A combination of coarse- and fine-bubble aeration helps wastewater lagoons meet regulations.

Lagoon Logic

Maintaining regulation-compliant wastewater lagoons

By Braden J. O'Leary

One-third of all wastewater treatment facilities in the U.S.—more than 6,000 systems—utilize a lagoon in some capacity during their treatment processes. They affect all 50 states, practically every American watershed and millions of people nationwide. Despite this overwhelming prevalence, wastewater lagoons garner little attention. While these lagoons are not as technologically advanced as activated sludge plants, they still play an extremely important role in treating sewage for thousands of small municipalities. This neglect leaves hundreds of wastewater lagoons in disrepair every year, eventually leading them to fall out of compliance with state regulations.

ARTICLE SUMMARY

Challenge: Five of Parsons WWTP's eight surface aerators were broken, and the situation was becoming so dire that the plant experienced several DEP violations for its BOD effluent levels.

Solution: The city turned to a new portable aeration technology that saves energy and uses a combination of coarse- and fine-bubble aeration.

Conclusion: After installing several MARS aerators, the system is continually in compliance, and energy and maintenance costs have decreased.

Descending Into Disrepair

During a time when governments are constantly pressured to reduce spending, small municipalities often are forced to operate their wastewater lagoons on tight budgets with modestly sized staffs. These two factors mean that there is little room for error, as neither the money nor the manpower is available to properly fund and execute large maintenance projects.

In 2009, a small wastewater lagoon in Parsons, W.V., fought the same battle that befalls municipalities nationwide. Five of its eight surface aerators were broken, which was not uncommon. Parsons City Administrator Jason Myer described it as "an antiquated system—an old maintenance nightmare." Each year Parsons was forced to spend approximately $6,000 and many hours maintaining these systems.

"It got to the point where we were getting several violations from the DEP [Department of Environmental Protection] because we didn't have the money to keep repairing these [surface aerators]," Myers said.

As a result, high biochemical oxygen demand (BOD) effluent levels were recorded monthly at Parsons, leading to more than 40 violations on its permit. If steps were not taken to reduce these BOD levels, Parsons Wastewater Treatment Plant (WWTP) would face sanctions from the West Virginia DEP.

Alternative Aeration

Given that aeration accounts for 60% to 80% of energy costs at most wastewater lagoons, it is often the first target for trimming costs. MARS is a new portable aeration technology that looks to accomplish this with a combination of coarse- and fine-bubble aeration. The MARS system has been tested at an independent lab and proven to be as efficient as fine-bubble systems with a standard aeration efficiency (SAE) of 4 to 7 lb oxygen/hp-hr, while also retaining the effective mixing performance of a coarse-bubble system.

Although many municipalities, like Parsons, have a lagoon that requires little maintenance, they often invest in aeration technologies in an effort to save money in the short term, even if the operation and maintenance costs may lead to a higher life-cycle cost. Surface aerators are the most common aeration technology in wastewater lagoons. This makes sense in that they are portable and can be installed quickly and easily without draining the lagoon. They have limited zones of influence, however, allowing for dead zones in which oxygenation and mixing do not occur and water is left only partially treated. Moreover, surface aerators generate extremely low aeration efficiencies, with an SAE of just 1.5 to 2.25 lb oxygen/hp-hr. For Parsons, this meant a cost of $24,000 per year on energy alone.

Aeration Comparison No. 1

In April 2009, Parsons WWTP installed four emergency MARS aerators in its lagoon. Due to the technology's portable design, the installation occurred from the surface, without incurring any system downtime. By May, Parsons WWTP was back in compliance with state regulations. One year later, 14 more MARS aerators were installed to complete the system. Parsons WWTP has not been out of compliance since then, always achieving BOD effluent levels of less than 30 mg/L. Energy costs have declined by $15,000 (now $7,000 to $9,000 per year), and maintenance has decreased by more than $5,000 (now $500 per year).

"Based on savings for energy and maintenance cost, it's going to save the city hundreds of thousands of dollars over the life expectancy of this system," Myers said.

"The system will pay for itself within four years," added Parsons WWTP Operator Frank White.

Much like at Parsons, rehabilitation of ailing

surface aeration systems with MARS aerators is applicable on much larger scales. For instance, the West Jackson County WWTP in Mississippi is one of the largest lagoon systems in the county at 7 million gal per day. Hurricane Katrina destroyed eight of the facility's 50-hp surface aerators, and similar to Parsons, the WWTP desired a lower-maintenance solution that would not be prone to weather damage in the future. Additionally, West Jackson County desired a system that would prove to be more aeration efficient and offer a more effective, evenly distributed mixing solution than surface aerators. Due to their diffused design, which incorporates both coarse- and fine-bubble aeration, 288 aerators were purchased and the system now is operating successfully.

Nearly 300 aerators keep the West Jackson County WWTP, one of the largest lagoon systems in the county, running efficiently.

A combination of coarse- and fine-bubble aeration at the Wasco, Ill., lagoon keeps odor low and DO levels high.

Aeration Comparison No. 2

Another popular aeration technology for wastewater lagoons is fine-bubble diffusers. These systems offer significantly higher aeration efficiencies (SAEs of 4 to 7 lb oxygen/hp-hr) than surface aerators, which translates to lower operating costs. Additionally, the maintenance requirements in fine-bubble systems can be less, as there are relatively few onshore motors to maintain. For these reasons, the Wasco Sanitary District (WSD) in Wasco, Ill., replaced its coarse-bubble aeration system with one that utilized only fine bubbles. This decision was made in an effort to improve the system and save money, as there were budget concerns for this municipality, much like at Parsons.

"The board was concerned about finding a system with the lowest upfront cost, even if it meant sacrificing some water treatment ability in the system," said WSD Operator Matt Wilson.

Unfortunately, the new system did not take mixing into account. Fine-bubble aeration is capable of moving the water around the lagoon, but it is unable to add the turbulent mixing that keeps solids in suspension. Without this mixing aspect, lagoon systems are more prone to sediment buildup and diffuser fouling.

Over five years, 4 ft of undigested solids accumulated on the bottom of the lagoon at WSD. This unmixed sludge eventually enveloped the diffusers and accelerated fouling. As a result, backpressure on the system increased to 3 psi above design, energy costs soared and eventually the blowers failed entirely. That winter, when DO should have been at its highest, it dropped to a dangerously low level of less than 1 mg/L, staunch odor emanated into neighboring homes and the system bordered on becoming septic.

"It was clear that new steps needed to be taken to solve the extreme problems we were having at Wasco," Wilson said.

In January 2010, just as in the case of Parsons WWTP, emergency MARS aerators were installed quickly. By maintaining the oxygen transfer efficiencies of the fine bubble, WSD was able to raise its DO level above 4 mg/L. In addition, the solids were properly mixed by the MARS system's coarse bubble, which is capable of mixing up to 7,000 gal per minute. In June 2010, a full MARS 3000 system was authorized. DO has been at normal levels since, and backpressure has decreased significantly. WWD

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