Investments Never Wasted in Water

Carrie Ellis, Editor

John Kenneth Benner, Severn Trent Services area manager for the Elkton water and wastewater facility, stands overlooking the integral Siemens Orbal® oxidation basin.

Wastewater treatment may not be the prettiest job—or sweetest smelling, for that matter—but somebody has to do it. One organization considered to be an industry leader is Severn Trent Services of Fort Washington, PA, a supplier of water and wastewater services, and the operator of the recently erected $30 million Elkton water and wastewater treatment facility, located near the Chesapeake Bay in MD. The town serves a population of about 16,400 people.

Receiving its formal dedication on April 30, 2010, the plant was constructed as part of a larger effort to restore the Chesapeake Bay. In 2004, Maryland passed an initiative to reduce nutrient loading into the bay by upgrading certain water and wastewater treatment facilities that discharge into it with better equipment, systems and processes. Governor Robert L. Ehrlich, Jr.’s Chesapeake Bay Restoration Act appropriated grant money for technological upgrades, which accounted for about 50 percent of the construction costs.

Eliminating a Big Environmental Stink

Severn Trent personnel operate and maintain a 2 million gallon per day surface water treatment plant and a 3.2 million gallon per day wastewater treatment plant together, with Big Elk Creek acting as their water source. Moreover, the Elkton wastewater treatment plant is considered advanced, meaning it uses biological nutrient and enhanced nitrogen removal to achieve environmental goals and regulatory compliance. These methods replace existing rotating biological contactor equipment—technology that was first used in Germany in 1960.

Since its upgrade, the facility has reduced the level of nitrogen and phosphorous effluent to the Big Elk River, and ultimately, the Chesapeake Bay, by approximately 80 and 70 percent, respectively. According to John Kenneth Benner, Severn Trent Services area manager for the Elkton water and wastewater facility, there is still a lot of work to do, “The bay isn’t doing well—there are large dead areas with no oxygen at all—and nothing can survive without it.”

But Benner remains optimistic: “I think the fact that the town was able to upgrade its wastewater treatment plant to such an exceptional level of discharge is phenomenal—it went from being in violation of its discharge permit to putting out wastewater above and beyond compliance,” with:

- Total biochemical oxygen demand (BOD) levels of 3 PPM.
- Total nitrogen content of less than 2 milligrams per liter.
- Suspended solid levels of 3 milligrams per liter.
- Phosphorous content measuring down to 0.05 milligrams per liter.

The Ashbrook Simon-Hartley belt press can dewater sludge to approximately 18 percent solids.

Because so many facilities in the state eventually discharge wastewater to the bay, the Chesapeake Bay Restoration Act is critical to protect both the water supply and the environment. Benner says the ultimate goal is to reduce phosphorous and nitrogen levels in order to prevent algal blooms and potential water contamination issues. The buildup of too many nutrients or organic matter—like phosphorous and nitrogen—in the water can instigate algae to grow to the point that they can't be sustained. In this vicious cycle, the algae die and decompose, exacerbating oxygen depletion enough to stifle surrounding life.

But the environment wasn't the only thing suffering, says Benner, "The existing facility also had a reputation for having the worst odor imaginable. It would make the hair stand up on the back of your neck. [That's why] one of the goals of the new plant was to eliminate any stench. We've been living with it too long."

In order to prevent, as well as negate, any odors, the Elkton wastewater treatment facility installed two biofilters and one chemical scrubber. Exhaust now runs from the main pumping station through a biofilter, while another biofilter defuses any odor lurking around the head works, where raw wastewater flows. Additionally, the company decided to implement a chemical scrubber down in the thermal fluid dryer where sludge is processed. Benner concludes, "You better believe that the people who live around here are much happier now."

Nitrogen Levels Make a Difference

According to Benner, "Whereas conventional wastewater plants only remove BOD and suspended solids, and maybe phosphorous, this plant removes nitrogen, in addition to all those other pollutants." The facility's discharge permit limits nitrogen to just 4 milligrams per liter, so the facility continually exceeds expectations as a result of combining both biological nutrient removal and enhanced nitrogen removal technology.

Biological nutrient removal is the first step in removing total nitrogen from wastewater; Benner says plants have been doing it forever, and it can single-handedly achieve nitrogen levels of 8 milligrams per liter or below. It begins in the activated sludge process in which nitrification—or the practice of using nitrogen-reducing bacteria to convert ammonia to nitrite, then nitrite to nitrate, by oxidation—occurs. Incoming wastewater then acts as a carbon source to drive the next step in biological nutrient removal, the denitrification process, which essentially reduces the nitrate to nitrogen gas, which can escape into the atmosphere, effectively extracting it from the wastewater.

This Orbal® oxidation basin incorporates three concentric channels: the outer channel, which is an aerated anoxic reactor, the second channel, which is where dissolved oxygen operates in swing mode to vary with daily load conditions, and the third channel, which maintains a polishing mode to remove remaining BOD and ammonia.

The Elkton wastewater treatment plant accomplishes denitrification through its activated sludge reactor. It's a Siemens Orbal® multi-channel oxidation ditch that is specially designed to not only convert ammonia to nitrate, but also reduce the nitrate down to 4 milligrams per liter. The Orbal® oxidation basin incorporates three concentric channels. The outer channel, where the majority of the process takes place, is an aerated anoxic reactor. In the second channel, dissolved oxygen operates in swing mode to vary with daily load conditions. Last but not least is the third channel that maintains a polishing mode to remove remaining BOD and ammonia before the flow exits to the final clarifiers.

When the wastewater leaves the Orbal® oxidation ditch, it flows into a post-anoxic tank, which is where enhanced nitrogen removal finally takes place. The utility doesn't add oxygen to the activated sludge, however, to complete nitrogen removal. Because all of the BOD has been consumed in the reactor, methanol is fed into the process as an external carbon source.

Automation = Almost Autonomous Operations

"When this plant went online, I said 'I can't leave this plant just in case something were to happen,' so we operate 24/7. I've got someone here all the time, each working 12-hour shifts so that we can operate with the minimum amount of staff,

yet still have total coverage. Our operators work about 15 days a month ... They love it. At first, they were a little leery, so initially, when we were only doing 20 hours a day, we tried 10-hour shifts, and they liked that, too."

Regardless, in order for staff to be successful and performance to be repeatable, automation is fundamental. "Operations are very stable at this facility—and from an operating point of view, it's very simple because [the process] basically operates itself." Benner notes, "In the Orbal® oxidation ditch, a dissolved oxygen meter and an oxidation reduction potential meter control the speed of the rotors, which dictates the amount of oxygen that enters the waste stream. The equipment is constantly and automatically adjusting. I rarely have to mess with any of it.

"The only thing that we have to do is maintain the proper sludge retention time in the process: If the proper sludge retention time is maintained, nitrification is maintained. Bacteria feed on the carbonaceous and nitrogenous waste coming into the plant, then they multiply and produce cell mass or excess sludge. For every pound of BOD that is destroyed, about half a pound of mixed liquor suspended solids is generated. That's just a rule of thumb."

According to Benner, "A key factor in operating an activated sludge system is controlling the amount of oxygen that you provide to the bacteria. If you want them to achieve BOD removal and nitrification, then provide them with enough oxygen to do that and maybe a 1.5 milligram per liter of oxygen residual to make sure you're providing enough oxygen throughout the entire activated sludge process.

"It's really important because when you provide 2 to 4 milligrams per liter of oxygen (and I see this a lot in other facilities), the bacteria don't know any better. They're going to consume everything they can. So you may remove the BOD and complete nitrification, but if you maintain 4 milligrams per liter of residual oxygen, that bacteria is going to go into an endogenous phase and start eating themselves. They're cannibalistic. Then you get very over-oxidized sludge and that's no good.

"So you control the growth of your activated sludge by the amount of sludge and oxygen that you provide. That's how we operate the plant, and we achieve really good results. The other thing is that you don't waste energy because it takes a whole lot more energy to maintain 4 milligrams of oxygen as a residual than 1 milligram."

Nonetheless, to maintain sludge retention time, Benner suggests getting rid of excess sludge at the appropriate age. (To determine the right age, simply measure the concentration of the mixed liquor suspended solids in the tank, and based on that, derive the requisite wasting rates.)

The Elkton wastewater treatment plant moves excess sludge to holding tanks, then uses meter belt presses to dewater it to about 18 percent solids, which comes out looking like dry sludge cake. From there, it travels to the thermal fluid dryer to be heated up to about 280°F. With most of the water evaporated, the sludge transforms into approximately 95 percent solids—or about a three-to-one volume reduction, according to Benner.

One benefit of this procedure is that it kills all the bacteria that may be harboring in the mixture, sterilizing it to create Class A sludge, which is easily disposed of by distributing it to the public. “Our game plan is to distribute it to local farmers,” says Benner. “It makes for an excellent soil additive and has a lot of nutrient value.”

On Safety & Efficiency Successes

Severn Trent, which oversees 15 employees total, has a full safety program in place. The facility has not only completed all of the standard operating procedures required by OSHA, but it also boasts on- and off-site training, a confined space entry permit program, a lockout/tagout program, a health and safety plan, and more. “Part of my job is to promote safety, and we’re up to snuff,” announces Benner. “And I’m very fortunate to have great staff because they are the ones who really make or break the operations. You take care of them, and with luck, they take care of you.”

One of the ways that Severn Trent protects its employees from potential danger is by attempting to avoid it in the first place, if possible: “We don’t use any gas chlorine or any sulfur dioxide at the wastewater plant. Instead we use ultraviolet disinfection, which is unquestionably safer than chlorine.” Although the wastewater plant doesn’t use these chemicals, it doesn’t necessarily mean that they are completely nonexistent at the plant.

“Sulfur dioxide and sodium hydroxide are probably some of the most hazardous materials that we use. At the water plant, we still use 150-pound chlorine cylinders,” admits Benner, but he is perpetually on the lookout for ways to improve safety. For instance, “The wastewater plant originally started with 50 percent sodium hydroxide in the odor scrubber, but downgraded to use 25 percent. It’s a lot safer.”

The utility also uses the minimum amount of chemicals to do the job (of course, without sacrificing performance), which cuts down on both their handling and storage of larger than necessary quantities. As an example, Severn Trent employees ritually do jar testing, which translates into taking water samples and adding different chemical concentrations, and based on that concentration, analyzing the sample to determine the optimal chemical blend.

Benner instructs his operators, “When you do your jar testing, and you should be jar testing everyday, I want you to look at the raw water and determine the exact concentration of coagulant you have to add. But I don’t want you to base it on turbidity, I want you to base it on true color (not to be confused with apparent color). True color is the answer to optimizing feed rates. Sadly, in the past and even today, when adding a coagulant to water, some operators only look at turbidity.

“If I only looked at turbidity,” Benner postulates, “but had high color alongside low turbidity, then hit it with chlorine, my trihalomethanes are going to be so high that they could be in violation, and they’re carcinogens. They’re dangerous. Just take a sample, put it through filter paper and throw it in a color machine. When you hit a

negative number, you've removed all the color, and when you've removed all the color, you've removed as much dissolved organic material as you can. Trihalomethane concentrations go from 70 to 30 PPB."

A Better Place ...

Since its inception, this wastewater plant has become an award-winning facility. As a matter of fact, the Severn Trent and town of Elkton partnership blipped Chem.Info's radar because the Maryland Rural Water Association recently named it the 2010 System of the Year. The association's award criteria are ambitious, too—they include:

- Quality and consistency of treatment process and results.
- Quality and consistency of wastewater service to customers.
- A special new project, program or upgrade instituted within the past year.
- Demonstrated innovation or creativity in addressing a system function, problem or operation.
- Exceptional effort by system personnel under difficult circumstances.
- Outstanding professionalism of system operations or management personnel.

Severn Trent's efforts and accomplishments helped the organization gain acceptance from a public wary of its formerly pungent and environmentally damaging ways. The partnership works not only because residents can now stop pinching their noses, but also because it makes the Chesapeake Bay, and even the state of Maryland, a better place to live.

For more information on Severn Trent Services, please visit www.severntrentservices.com [1].

Links:
[1] http://www.severntrentservices.com/