Water Management District Update

Patrick J. Gleason and Robert Powell

FSAWWA's Water Management District Coordination Committee held its meeting in September in Orlando. Estus Whitfield, the governor's advisor for environmental affairs, and the Honorable Lee Constantine (Rep.-H-37) from Altamonte Springs were both invited speakers, in addition to our usual cadre of excellent speakers from the water management districts.

Whitfield said that he had talked to Governor Chiles about attending the FSAWWA meeting and Governor Chiles had instructed him to get answers to water questions rather than for Whitfield to give answers. Whitfield indicated that he was not an expert on water management, but he was an expert on government bureaucracy. He had been working for the state of Florida for 25 years and his job early-on was to drive the U.S. Army Corps of Engineers and the Soil Conservation Service out of Florida. He gave an excellent history of the water management districts starting in 1971. He said he gets all the complaints directed to the governor, and that in the early 1990's there was a strong feeling that regulation was adversely affecting property rights, which eventually let to the passing of property rights legislation in 1995. Whitfield said that the districts were accused of being arrogant, and they probably were, but the water management districts have made some adjustments and complaints have been down the last several years. Governor Chiles believes that the water management district system is sound, but still needing some improvement. The governor believes that "water is the key to the future of Florida." Whitfield indicated that changes in government come out of shear frustration and that changes are brewing in water management with "water overwhelming all other environmental issues." Whitfield believes that "water supply is the key issue...the rip tide where issues will be."

He said that SWFWMD had been bold and courageous at increasing ad valorem taxes to come up with more money for water supply projects. St. Johns River Water Management District had performed a needs and sources analysis working directly with utilities. He said that SFWMD is working towards a Lower East Coast Regional Water Supply Plan, and working with the Corps of Engineers on a "Restudy" of South Florida, now, with a water supply element.

According to Whitfield, an ELMS Study Commission recommended a Land and Water Supply Planning Task Force in 1993-1994. The task force concluded that a weak link existed between local government planning and water supply. Subsequently, many recommendations for integrating land and water planning have been developed but have not been implemented yet.

In 1994 the legislature created a Water Management District Review Commission under the leadership of former Senator Phil Lewis. The group will be coming up with substantial recommendations, and they will make a difference in the way water is managed, according to Whitfield. Some general findings include: the commission doesn't believe in a statewide water board because it would further complicate an already complicated situation. Board members should continue to be appointed. Whitfield indicated that the governor doesn't believe that the legislature should approve the water management

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district's budget on a line-item basis nor does he want micromanagement by the legislature. The governor favors legislative oversight of the districts, however. (Senator Lewis has indicated that the Review Commission will come up with a final document by December 15 and submit it to the legislature by January 1, 1996).

The legislature has also been active in setting the stage for changes to Florida's water policy. The house set up a Select Committee on Water Policy headed by Representative John Rayson of Pompano Beach. In September the senate also set up a Water Policy Committee headed by Senator Jack Latvala of Pinellas County.

Governor Chiles, in discussions with Senator Bob Graham, decided that a more intensive look at South Florida was necessary. Consequently, the governor appointed a 43 member Commission on Sustainable South Florida. A report was finalized in September 1995 with 300 recommendations for consideration by the governor.

Whitfield said that the 1995 session of the legislature will be "full of water." He said that mitigation of consumptive use impacts on wetlands is an issue that exists in different places in Florida, particularly in the Northwest Wellfield of Dade County. He spoke with DEP and indicated that there is a willingness to resolve this issue. He indicated that consumptive use and mitigation of wetland impacts will be resolved in the next two years

Reuse is also an important issue to utilities, and who determines the feasibility of reuse is key. He indicated that there were different ways to look at the problem, such as the utility performing the feasibility determination; mutual agreement between the utilities and the regulatory agencies, or determination of feasibility by a third party. He stressed the importance of the utility's involvement in feasibility determination, but indicated that feasibility determination was an "open-ended" issue at this time.

With respect to water transport, Whitfield said that Florida won't be transporting water (between districts) for probably the next ten years, and it will take that long, at least, to get support for the concept. He also didn't believe that there would be a water use fee this year, but it could be coming in the future. He reviewed Governor Bob Martinez's efforts to get a water use fee and said that Chase Manhattan Bank had evaluated the concept and thought it could be done.

Bob Brotherton of Dunedin said that two-thirds of desalination costs are power costs, and perhaps the state could make desalination more feasible by "wheeling of power," which would reduce costs.

Christine Jackson from SWFWMD gave an update on the district's activities. She said that challenges to the Southern Water Use Caution Area rules won't be over until early to mid-November. She said that there are more administrative hearings on one-year wellfield renewals, specifically with the city of St. Petersburg, West Coast Regional Water Supply Authority, and Hillsborough County, but that one board order had been canceled because agreement has been reached and another is undergoing settlement talks.

Jackson addressed the New Water Sources Initiative Program. Three projects are funded to provide reclaimed water for indirect potable reuse.

These are augmenting Tampa's water supply by recharging the Hillsborough River with reclaimed water; recharging wetlands at the Section 21 Wellfield Rehydration Pilot project, and the Pasco Rainbow Project, which will inject reclaimed water into the aquifer at three regional public supply wellfields. Five new projects have been added, including an interconnect between the city of Tampa and Hillsborough County, a central Sarasota County reuse project interconnecting agricultural operations and golf courses with reclaimed water, an aquifer storage and recovery project at Punta Gorda, interconnecting several Hillsborough County wastewater treatment plants to provide reuse for agriculture and potential wellfield recharge. She also said the district expects to ultimately commit $50 million to a major desalination project (interested utilities are invited to contact the district's local governmental affairs coordinator). To date, the district's Cooperative Funding Program involves 35 of the district's 50 local governments that have wastewater treatment plants.

Lou Devillon from SFWMD discussed the status of planning at his district. He addressed raw water aquifer storage and recovery as an option in South Florida. He said that SFWMD had met with EPA and DEP. SFWMD had given raw water quality from Lake Okeechobee and the Everglades Agricultural Area (EAA) to the agencies. The data showed few exceedences of primary drinking water standards. SFWMD believes the analyses meet the intent of the EPA regulations for raw water ASR. He said that 750 MGD of storage capacity is needed to provide for the water demands of the EAA. The time is right, according to Devillon, to pursue raw water ASR. A draft water supply plan should be ready for southeast Florida by Christmas.

Hal Wilkening of the Department of Resource Management at St. Johns River Water Management District showed a map of the Water Resource Caution Areas in SJRWMD. Contracts have been initiated with consultants to look at alternative water supplies. SJRWMD is evaluating ASR to promote reuse of reclaimed water. New Smyrna Beach is spending $0.5 million to look at this alternative. Wilkening said that the district is working with the water supply advisory utility group to ensure that there are no surprises. Currently the district's water supply cost share program is only $0.5 million, but in a few years the district will have a better understanding of what are the best programs to invest in.

The SJRWMD governing board is streamlining its regulatory process. In consumptive use, the district is proposing to adopt a general permit that doesn't have to go to the governing board for uses under 0.5 MGD; 70-80 percent of existing permits fall into this group. The district is also trying to increase the duration of water use permits. The board will issue consumptive use permits for up to seven years, but general permits are issued for 10-15 years. Only five-year permits will be issued in water resource caution areas until solutions to water supply problems are worked out. Under new rule proposals, short-term construction dewatering would become a general permit.

Bob Brotherton from Dunedin and Dave Henderson from the city of St. Petersburg both recommended longer term permits.

The district is also trying to amend its reuse rule to allow the allocation of back-up sources of water to reclaimed water systems. It has been trying to tweak the rule based on comments from Altamonte Springs. Pat Gleason of Montgomery Watson said he would send the new reuse rule to all members of the committee.

Robert Powell from Pinellas County discussed the reorganization of the FSAWWA Utility Council. He said that utilities haven't been effective in getting their points across to the legislature. Technical advisory groups are being set up for reuse, water quality, underground injection control, aquifer storage and recovery, and groundwater supply. Participation is needed, and he asked volunteers to contact him at 813-582-2302.

Pick Talley from Pinellas County said that utilities are having a difficult time with transfer of water because of the emphasis on local sources. He said that desalination would double their current utility rate to about $2.50/1000 gallons. SWFWMD wants them to reduce pumpage by 75 percent and is proposing only a one-year permit. Yet, to make system improvements they need to borrow money for a 20-year period. He believes that water issues before the legislature will last several years. Yet he believes that they have plenty of water—the Floridan aquifer is the largest freshwater aquifer in the U.S.; public water supply uses only 0.09 percent of storage within the aquifer. Rainfall in Florida in about 10,000 gallons per person per day while average per capita use is 150 gallons per person/day. Pinellas County is willing to spend $200 million to reuse reclaimed water to reduce demands on available potable water resources, but the county is concerned about water quality aspects of reuse near public water supplies.

Representative Lee Constantine is on the House Select Committee on Water Policy, which is currently in an education phase. Present and future leaders of the Democratic and Republican parties are both on the committee. He pointed out that the Water Policy Committee is neither a Republican or Democratic committee, because there are urban versus suburban versus rural interests. He said that he had written the Apricot Act and praised Altamonte Springs for implementing reuse while keeping rates in the lower one-third of all rates locally. He addressed adding incentives and reducing consumption as future components to State Water Policy He said that last year's alternative water supplies bill was "stop gap" to be added onto this year. He indicated that he doesn't believe that Hollywood should require reuse by golf courses and that it should be a voluntary program. Reuse should be built only if the majority want it. Altamonte Springs marketed reuse and eventually had people demanding that it be put in their neighborhood.

Bob Bailey from CH2M HILL, chair of the Legislative Committee, indicated that FSAWWA is working with the League of Cities and the Florida Association of Counties to avoid tunnel vision on reuse. He said that the Altamonte Springs system may not be possible for everybody. Ray Taylor from the city of West Palm Beach pointed out that local residential systems may not be possible because of numerous underground facilities. Bob Brotherton said that Dunedin can't build reuse lines fast enough for people that want reclaimed water. Whit Van Cott from Hollywood said that different communities have different solutions to reuse and that to be successful, there may need to be three or four potential solutions to disposal. Representative Constantine said that he is a strong supporter of local government and doesn't see a need to mandate reuse because the state isn't going to pay for a reuse program. He is a strong supporter of user fees and believes in flexibility on the part of local government. He said that from a legislative viewpoint, he doesn't view public water and sewer systems as having a low priority. He doesn't believe that we are going to see one big Florida water policy but differences from region to region. He indicated that the Water Policy Committee serves at the pleasure of the speaker and will change next year. Therefore, the Water Policy Committee needs to come up with a plan by the end of this legislative session in April 1996. The Water Management District Review Commission findings will be funneled through the Water Policy Committee for implementation. He asked to come back to address FSAWWA in four months, and we could contact him at 407-33l-WORK with input on any of these issues.

Pick Talley suggested formation of an Urban Coalition for urban water supply. He said the urban areas in Florida should hire a full time urban water supply lobbyist. Fred Rapach from Palm Beach County supported the recommendation. Bob Bailey suggested that FSAWWA should focus on narrow areas, such as the Water Policy Committee and the Water Management District Review Commission, and that we want to extend the duration of permits and limit the ability of the state to set rates. Bob Morrell with Post Buckley Schuh and Jernigan, recommended joint activities by the Florida Engineering Society and FSAWWA.

Gary Williams with the Florida Rural Water Association gave a report on regulatory activities by DEP. DEP is proposing splitting Florida Administrative Code 62-555, focusing on cross-connection control issues. DEP is also looking at a monitoring review waiver for public water systems that would consist of determining contamination sources in a 1200-foot radius around each wellhead and determining whether monitoring could be reduced; a sanitary survey would be necessary for the waiver. He said that the NPDES program for wastewater was transferred to DEP from EPA but no money came with it.

Williams said that the Department of Business and Professional Certification is reviewing whether water treatment plant operators need to be certified. More information on operator certification can be obtained from Williams at 800-872-8207.

Bob Morrell indicated that nothing is going on with the wellhead protection rule at this time insofar as the formation of committees to evaluate the next phase of wellhead protection.

The tentative plan for the next Water Management District Coordination Committee meeting is January 26, 1996 at 10:45 a.m. at the Orlando Utilities Commission. If you would like to join the committee and receive announcements of meetings, please contact Pat Gleason at 407-586-8830. ■

Biofilters: An Alternative Approach to Hydrogen Sulfide Removal

Kiera S. Fitzgerald, Doug G. Harris and David Kowalski

As the public becomes more vocal in its opposition to wastewater treatment plants, operators are striving to reduce impacts on the surrounding communities. As a result, more treatment facilities are installing systems to help reduce odor.

Major odor sources at wastewater facilities include (1) pump stations, headworks, and primary clarifiers, where the predominant odor-causing chemical is hydrogen sulfide, and (2) the solids handling processes, where a mixture of hydrogen sulfide, ammonia, and complex sulfur-based organics cause odor.

At plant headworks and upstream pumping stations, common treatment methods to reduce odor caused by hydrogen sulfide include wet scrubbers and activated carbon scrubbers. These systems are costly to construct and have high operation and maintenance costs because of chemical requirements and media replacement. Biofilters, on the other hand, have been used extensively in Europe to control various sources of odor. They provide a simple, cost-effective technology to control odor caused by hydrogen sulfide. In North America they have been used primarily to treat compost odor.

Aqueous hydrogen sulfide is rapidly oxidized in an aerobic environment. Therefore, removing malodorous compounds such as hydrogen sulfide from the air stream is a two-step process: the compound must be sorbed into a liquid phase and then microbially oxidized. By nature, municipal wastewater compost offers a perfect media for this process. With the proper mixture of sludge and wood chips, compost provides a porous yet moist media for sorption and a high concentration of microbes for biological oxidation. In addition, for most wastewater treatment facilities, compost is free. Alternative methods of odor control, such as chemical oxidation and activated carbon, require expensive chemicals or media.

A review of the literature and discussions with biofilter operators indicate that the following parameters are important in the proper operation of a biofilter:

Media Blend. The compost must have enough biosolids to promote biological oxidation while having enough wood chips or inert material to provide a porous structure for air to penetrate.

Moisture. Although moisture is essential for microbial growth, excess moisture can prevent proper air distribution and cause souring of the pile.

Air Distribution. Air must be properly distributed to provide adequate contact and to avoid leakage of untreated odorous air.

pH. The pH must be neutral to promote microbial growth. The microbial population uses sorbed organic materials and oxidizes them to carbon dioxide and water, which lowers the system pH (1). Lime or caustic can be added to the pile to maintain a neutral pH.

*Drainage***.** A well-drained system is critical to maintain sufficient voids for adsorption of odor-causing chemicals and to prevent excessive head loss in the system.

Loading Rate. The loading rate must be low enough to allow the media to adsorb the compounds and to prevent leakage of untreated air. The air flow rate should be adjusted according to the influent concentration of odorous compounds.

Temperature. As with any biological system, air temperature affects the efficiency of the microbes. Ideal temperatures are between 2 and 35 degrees C (35 to 95 degrees F) (2).

The above information was used to develop design criteria (Table 1) to optimize biofilter operation.

Parameter	***Criteria***
Media type	Municipal compost made with wood chips
Media porosity	>80%
Particle size by % wt. (limit fines)	<2mm,<20%; >3mm,>60%
Organic content	>70%
Moisture	50-60%
Moisture control system	SST mister box for influent air
Air distribution	Perforated PVC in gravel or precast concrete undervent system
Air flow loading rate	8 scfm/sf maximum, 2-3 scfm/sf typical
Bed depth	1-2 foot air distribution zone, 2-3 feet media
Influent air temperature	2-35 degrees C
pH	6-8
Air retention time	40 seconds minimum
Chemical addition	Quarterly liming/caustic addition
Media replacement	3-5 years
Materials of construction	SST, PVC, FRP, coated concrete

Table 1. Typical Design Criteria for Biofilters

Case Histories

Table 2 provides a summary of three wastewater treatment facilities that use biofilters to reduce hydrogen sulfide to levels near or below olfactory detection. In addition, these facilities have achieved odor control at low cost and with minimal operator attention. A review of these operations revealed the following key design and operations concepts:

- Media replacement is usually required after 3 to 4 years of operation.
- Acid formation can be controlled by routine liming or caustic addition; however, a short-term, low pH does not necessarily result in failure. (The Kanapaha system continued working at a pH of 4.5.)
- Selection of appropriate underdrain and air distribution stone is critical. Florida "gravel" often contains limerock. When acid from the biofilter mixed with the stone at the Jacksonville facility, the stone essentially turned into con-

	Buckman WWTF Jacksonville	Lift Station No. 5 Ocala, FL	Kanapaha WWTP Gainesville, FL
Biofilter Location	Grit and Preaeration Tank	Lift Station Wet Well	Headworks
Number of Units	1	1	2
Biofilter Surface Areas, sf	2500	289	925
Media Dept, ft	3.5	5	3.5
Air Flow Rate, scfm	17,000	450	1400
Loading Rate, cfm/sf	6.8	1.6	1.5
Media Type	Sludge compost with wood chips	Sludge compost with wood chips	Sludge compost with wood chips
Drainage System	Roof drains under mine slag	Gravel over slotted PVC	Gravel over slotted PVC
Moisture Control System	Spray chamber on influent air	Spray chamber on influent air	Spray chamber on influent air
Air Distribution System	Mine slag	Perforated PVC pipe in gravel	Precast concrete undervent on sand and gravel
Materials of Construction	Concrete slab with block wall	Concrete slab with block wall	Asphalt, concrete under-vent with block wall
Chemical Addition	Caustic soda addition 4 times/year	None	Calcium carbonate sludge from water plant
Annual Operating Cost,$	35,950	2,500	11,500
Capital Cost, $	250,000	65,000	100,000
Year Built	1991	1993	1988
Influent H2S, mg/L	20	150-250	181
Effluent H2S. mg/L	0	0-10	0.17

Table 2. Biofilter Data Summary

crete and blocked the air flow through the pile. Since the distribution and drain system was replaced with mine slag (used for railroad bedding), there have been no problems with plugging.

- Humidification, which is critical, is best achieved by inlet air misting. Drying of the biofilter can be unexpectedly high because of the exothermic reactions that occur in the decomposing biofilter.
- Sprinkling the biofilter is not as effective as misting the influent air because sprinkling is not as controllable and because it compacts the upper zone of the biofilter, which reduces air flow.
- A prototype lift station biofilter used by Gainesville Regional Utilities (GRU) functioned well with weekly watering of the pile using a hose. However, because this was a passive biofilter, the only air that permeated the pile was air that had escaped from the lift station. Although the need for biomedia acclimation is documented in the literature, the use of wastewater biosolids seems to eliminate this requirement. These systems reported a negligible startup time.
- Although temperature is important for any biological system, some biofilters have operated successfully at outdoor temperatures as low as -30 degrees F (3).
- Construction materials are critical. Because biofiltration produces sulfuric acid, which makes the air and water corrosive, the use of corrosion resistant material is critical. Metal in or around the system should be stainless steel, piping should be non-metallic or stainless steel, and concrete should have an acid resistant coating. The system should be designed for truck loading in the media area to allow front-end loaders and scrapers to be used to build or remove the media.

Advantages of Biofilters

Biofilters have several advantages over conventional chemical scrubbers or activated carbon systems. First, for large systems, capital costs are significantly lower. The three systems described in this paper had capital costs ranging from $65,000 (Ocala) to $250,000 (Jacksonville). A packed tower caustic scrubber system for the headworks at a plant the size of the Jacksonville facility was estimated to cost almost $1 million, four times the capital cost of the Jacksonville facility. For smaller systems, such as the Ocala lift station, capital costs for carbon filters can be competitive with that for biofilters.

Second, the biofilters require minimal chemical addition. At the Kanapaha plant, annual odor control chemical costs were approximately $150,000 before converting to biofilters. Now, the estimated annual cost for the biofilters is only $11,500.

Finally, the use of biofilters with quarterly dry lime or caustic soda addition eliminates the need for handling, storing, and neutralizing large quantities of hazardous chemicals. For some municipalities, this factor alone makes biofilters worth a try.

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Biofilters For Control of Wastewater Lift Station Odors

Armand LeBeau and Darrell Milligan

Hillsborough County Public Utilities Department (HCPUD) has tried numerous physical and chemical processes to reduce the hydrogen sulfide odors at its wastewater facilities. Recently, a pilot project using an enclosed vessel biofilter was constructed for the control of hydrogen sulfide odors at a wastewater lift station. The results demonstrated that biofilters can consistently reduce hydrogen sulfide levels of up to 85 ppm down to less than 1 ppm.

With the success of the pilot project, a second biofilter was constructed using a lined-trench configuration. This biofilter also proved effective for controlling hydrogen sulfide levels up to 200 ppm. HCPUD designed and constructed both biofilters.

Traditionally, the approach to the control of hydrogen sulfide gas has been through chemical or physical methods. Biofilters using biological organisms to oxidize hydrogen sulfide have had only limited application. Biofilter efficiencies greater than 99 percent have been reliably recorded. Typical capital and operating costs for biofilters can be substantially less than for other odor control technologies.

Because of the low costs, and the demonstrated effectiveness of biofilters for the control of hydrogen sulfide odors, HCPUD will begin to assess other facilities for the application of this technology. With careful consideration given to site limitations, design, and operation, biofilters will play an increasingly larger role in HCPUD's odor control program.

Design And Operating Parameters

Media successfully used for the control of hydrogen sulfide include sewage-sludge derived compost, composted yard waste, soil, peat, wood bark, and wood chips. A suitable media should be easily re-wetted when dry, drain readily, and have minimum static pressure to minimize fan capital and operating costs.

Moisture is required for the survival of the microorganisms, it aids in the sorption of the gaseous hydrogen sulfide onto the media particles, and contributes to the media's buffer capacity. Without providing additional moisture, the influent air stream would quickly dry out the media bed. Typically, soak-hoses, periodic top-down wetting, or influent gas humidification are used.

An adequate gas retention time (GRT) to ensure sufficient adsorption is essential to the efficiency of the biofilter. The proper GRT is controlled by selecting an appropriate bed depth which generally ranges from 24 to 60 inches (Frachetti, 1992) to provide a GRT between 30 and 120 seconds.

Higher surface loading rates increase static pressures and the media bed may also become more susceptible to drying out. A very low SLR requires a large plan area and may be difficult to site. Frachetti (1992) reports that SLR's between 1.0 to 7.8 cfm/sf while Leson (1991) indicates that SLR's up to 26.7 cfm/sf have been used with high efficiency and low static pressure.

The pollutant loading rate (PLR) is the amount of hydrogen sulfide introduced per unit weight of media organic matter per unit time (Allen 1992). The maximum loading capacity (MLC) is the maximum PLR that the media can bear without inhibiting its microbial activity. Allen (1992) determined that the MLC is specific for each type of media mixture. For the type of compost Allen (1992) used, the MLC hydrogen sulfide was determined to be 2.2 milligrams per kilogram per minute (mg/kg-min). No other values for PLR or MLC were published.

Media pH: as a result of the microbial oxidation of hydrogen sulfide, sulfuric acid is produced which results in an increasingly acidic media over time. Conflicting reports on the effect of bed acidification on biofilter efficiencies have been reported (Bohn 1976, Pomeroy 1982, Furusawa 1984). However, more recent reports (Allen 1992) notes that the drop in the media's pH may actually enhance the removal of hydrogen sulfide by activating such organisms as Thiobacillus sp.

The most popular method to uniformly distribute air throughout the media bed is utilization of manifolded, corrosion resistant pipes placed in a bed with stones ranging in diameter from one-half to two and one-half inches thick. The piping should be sized according to standard ventilation criteria. The pipe bed depths range from several inches to 24 inches (Frachetti, 1992).

Collection and proper disposal of the acidic leachate must be provided. Sloping the lined media bed to a gravity drain or to a sump with pump are the two most common methods.

Apollo Beach Pump Station

The Apollo Beach biofilter was constructed as a pilot project to evaluate the effectiveness of biofilter technology. The system consists of six-inch PVC ducting, valves, a humidifier, a fan, and a surplus hydro-pneumatic tank used to contain the media. The fan pulled air from the wetwell, through the humidifier, and into the tank.

The 6-foot diameter, 20-foot long steel tank was divided into two equal sections to allow for testing of different media. The tank was mounted above ground to allow for gravity feed of the leachate to the wet well. Media was installed through an 18-inch wide opening along the top of the tank. The openings were fitted with 3/4-inch plywood covers, which allowed for better control of the media moisture content and allowed a composite air sample over the entire surface of the media to be collected for testing.

The humidifier was a converted single stage, packed tower scrubber chamber with the chemical feed system removed. The discharge side of the recirculation pump was valved to control the amount of water that flowed through the distributor nozzle to allow for optimum humidification.

Surplus 36-inch wide steel grating was placed along the tank bottom and provided a 6-inch air space. This allowed for even air distribution and also support for the media.

The FRP fan was rated to deliver 400 cfm at 9-inches WC. The belt driven fan was powered by a 3-phase, 230-volt, 1.66-BHP motor.

The size of media bed was governed by the most conservative design requirements for GRT. SLR, and PLR. The selected tank size allowed for enough media to provide approximately 60 seconds of GRT, a SLR of approximately 6.7 cfm/sf, and a PLR of 0.047 mg/kg-min.

The criteria used to select the type of biofilter media to be used were (1) low pressure loss, (2) locally available, (3) inexpensive, and (4) long life cycle. Two different media were tested. The first was a mixture of 20 percent top soil, 20 percent peat. and 60 percent cypress mulch. The second was a mixture of 20 percent top soil, 20 percent peat, and 60 percent wood mulch. The average organic contents for the mixtures were 88.6 percent and 84.9 percent, respectively.

Construction costs for the biofilter, including material and labor, were less than $6500. The low capital costs for the system are a result of utilizing surplus materials whenever possible. However, because this was a pilot project with a limited life cycle, some of the materials used would not have been selected for a permanent installation.

Apollo Beach Biofilter Results

During the acclimation period, which lasted for the first two weeks, the biofilter did not completely remove the incoming hydrogen sulfide levels, which ranged from 5 to 85 ppm. After acclimation, the biofilter efficiency improved until the hydrogen sulfide was reduced to below detectable levels. After 11 months in operation, infrequent hydrogen sulfide breakthroughs began to occur. It was noted that the original bed depth was reduced by approximately 1 foot. Smoke testing revealed that short-circuiting of untreated gas along the tank walls was occurring. The media was redistributed and the bed depth was brought back up to the original design level. Subsequent testing has shown that when breakthroughs occur, short-circuiting has been the cause. It has also shown that although the media bed was sized to provide 60 seconds of detention time, the actual detention time is as low as 30 seconds with no corresponding loss in hydrogen sulfide removal efficiency.

Over several months the leachate pH declined from 6.8 to as low as 0.9 with an average value of approximately 2.6. During the period when the pH of the leachate decreased to the minimum of 0.9, the efficiency of hydrogen sulfide removal remained at 100 percent regardless of the influent level. Therefore the performance of the biofilter was not adversely impacted by the decline in the media pH as indicated by the leachate pH.

The humidification system proved to be effective. The recirculation rate of the sump pump in the humidifier was set so that the biofilter media was saturated at the air-media interface, resulting in excess water or leachate collecting at the bottom of the tank. This required periodic checks on leachate generation and adjustment of the recirculation rate of the sump pump as necessary.

Several methods for maintaining a proper water level in the sump were tried. Manually filling worked well in the cool winter, but in the hot summer the sump periodically ran dry and caused sump pump failures. A water make-up line actuated by a float arm was installed. After a month of operating under these conditions, it was noticed that the pH of the sump water began to decline to below 2. This also caused sump pump failures. In order to keep the sump flushed, a restrictive orifice rated at 1 gpm was installed on the water make-up line. This provided adequate water for humidification and flushing of the sump thereby eliminating the pH depression.

The humidification system was out of service for a period of three days with no adverse impact on the performance of the biofilter. Thus it can be concluded that the biofilter system is tolerant of humidification system malfunctions of a short duration.

Westlake Pump Station

With the success of the Apollo Beach biofilter, a second biofilter was constructed at the Westlake Pump Station utilizing a lined-trench configuration. The system consists of 6-inch PVC ducting, valves, a humidifier and fan identical to the Apollo Beach biofilter, and a lined trench to contain the media. The fan pulled air from the wetwell, through the humidifier, and discharged into the media bed.

A 6-foot wide by 32-foot long trench was dug approximately 5-feet deep. A shell measuring 6-feet wide by 32-feet long by 6-feet deep was fabricated from a 80-mil flexible membrane liner. The liner was placed into the trench and supported with a PVC frame. The liner was seamed along the edges and corners to provide leak-free containment. The excavated soil was mounded up against the outside of the liner. The floor of the trench was sloped for better drainage. A flange was welded to the liner floor and a 3-inch PVC pipe, which was connected to a gravity wastewater line feeding the pump station, was used to drain leachate as well as rainwater from the media bed.

Approximately six inches of stone was placed at the bottom of the lined trench. Three pieces of 4-inch septic tank drainfield pipe, each measuring 28-feet in length, were placed on top of the stone. The pipes were connected at both ends as well as manifolded in the middle where the air flow was delivered. Enough stone was placed on top of the pipe to provide a 6-inch cover. A 6-inch layer of coarse pine bark was placed on top of the stone to minimize downward migration of the media.

Four feet of media, identical to the cypress mixture used in the Apollo Beach biofilter, was placed on top of the pine bark. This provided a GRT of 2.9 minutes and a SLR of 2.1 cfm/sf. Based on values for the GRT and SLR at the Apollo Beach biofilter, it was determined that the PLR would not be exceeded.

Construction costs for the biofilter, including material and labor, were less than $9000. All materials were purchased new. HCPUD designed and constructed all phases of the biofilter, with the exception of fabrication of the liner, which was contracted due to specialized equipment requirements.

Westlake Biofilter Results

After the initial two week acclimation period, the biofilter consistently reduced incoming hydrogen sulfide levels from as high as 200 ppm down to below detectable levels. Periodic short-circuiting of the untreated gas along the interface of the liner and the media occurred. Smoke testing quickly revealed these areas and media redistribution eliminated the short-circuiting. To minimize short circuiting, an additional 6- to 12-inches of media was placed on top of the existing bed so that all liner walls were also covered. This has reduced but not eliminated the intermittent short-circuiting.

Based on results from the Apollo Beach biofilter, the humidification sump water level was maintained with a rotameter to control the flow through the water make-up line. Overflow was directed through a line back to the wetwell. This method has provided adequate humidification and no operational problems have occurred.

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Wastewater Nitrate Removal by Power Conservation

Leonardo D'Angelo

Is it possible for nitrate removal and power consumption reduction to be accomplished together? Yes, unless the plant is maxed out in flows, organic loading, and aeration output. Nitrate removal and power conservation are accomplished together by intervallic on/off aeration cycles. The following will help illustrate the guidelines for the on/off aeration operations cycles.

The first factor to consider is aeration capacity (the capacity of all aeration tanks in MGD) versus influent feed rate, which is usually measured in gallons per minute. If the plant has a surge tank, once the off/on cycle is determined the cycles will remain constant for the most part, only varying with seasonal flow changes. Without surge basins, the off/on intervals will fluctuate with the influent flow. If no flow chart is available, perform pumping rate studies over 24-hour periods at the main lift station to determine low, average, and peak flows.

Following are some examples for calculating oxygen on/off cycles. The hypothetical plant has the following characteristics:

Aeration Total Capacity = 1.0 mgd

Average influent feed rate = 300 gpm = 0.432 MGD (or 43 percent of the total capacity)

Design influent CBOD = 200 mg/l

Actual influent average CBOD = 185 mg/l

Design influent TKN = 30 mg/l

Actual influent average TKN = 20 mg/l

Sludge retention time (SRT) = 25 days

Water temperature = 20°C summer, 10°C winter

If the plant has surge tanks, dye the influent and shut off aeration to estimate how long it will take the influent to reach the clarifier without being mixed in the aeration basin. This is called the "raw short circuiting point" (RSCP). Assuming the RSCP to be 2.3 hours, the maximum off time for adsorption and absorption to occur effectively is 43 percent of the RSCP, or 0.43 X 2.3 = 1 hour.

If the treatment plant does not have surge tanks, the influent flow varies through the day, and so will the off/on percent rate/time, perhaps like this:

6:00 - 11:30 a.m.: feed rate = 800 gpm,

11:30 a.m. - 4:00 p.m.: feed rate = 350 gpm

4:00 - 9:00 p.m.: feed rate = 700 gpm

9:00 p.m. - 6:00 a.m.: feed rate = 150 gpm

Once this system is set, it will remain the same throughout the year with some adjustments at the tourist season.

The next factor requires current CBOD, and TKN influent average against plant maximum design rates.

The plant's influent CBOD and TKN average 185 and 20 mg/l, respectively. In terms of pounds per day, CBOD and TKN are:

CBOD: 0.432 MGD X 185 mg/l X 8.34 = 667 lb/day

TKN: 0.432 MGD X 20 mg/l X 8.34 = 72 lb/day

Based on total aeration capacity, the maximum design loading rates are:

CBOD = 1 MGD X 200 mg/l X 8.34 = 1668 lb/day

TKN = 1 MGD X 30 mg/l X 8.34 = 250 lb/day

The amounts of underloading of the plant are:

CBOD: 1668 - 667 = 1001 lb/day (60% underloaded)

TKN: 250-72 = 178 lb/day.(71% underloaded)

The most common outcome of underloading is high dissolved oxygen levels causing high nitrate nitrification("pop ups"—clumps of rising sludge), floc shearing, TSS carry over, and effluent deterioration. Dissolved oxygen reduction can be accomplished in many different ways. If air is delivered by blowers, it can be blown off to digesters and surge tanks (if applicable), or air relief mufflers. With turbine blowers, air discharge valve can be choked to a lower amperage. On positive displacement blowers, an increased pulley size on the motor will lower rpm, cfm, and amperage (lowering amperage lowers kilowatt hours and motor wear).

With mechanical aerators, the most common practice for decreasing dissolved oxygen is lowering the aerator effluent weir or V-notch, thus dropping the water level in the aeration tank, which in turn lowers mass mixing, motor resistance, kwh, and equipment wear. Higher budgeted plants have variable speed motors which have obvious advantages.

The last factor to consider, and the only one controlled by the plant operator in nitrate removal, is aeration output, which is determined by motor rpm, blower discharge, psi, and discharge pipe size. On mechanical units aeration output is established by mixer immersion and design rpm per immersion level.

Check the immersion level against the manufacturer's specifications. After finding the present settings, increase the aeration to maximum output (if applicable) to reach high dissolved oxygen levels rapidly. Perform dissolved oxygen studies using a D.O. meter and a watch. Set the D.O. meter at the sample point where the normal highest D.O. level is achieved on the aerator. Shut aeration off and start timing the D.O. level. When it drops to below 0.5 mg/l, stop the timer. Restart aeration and the timer, take D.O. readings every 5 minutes or so until the D.O. level stabilizes (above 2.0 mg/l).

For example:

Time	*D.O Level*	*Time*	*D.O Level*
9:00	Aeration off	9:40	1.1 mg/l
9:23	0.3 mg/l	9:50	1.3 mg/l
9:23	Aeration on	10:05	1.7 mg/l
9:30	0.6 mg/l	10:15	2.3 mg/l
9:35	0.9 mg/l	10:30	2.4 mg/l

By 10:15 the dissolved oxygen has reached the target rate of greater than 2 mg/l. An on/off cycle for the plant in this example could be set as aeration on for two hours and off for 15 minutes. This setting will remain for a 24-hour period if the plant is equipped with a surge tank. Otherwise, the on/off cycle will fluctuate with flows. It is wise to start with a good buffer zone and then fine tune the off/on cycle as needed. Also, this process needs to be monitored closely, with D.O. profiles at least twice per shift, a close eye on alkalinity, and, settling tests.

OxR (oxygen required for CBOD reduction in lb/day) and OxN (oxygen required for ammonia conversion in lb/day) are helpful when problems are persistent.

Pounds of oxygen per pound of CBOD = SRT/temperature = 25 days/20°C = 1.25.

OxR = 1.25 X (200 mg/l X 1.0 MGD X 8.34) X 185 mg/l X 0.432 MGD X 8.34) = 834 lb/day oxygen required for CBOD reduction.

Approximately 5 percent of influent nitrogen will be used for cell synthesis. When oxygen required for nitrification is determined, cell synthesis (Ns) must be taken into account.

Ns = (20 X 0.432 X 8.34) X (0.05) = 3.6 lb/day.

Oxygen required for ammonia conversion is 4.6 pounds per pound of ammonia.

OxN = ((TKN lb/day) - Ns) X 4.6

= ((20 X 0.432 X 8.34) - 3.6) X 4.6 = 315 lb/day

The actual oxygen requirement (AOR) for BOD reduction and ammonia to nitrate conversion is then OxR + OxN = 834 + 315 = 1149 lb/day. However, we still need to solve for the standard oxygen requirement (SOR).

SOR = AOR X 9.17/Alpha (Beta X 9.17 - 0.0003 X H) - 2.0 mg/l/hr.

Where Alpha = 0.85, Beta = 0.97, H (elevation) = zero in Florida, and 2.0 mg/l/hr = motor capacity.

Therefore, SOR = 1149 X 9.17/0.85 (0.97 X 9.17 - 0.0003 X 0) - 2.0 = 1895 lb/day.

Thus, the amount of oxygen the aeration system needs to deliver to the aeration basin is 1895 pounds per day. If the plant has surge tanks, the hourly aeration rate (on/off cycle) is 1895/24 = 79 lb/hour.

If the plant's maximum designs are CBOD = 200 mg/l and TKN = 30 mg/l at maximum daily flow = 1.0 MGD, then OxN = 1093, OxB = 2085, AOR = 3178, and SOR = 5241 lb/day or 218 lb/hr or 3.6 lb/min.

Subtracting the applied SOR from the maximum SOR:

5241 - 1895 = 3346 lb/day = 2.32 lb/minute excess air delivered to the aeration tank.

Every minute 218/60 = 3.6 pounds of oxygen are produced. Therefore, in 22 minutes under maximum aeration output, all the CBOD has been removed and the ammonia fully converted for that hour. In the remaining 38 minutes, if the aeration is off, the mass will use nitrates instead of oxygen for energy conversion, thus removing nitrates by power conservation.

Leonardo D'Angelo is an "A" wastewater and "C" water plant operator for Indian River County.

Lift Station Odors from Page 36

Summary

The results show that a properly designed biofilter system is an effective, low maintenance, inexpensive, and reliable method for the control of hydrogen sulfide odors. The biofilter removed hydrogen sulfide odors to below measurable levels, except for periods when the media required replenishment or when short-circuiting occurred. Future installations should be designed without walls to minimize such short-circuiting.

A biofilter offers several advantages over conventional chemical scrubbers. One is that it does not require chemical addition. These chemicals can be hazardous to handle and also have a limited shelf life which requires constant coordination to ensure an adequate, fresh supply.

Another advantage is that the biofilter's maintenance is limited to ensuring that adequate water is available in the humidifier sump, routine fan and sump pump maintenance, and media redistribution and replenishment. This requires considerably less time than that needed for daily maintenance on chemical scrubbers, which utilize maintenance intensive chemical pumping and control systems with pH or ORP sensing units. The replenishment of the Apollo Beach biofilter media after eleven months required about six manhours and cost less than three hundred dollars.

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