal	606,000	908,000
	Organic loading	kg/m^3-d	6.4	5.4
	Total HRT	days	7.9	9.2
	Degree-days	deg C	400	465
	Volatile solids reduction	%	39	43
Pumps/mixers per reactor			2	2
	Pump power, 1^{st} and 2^{nd} reactors	Hp	50	50
	Pump power, 3^{rd} reactor	Hp	30	30
	Average power density	W/m^3	100	100
	Maximum power density	W/m^3	170	170
	Energy per unit of liquid	$kW\text{-}hr/m^3$		
	Average annual		23	27
	Maximum		32	37

From Kelly, H.G. et al, Design and Startup of an Innovative Large Scale *Autothermal Thermophilic Aerobic Digestion Facility*, Proceedings 72^{nd} Annual Conf. & Expo., WEF, New Orleans, LA., October 9-13, 1999

11. Solids loading criteria[7] and local climatic data are used to size cooling system and for ammonia reduction.

12. Waste characteristics determine biodegradability and heat production.[7]

13. Operating Temperatures: 40 – 45°C (first stage), 55 – 65°C (second stage) and 40 - 45° (third stage)[1]. EPA[3] reports ≥25° (first stage) and 55°C (second stage).

14. The controlling reaction capacity is digestion time for solids reduction (5-8 days), which is in addition to pasteurization requirements (1-2 days) for disinfection.[7]

15. The number of reactor stages selected will depend on fluctuations in hydraulic loading, or the desire to use continuous treatment with plug flow to achieve pathogen destruction.[8]

16. Three-reactor, series system using two screw centrifugal recirculation pumps and Venturi aerators per reactor provides flexibility to allow continuous feed mode by taking advantage of variable reactor volumes, while achieving the pasteurization criteria and digestion time required to comply with the 503 Rule for pathogen /vector control. [7]

17. The Venturi-pump system is reportedly preferred by plant operators because of ease of maintenance and the ability to house components within an enclosed structure.[12]

18. Sludge feed to ATAD trains will be continuous over a 12-16 hour day, 7 days a week from DAF thickeners.[7]

19. Biosolids from plants, such as the city of Sunrise, which do not employ the use of primary clarifiers, and with food-to-mass ratios (F/M) as low as 0.01 to 0.15 (lb BOD/day)/ lb VS are suitable for ATAD.[3]

20. Biosolids transfers occur from the first to the second, and from the second to the last reactor stage (of each of two ATAD

trains) to ensure batch operation.[7] Batch operation prevents short-circuiting and possible bleed-through of pathogens.[13]

21. The ATAD system process instrumentation and controls (P&ID) should be designed to minimize short circuiting during the sludge cycling period, which is characterized by a plug fill situation. This plug fill results in the partially treated biosolids being forced up and across to the second-stage reactor, reducing the possibility of raw biosolids contaminating the process.[9]

Post-ATAD Holding Tanks

1. Re-use existing aerobic digestion tanks.

2. Cool digested sludge before dewatering. This will improve dewatering by reducing polymer use, and avoid fog formation during the dewatering process.[7]

3. In the absence of heat exchangers, a 20-day post-digestion holding period is desirable to reduce the temperature to 20°C[10]. A higher temperature — and thus a shorter holding period — would be acceptable in warmer climates.

4. Transfer the extracted heat into the Pre-ATAD units to help equalize the feed temperature entering the first-stage ATAD reactors.[7]

Digested biosolids are conveyed to the dewatering facilities with peristaltic hose pumps.[7]

Heat Exchange System

1. Should be constructed of AISI type 316 L stainless steel, with flushing connections, condensate traps, and two doors for cleaning.[7]

2. Spiral (i.e., two-compartment) or tube-in-tube heat exchangers are preferred. The former provides space-saving features in large installations.[7]

3. For raw biosolids, a grinder constructed of stainless steel must be used ahead of the heat exchangers. Grinders were selected to precede the heat exchangers being fed from the DAF thickener pumps.[7]

4. Heat exchanger feed should be well mixed or have a Reynolds Number greater than 7,000 - 10,000 to minimize wet film insulation effects.[14]

5. Thermodynamic qualities of the ATAD system must be thoroughly evaluated. A heat balance (or budget) for each reactor must consider the following heat sources and losses:[14,9]

- Heat generated through VS destruction and mechanical mixing energy,
- Heat change due to rate of addition of influent,
- Heat loss/gain through reactor and pipe insulation, heat exchangers, addition/removal of air, evaporation internal recirculation, and
- Heat change factors caused by phase changes, cavitation and other factors not yet accounted for, or are otherwise unquantifiable.

Mixing & Aeration Systems

1. A Venturi aeration-recirculation pump system was preselected for ATAD.[7] Fuchs ATAD systems utilize side-mounted self aspirating jet aerators.[3,9] Note that in Canada, aspirating aerators are known to have experienced plugging from excessive oil and grease[10].

2. Venturi aeration produces fine and elongated bubbles for improved oxygen transfer, and redirect energy to assist in the mechanical breakup of large particles through implosions (i.e., cavitation). This may provide an advantage over other less violent forms of mixing/aeration.[8]

3. Air flow rate and oxygen transfer efficiency depend on system geometry (e.g., height/depth ratio; location of aerators and mixers), feed characteristics (e.g., TS, VS, viscosity), and turbulence conditions.[3]

4. Design criteria:

Mixing power	= 5 - 6 HP/1000 ft^3 (First stage)[7]
	= 4 - 6 HP/1000 ft^3 (Second stage)[7]
	= 2 - 4 HP/1000 ft^3 (Third stage)[7]
	= 3.2 - 4.0 HP/1000 ft^3 (Two-stage reactor)[3]
Air flow	= 0.5 - 1.5 ft^3/ft^3-hr reactor volume[7]
	= 4 m^3/m^3-hr active reactor volume[3]

5. Minimum mixing energy is determined by calculating the power required to achieve a shear gradient of 450 sec^1. This does not include a safety factor which must be applied to ensure adequate power is available to compensate for periods of thin sludge, high or low feed rates, etc.[15,8]

6. The design basis for foam cutters is a function of the ATAD reactor's surface area. However, reactors are sized to accommodate 0.5 - 1.0 meters of freeboard, part of which is used for foam development and control. A minimum of two foam cutters per reactor is required.[3] The design criterion for the city of Sunrise is 3 - 12 feet of operating freeboard.[7] A well-managed foam layer acts as insulation, preventing heat loss through the reactor's top, leading to an improvement in the utilization of oxygen and an increase in biological activity.[13]

Recirculation & Transfer Systems[7]

1. Recirculation pumps must be NPSH-compensating centrifugal screw impeller with high chrome casing and impeller, with 316 L stainless steel backing plates.

2. Transfer pumps should be Type 316 stainless steel WEMCO, Type E for thickened sludge.

3. Digested biosolids transfer pumps should be rubber-lined (e.g., peristaltic Waukeshaw Bredel-type, or 2-stage progressive cavity Moyno-type). Positive displacement pumps are preferred, since discharge rates can be readily set without the need for flow control valves.

4. For raw biosolids, grinders manufactured from stainless steel must be used.

5. Recirculation pumps continuously recycle flow within each ATAD digester. Flow is discharged through a nozzle and Venturi section design to discharge air at supercritical velocities. This enhances the physical destruction of solids by cavitation. The recirculation pumps are interfaced with temperature controllers to maintain temperatures at a design set-point.

Conclusions

ATAD systems are relatively new in the U.S., and a great deal of analysis and planning should be undertaken prior to applying this technology utilizing information obtained primarily through experiences gained at German, French, and English installations. This may be particularly important in Florida where climatic conditions are significantly different from that of Western Europe.

Research efforts continue to shed light on the fundamental biochemical mechanisms involved in the ATAD process. However, the engineering design of ATAD facilities continues to rely heavily on the (collective and individual) experiences gained from the operation of existing facilities and the designers' knowledge of related unit processes. Until we are able to describe the ATAD process from a more theoretical perspective, a significant amount of the design, except under the most typical conditions, will involve test-based techniques. This approach most certainly has and will continue to lead to potentially short-term increases in cost. In addition, the required level of practical design, construction and operations experience is currently in the hands of a relatively few individuals and companies. Consequently, the widespread use of ATAD may be limited by the high capital costs typically associated with a lack of competition, and a general lack of interest among those municipalities most capable of benefiting from the technology.

We have presented a series of design criteria and guidelines, organized around the major ATAD unit processes planned for the city of Sunrise. Some have a theoretical foundation, many are informal in nature, but almost all are to some extent implicitly embedded in the final plans for construction and technical specifications. Unless they are explicitly documented, as has been attempted in this paper, much of the design criteria will be lost or otherwise inaccessible. Preliminary design of an ATAD system should consider these criteria, as well as many others not included here (e.g., biosolids thickening, conditioning, dewatering, process piping/ducting, and off-gas air quality requirements). Finally, the city of Sunrise's ATAD system, equipped with the latest state-of-the-art instrumentation, and real-time electronic data acquisition, processing and storage capabilities, as well as the city's new 5,300-square-foot laboratory, can provide much-needed design and operating data for current and future ATAD installations.

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DEP Requirements *from Page 23*

- Development of compliance schedules for industrial users
- Require the submission of self-monitoring reports
- Carry out all inspections, surveillance and monitoring
- Obtain remedies for non-compliance
- Comply with confidentiality requirements
- Identify and locate all possible industrial users
- Identify the character and volume of pollutants contributed to the POTW
- Notify industrial users of the applicable pretreatment standards
- Receive and analyze self-monitoring reports
- Randomly sample and analyze effluent data from industrial users
- Evaluate, at least once every two years, whether each significant industrial user needs a plan to control slug discharges
- Investigate instances of noncompliance
- Develop and implement an Enforcement Response Plan
- Comply with public participation requirements

So, When Dep Comes to Audit You ....

Changes in the regulatory community primarily focus on the delegation of pretreatment activities from the federal government to DEP. The effect of this change is an enhanced ability of the state to monitor pretreatment program implementation. DEP has created a section in its Domestic Wastewater Division whose primary focus is to monitor pretreatment programs within Florida. The division's staff actively inspect and monitor pretreatment programs state-wide, generally on an annual basis for larger programs. Within the first year of pretreatment delegation from EPA to DEP, Hollywood's industrial pretreatment program was audited.

When DEP comes to audit a POTW's program, be assured that a series of modifications to the program to meet state standards will be identified. Options available to the state include to address significant non-compliance include significant financial penalties, revoking of operating permits, and the setting of compliance schedules.

For Hollywood, DEP selected the setting of a compliance schedule as its action. The implementation of changes required for the industrial pretreatment program have generally been designated as mandatory via a DEP consent order.

DEP advises that pretreatment scrutiny will be standard procedure for all surface water discharges with metals violations, especially those with pending mixing zone applications.

While the pretreatment requirements are now significantly more rigid than those imposed by EPA in the past, pursuing the program outlined by the state has allowed Hollywood to obtain a much more detailed understanding of its wastewater collection system.

We now have information on the types of constituents we can expect on average, can provide data on reducing pollutant flows to inquiring industries, and have discovered that the industrial components do not match prior laboratory analyses, indicating that sloppy laboratory work may have triggered our current consent order.

In addition, we have a better feel for timing and quantities of pollutants from large users, as well as commercial versus residential flows. This will help us substantiate our need for a copper mixing zone.

The effort has taken Hollywood three years, with another year to go, to survey 7,000 industries, permitting as many as 200 of them, which is ten times the amount in 1995. This will help the program become self-sustaining in the future. ■