Comparative Analysis of the Glendale Advanced Wastewater Treatment Plant in Lakeland, FL Using Bioaugmentation

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ABSTRACT

The City of Lakeland, Florida selected bioaugmentation in 2001 to treat odor and corrosion in a partial section of the collection system. The technology was in place within the sewer system for approximately six months on a limited scale and successfully controlled the odors, which challenged the City for many years. The City elected to expand the program to other select sewer areas. Over three years, bioaugmentation expanded to cover the entire sewer system, which is an area of about 100 square miles.

The wastewater treatment plant consists of three parallel trains of a Modified Ludzack Ettinger (MLE) process designed for 40,900 lbs/day of influent BOD. Prior to bioaugmentation, the city operated all three trains and processed approximately 30,000 lbs/day of influent BOD. In 2004, the plant turned off one train as a result of additional organic capacity and operated only two trains for 5 years; however, the loading into the sewer system grew more than 25%. With additional biological capacity and operational flexibility from external bioaugmentation, the plant is capable of processing shock loads from a single industrial contributor that discharges 50% of the influent load while staying well below permit limits.

This paper compares plant performance using operating data from 2009 after the technology was in place continuously for nine years to 2000 prior to the start of bioaugmentation. The evaluation of plant influent conditions and performance operating three trains in 2000 versus two trains in 2009 is examined in detail using an independent statistician. The approach focuses on the following areas of impact: load reduction, plant capacity, nutrient removal, and sludge reduction.

Keywords: Bioaugmentation, Biofilm, Biosolids, Capacity, Efficiency, Nutrient Removal, Sewer, Treatment, Wastewater.

INTRODUCTION

The City of Lakeland, Florida selected In-Pipe Technology Company, Inc (IPTC) to provide odor control services in critical sections of their sewer system for the Glendale Advanced Wastewater Treatment Plant after trying many other conventional means of odor control without success. Cultured bacteria addition is a liquid phase treatment approach for collection system odor control and FOG (fat, oil, and grease) removal. Bacterial addition involves the application of cultured microorganisms aiming to alter the microbiology and oxidize carbonaceous matters in wastewater collection system. The cultured bacteria can grow quickly under anoxic condition or aerobic condition. As a result, the added bacteria have a competitive advantage over sulfur reducing bacteria to take up organic matters in the wastewater [3]. Advantages of this process include low cost, as it does not involve the use of expensive chemicals.

Over two years IPTC expanded coverage to include the entire sewer system for control of both odors/corrosion and Fats, Oils and Grease (FOG). In 2003 IPTC began making modification and optimization to their design, and included evaluation of impact upon plant performance. In February 2004 one of three identical aeration trains at the Glendale plant was taken out of service and remains out of service. The influent load entering the plant is, statistically the same in 2009 as in 2000, yet the city has experienced growth of more than 20%. Moreover, the plant routinely receives unannounced influent organic loading spikes far in excess of the collective design capacity of all three trains and successfully processes the material without a statistically noticeable impact on the effluent quality with only two trains in service. This paper focuses on the following areas of impact: load reduction, plant capacity, nutrient removal, and sludge reduction.

1 - PROJECT HISTORY

The Glendale WWTP in Lakeland deals with a challenging situation, which includes an extremely high and highly variable organic loading from the food industry (Publix). This industrial user represents 10% of the total hydraulic loading to the plant and comprises 50% of the total influent organic load.

The Glendale Plant is a Modified Ludzack Ettinger (MLE) Process for biological nutrient removal that treats 8 million gallons per day (MGD). The effluent passes through a large, constructed wetland before entering into a watershed that drains into Tampa Bay. The plant does not have tertiary filters, only secondary clarification.

This analysis compares plant performance in 2000 without In-Pipe Technology to 2009 after In-Pipe Technology has been in place, continuously, for nine years. The flow is measured daily (7 days/week) with composite samples taken for analysis by a certified testing laboratory at the plant. Additionally, numerous operational samples are collected each day, along with pertinent operational data.

In-Pipe Technology provides a service that supplies a consortium of live, facultative, heterotrophic naturally occurring bacteria into the outer reaches of the wastewater collection system. Once introduced into the collection system this treatment strategy enhances the microbial community such that the In-Pipe bacteria out compete the endemic bacteria for food and nutrients to populate and eventually thrive in the sewer environment.

The In-Pipe microbes impart treatment on the wastewater during transit in two ways: 1) converting the inner surface area of the pipe into a beneficial biofilm, similar to the biofilm present in attached growth activated sludge systems and 2) populating the bulk liquid wastewater and constantly seeding the wastewater treatment process with beneficial microbiology that are capable of nitrification and denitrification. [2]

In-Pipe completed the installation of 70 G2 dosing units over multiple years for the gradual conversion of the collection system biofilm to the IPT biofilm. Each G2 dosing unit (G2 Panel) consists of a self contained enclosure housing a battery powered solenoid pump operated by a small circuit board. The dosing panel holds a 1 liter replaceable reservoir with a 30 day supply of microbes that dispenses a preset volume of IPT microbial formula per day. The microbial formula contains the proper blend of bacteria to establish a beneficial sewer biofilm, remove fats, oil and grease (FOG), and to inhibit sulfate- reducing bacteria (SRB) in the collection system while improving treatment performance at the plant. The G2 panel is certified by the CSA as intrinsically safe and the microbial formula is proprietary to In-Pipe Technology.

The dosing panels installed in the distant reaches of the collection system provide the IPT bacteria abundant interior surface area in the collection system to form a biofilm. The vast surface area of biofilm that develops with In-Pipe treatment transforms a passive conveyance system, into a part of the wastewater treatment process.

2 - ANALYSIS

In-Pipe Technology Company contracted with Professor Pete Kaslik, Math Handyman, LLC, to perform statistical analysis of the plant data, comparing May through November in 2000 to 2009. The statistical analysis is particularly relevant because the plant operated three identical, parallel, aeration trains in 2000; however, in 2009 only two of these trains was in operation. Additionally, a perspective is given regarding the inflow into the sewer system from meter counts. Lakeland changed the tracking of meter counts and reported consumption when a new computer system was placed into service in 2002. As a result, 2002 users are compared to the number of meters in 2009.

2002		
Class	Count	Consumption
COMDM	450	27,986
COMM	1,550	22,481
GOVT	58	2,913
IND	22	13,323
MUNI	86	4,348
MXDUS	65	5,156
RES	10,476	109,458
RESAT	2,252	27,894
RESMH	1,082	20,317
Total	16,041	233,876

Table 1: Meters Counts Connected to the Sewer System in 2002 with Consumption in 1,000's of Gallons.

2009			Increase
Class	Count	Consumption	Counts
COMDM	504	23,758	
COMM	1,929	23,346	
GOVT	63	2,953	
IND	27	13,706	
MUNI	89	2,901	
MXDUS	84	6,673	
RES	12,780	95,228	22%
RESAT	3,146	30,238	
RESMH	1,458	18,679	
Total	20,080	217,482	25%

Table 2: Meters Counts Connected to the Sewer System in 2009 with Consumption in 1,000's of Gallons and Comparison to 2002.

Residential meter counts increased 22% as the number of overall meter counts increased 25% in 2009 compared to 2002. Interestingly, water conservation efforts appear to have been effective because the overall consumption was down just under 7%.

The actual loading from industrial clients is tracked on a monthly basis, with Publix being tracked on a daily basis.

The actual industrial discharge to the sewer in the comparable periods showed a 9.6% increase between 2000 and 2009. It must also be mentioned that the Lakeland sewer system experienced significant Infiltration and Inflow (I&I) at the time In-Pipe began in Lakeland. Thanks to an aggressive program of sewer repair, the I&I was substantially reduced.

The detailed report included graphical displays for ease of understanding. The summary in Table 3 displays the results of statistical testing for influent load, concentration, and interaction. Some values could not be analyzed because the laboratory does not test for those. Where this occurs the notation N.T. is used. Blanks within the table indicate no statistical difference. In the case of statistically significant differences, the notation will show the values greater than or less than, with or without, IPTC.

	Ammonia	TN	NOx	Organic Nitrogen	TKN	TP	Ortho-P	Poly-P	BOD	TSS
Influent Concentration	Sig, >IPT		N.T.	N.T.	N.T.	Sig, <IPT	Sig, <IPT			
Effluent Concentration		Sig, >IPT	Sig, >IPT			Sig, <IPT	Sig, <IPT			
Concentration Interaction	Sig, +IPT		N.T.	N.T.	N.T.					
Influent Load	Sig, >IPT	Sig, >IPT	N.T.	N.T.	N.T.	Sig, <IPT	Sig, <IPT			
Effluent Load	Sig, >IPT	Sig, >IPT	Sig, >IPT				Sig, <IPT			
Loading Interaction	Sig, -IPT		N.T.	N.T.	N.T.			Sig, +IPT		

Flow	MLSS	SVI	O2 uptake	SRT
	Sig. +IPT			

>IPT & -IPT = better w/o; < IPT & +IPT = better w/ IPT

Table 3: Results of Statistical Testing for Influent Load, Concentration, and Interaction.

3 - RESULTS

The plant processed more organic and nutrient loading in 2009 with two trains in operation instead of three compared to 2000. Flow, BOD, TSS, SVI, Oxygen Uptake and SRT were statistically the same in 2000 versus 2009. The Mixed Liquor Suspended Solids (MLSS) was better with IPT. This is noteworthy since the same amount of organic loading was processed with only 2/3rds of the biomass from elimination of the third process train. Also, the concentration in the remaining biomass was significantly lower. This points to an increase in the efficiency of the IPT dominated biomass over the biomass without IPT.

The oxygen uptake rate is statistically the same at 32.7mg/l-hr in 2009 compared to 28.2mg/l-hr in 2000; however, the total amount of biomass to process similar total influent load is 1/3 less with one train eliminated. The plant was able to produce high quality effluent BOD at 133lbs/day in 2009 compared to 118lbs/day in 2000 and TSS at 181lbs/day in 2009 compared to 208lbs/day in 2000.

The original design load of the WWTP running three trains is 40,904lbs/day compared to 27,270lbs/day running on two trains. As mentioned previously, Public discharges periodic shock loads to the plant. In February 2009, Publix delivered an average of 90,000lbs/day over the course of three days without any significant changes to effluent quality. This is approximately 3 times the design loading of two trains running in parallel.

Although sludge disposal was difficult to track, the Sludge Volume Index (SVI) and Solids Retention Time (SRT) were analyzed. The SVI decreased 10% to 74ml/mg in 2009 compared to 83ml/mg in 2000. The SRT increased 5% to 8.6 days in 2009 from 8.2 days in 2000. This suggests that a greater rate of sludge reduction is likely as treatment continues which is consistent with findings during other IPT programs. [1]

CONCLUSION

The application of In-Pipe Technology to the entire collection system for the Glendale WWTP in Lakeland provided many benefits beyond the original goals and objectives of controlling odors and corrosion. Odors, corrosion, and FOG are controlled within the collection system. Influent BOD and TSS loads are processed in the sewer as evidenced by no statistical increase in these parameters while Lakeland experienced increased water meter counts and industrial loads.

The plant operates only 2 of the 3 process trains since February 2004 without any negative impact upon effluent quality. In addition, the plant has processed numerous instances of unannounced extreme influent loading spikes, some lasting three days or longer, without exceeding effluent permit limits.

The City of Lakeland selected an emerging technology, collection system bioaugmentation, to reduce collection system issues and received improved operating performance of the wastewater treatment process. In-Pipe treatment optimizes the biology of the wastewater, the fundamental mechanism of the biological treatment process. In-Pipe develops the collection system into an active part of the wastewater treatment process by extending treatment from the plant into the sewer collection

system. Utilizing miles of existing pipe, In-Pipe Technology converts the passive sewer system into a meaningful treatment step. Performance in the collection system provides increased additional capacity within the plant, forestalls costly upgrades, and extends the life of existing infrastructure. Providing sustainable solutions to collection system and wastewater treatment plant challenges without additional energy input and capital expansion will take considerable attention as we move into a future of limiting resources.

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