old dog new tricks

By Braden O'Leary

Activated sludge-lagoon hybrid saves millions for rural town

Coopersville is a small community in western Michigan that is home to approximately 5,000 residents. As a rural town, it invested in a lagoon-based wastewater treatment system 25 years ago that was sized to handle the biological oxygen demand (BOD) influent of its residents (250 mg/L). These lagoons had low overhead requirements, easy maintenance, and relatively simple and flexible operation. It was an ideal solution for a town that had become well versed in budget constraints.

In 2011, a dairy company made plans for a new facility in Coopersville. It intended to send its waste through the Coopersville municipal system. This meant the community could expect spikes in BOD from the original 250 mg/L to anywhere from 600 to 2,000 mg/L, with unpredictable "slugs" of up to 4,000 mg/L. While the new dairy facility would benefit the Coopersville economy, the town faced a mandatory wastewater system upgrade and expansion.

Mechanical Plant vs. Lagoon System

This circumstance presented Coopersville with a difficult question: On a small-town budget, how do you expand a wastewater system to treat 20 times the BOD?

Cue Chief Operator Steve Luke, some creative thinking, a dedicated team of engineers and one innovative solution.

Conventional thinking in the wastewater industry says that treatment of high BOD levels requires a mechanical system, and that not only are lagoons outdated, they also are unable to handle highly concentrated BOD loads in a small footprint.

With this project, Luke has proven that this is not always the case.

"We're a smaller city. We don't have money to waste," Luke said. "We had to be very cautious. This city just came off of hard financial times—we had to make good financial decisions."

A conventional mechanical plant would have meant building a completely new facility. The town would have had to install concrete aeration tanks large enough to receive slugs of up to 4,000 mg/L, which would have been costly. It also would have meant hiring additional operators, extensive training, additional overhead, and a huge increase in operation and maintenance costs for the system. All told, this would have cost $15 to $18 million. Given the high price tag, Luke looked for a hybrid solution that would yield the benefits of a mechanical system without the costs.

"We wanted to be as cost-effective as possible while upgrading, and to do that we utilized resources we already had," he said.

What Luke already had were lagoons and a small staff that understood how to operate them. He viewed these lagoons as resources to be leveraged—why build concrete aeration tanks when your lagoons can perform the same task? Moreover, one of the benefits of lagoons comes from what is perceived to be their biggest weakness: Because they hold such a large amount of water, they can absorb spikes in flow and BOD without immediately affecting the effluent quality. As a result, operation is less complex and fewer people and less time are needed to make them work.

Creating the Hybrid

When setting out to create the hybrid system, Luke had a clear set of criteria in mind. Due to high BOD and unpredictable slugs, he knew he would need a technology with an efficient fine-bubble element to keep dissolved oxygen (DO) levels high. Second, in order to keep the large volumes (especially in a lagoon) of solids mixed, he knew that the technology must have a robust complete mix component. Luke and OMM Eng. realized covering the entire lagoon floor with fixed diffusers would be impractical, so another solution was desired.

The technology that made this hybrid lagoon system possible was a Mars aeration system, designed specifically for use in wastewater lagoons, from Triplepoint Water Technologies. In this system, an aerator incorporates coarse bubble mixing within a fine bubble design. Discussions with Triplepoint and OMM Eng. confirmed that this would achieve turbulent mixing throughout the lagoons, with each unit moving 7,000 gal per minute, while utilizing half the diffuser units of an alternative fine-bubble system. This would provide a complete mix environment that would keep the return activated sludge (RAS) in suspension. Furthermore, oxygen would be supplied efficiently via the Mars' EPDM fine-bubble tube diffusers, thereby maintaining the necessary DO. Finally, the system is retrievable from the surface, allowing the diffusers to be maintained without interrupting operation.

Luke and OMM ultimately chose to install the Mars aeration system into the lagoons, expanding treatment capability by incorporating clarifiers and an RAS component. They settled on two 5.7-million-gal cells with 240 Mars aerators placed in each. Two Amwell clarifiers and three 300-hp Siemens centrifugal turbo blowers rounded out the system. The total project cost was under budget, saving Coopersville $9 million compared with a conventional system.

"People need to know they can update their lagoons to a state-of-the-art treatment system with quite a bit of flexibility at a lower cost," Luke said.

Hybrid System Exceeds Expectations

"We started taking raw dairy waste since day one, and the system handled every bit without a violation," Luke said. "That's phenomenal for a new activated sludge plant, and we still have not had a violation since startup."

ARTICLE SUMMARY

Challenge: A new dairy facility in Coopersville, Mich., intended to send its waste through the Coopersville municipal system. This meant the community could expect spikes in biological oxygen demand.

Solution: In an effort to control costs, the town decided on a hybrid mechanical plant/lagoon system that would yield the benefits of a mechanical system without the costs.

Conclusion: The high-mixing, aerating, activated sludge-lagoon hybrid saved $14 million while increasing capacity.

In response to the facility's continuous flow of about 1.65 million gal per day, averaging 1,50 mg/L BOD, Luke operates the system at 8,700 cu ft per minute (cfm), holding a DO of 6 mg/L and maintaining mixed liquor. Mixed liquors are kept at 4,500 mg/L; given the size of these lagoons, that means there are 214,000 lb of waste solids in each pond at any given moment. The resulting effluent BOD is a consistent 2 mg/L straight out of the clarifiers.

During slug events, the system can be ramped up to 12,000 cfm. "You can dump two tankers full of straight dairy into this lagoon and you won't even see the DO drop," Luke said. "That would be disastrous for most plants."

The dairy facility was expected to send 600,000 gal per day (gpd) of wastewater, but instead it is actually sending between 700,000 and 900,000 gal. This is resulting in influent BODs that are higher than expected by about 20%. The hybrid lagoon, however, is flexible enough to handle it.

"It eats up everything it takes in," Luke said. "It handles the unpredictable slugs well, even with only one cell in operation."

Luke found that running just one lagoon cell has been so proficient that it will treat what it was designed for and more. Recently, the dairy facility considered an expansion that would result in another 200,000 gpd of flow. Due to this system's performance, another expansion will not be necessary; all Luke will need to do is activate the second lagoon cell.

Not only does this mean that the original design saved money by avoiding a completely new mechanical plant, but avoiding a second expansion will save an additional $5 million.

The system has been in operation at the Coopersville wastewater facility since 2011. Luke's solution successfully resulted in a low-cost lagoon system that treats high, unpredictable levels of BOD. Luke suggested that, due to the system's low cost, high flexibility and simple operation, it does the job better than a mechanical plant.

"This plant runs on a staff of only three," Luke said. "If you've got a reliable treatment plant that runs excellently, that gives you a lot of extra time to do other jobs around the city. People need to know that. This design isn't a time-stealer."

As a solution for a rural town that already had a number of resources in its lagoons, this high-mixing, aerating, activated sludge-lagoon hybrid saved $14 million while increasing capacity.

"Some people think that we had to build a purely mechanical plant," Luke said. "They're wrong. We've always had great luck with lagoons; we just put this lagoon on steroids. That's taking something old and turning it into something new with a lot of future possibilities for the city." WWD

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