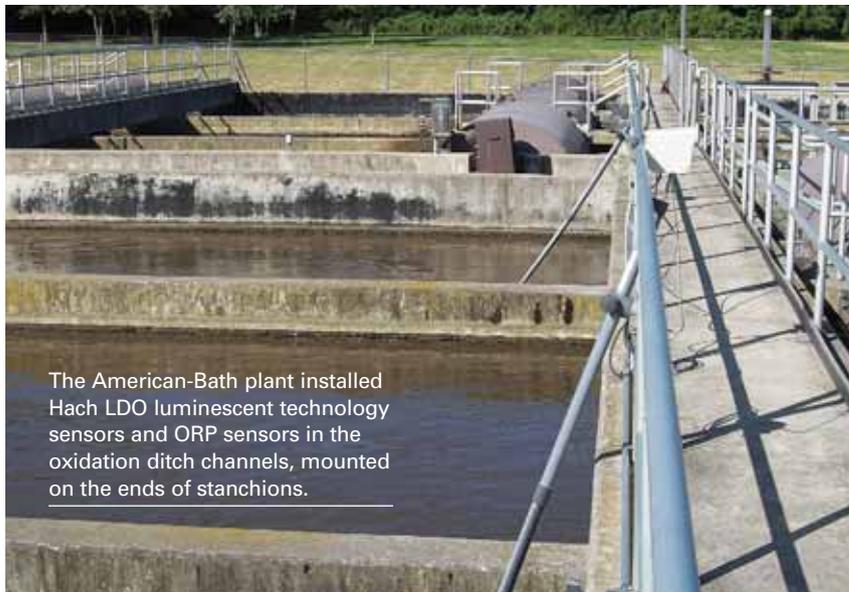


# The Power of Data

INLINE DO AND ORP MONITORING YIELDS INFORMATION THAT HELPS AN OHIO TREATMENT PLANT IMPROVE BIOLOGICAL PHOSPHORUS REMOVAL AND CUT COSTS

By Bob Dabkowski



The American-Bath plant installed Hach LDO luminescent technology sensors and ORP sensors in the oxidation ditch channels, mounted on the ends of stanchions.

PHOTOS COURTESY OF HACH COMPANY

**F**or years the American-Bath Wastewater Treatment Plant (WWTP) in northwest Ohio's Allen County had met stringent phosphorus limits through biological removal and aluminum sulfate (alum) addition.

But when the cost of alum more than doubled from \$161 per ton in 2006 to nearly \$443 per ton in 2008, management decided to improve the plant's process control for biological phosphorus removal and so reduce alum consumption.

"These probes finally allowed us to see what was going on in our system and make the necessary changes to significantly improve our process control."

**JOHN MOTYCKA**

"We are very concerned about maintaining our phosphorus limits, and we never had a problem before with using alum to help us accomplish that," says plant superintendent John Motycka. "But when we went from spending about \$2,000 a year for alum to upwards of \$5,000, it got us to thinking about how improving our biological process could lower our alum consumption while still maintaining our phosphorus limits."

Motycka knew the plant needed to attain precise and continuous process information to achieve that goal. To that end, the plant installed new inline instrumentation to provide real-time dissolved oxygen (DO)

and oxidation reduction potential (ORP) measurements. With the process control improvements enabled by the new process sensors, the plant has significantly improved biological phosphorus removal while reducing annual chemical and energy costs by more than \$11,000.

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## CHANNELS IN SERIES

American-Bath is one of three wastewater treatment plants (along with two smaller package plants) that comprise the Wastewater Treatment Division of the Allen County Sanitary Engineering Department. The plant, which serves about 8,000 residents in American and Bath townships, uses an ORBAL (Siemens) three-channel oxidation ditch system for biological treatment.

The system includes three concentric elliptical channels, each operating at different DO levels. The wastewater passes through the channels in series, from outermost to innermost. Flow circulates around each channel, allowing the raw sewage to be dispersed quickly with microorganism flocs.

The outer channel is the anaerobic ring, where the raw influent mixes with the mixed liquors. The middle channel is the anoxic zone, and the inner channel is the aerobic zone, where oxygen levels are brought up to maintain free DO for the aerobic bacteria.

The plant's phosphorus limits are 1.5 mg/l weekly average and 1.0 mg/l monthly average. According to Motycka, the key to achieving more stringent biological process control and meeting those limits is to have accurate control of oxygen levels in the treatment channels.

"For us, one of the most important things is maintaining anaerobic conditions in our outer channel by creating an oxygen deficit condition," he says. "This causes the aerobic phosphorus-consuming bacteria in the mixed liquor to release the phosphorus they have consumed."

"Then, when they enter the second and third channels, the phosphorus-consuming bacteria will consume the phosphorus that was released, as well as additional phosphorus from the raw wastewater (termed 'luxury uptake'). Our goal is to have the bacteria consume enough phosphorus so that we can keep the level below 1.0 mg/l and not have to add alum."

## SENSOR TECHNOLOGY

Essential to success was the decision to add inline dissolved DO and ORP probes to provide continuous, real-time measurements within the biological processes. The plant installed Hach LDO luminescent technology sensors and Hach ORP sensors in the channels: one ORP probe in the outer channel, ORP and LDO probes in the middle channel, and an LDO probe in the inside channel.

The probes plug into Hach sc100 controllers that continuously read the process sensors and can communicate via a 4-20 mA signal to a plant's PLC or SCADA system. The controllers also have built-in dataloggers that collect measurements at user-selectable intervals (1 to 15 minutes), along with calibration and verification points, alarm history, and instrument setup changes for up to six months. The controllers are designed to receive data from one or two sensors simultaneously.

With the inline meters providing a real-time and historical picture of DO and ORP values at different organic/hydraulic loading rates, recycle rates, solids retention times and seasonal conditions, operators were able to establish trends to optimize DO control, and determine the time and cause of any transient conditions.

In selecting the DO probe, the plant chose a new technology. Hach LDO probes do not consume oxygen during measurement, as that often creates a fouling buildup in membrane sensors and an oxygen gradient that slows down response. Because there is no membrane, there is no replacement due to fouling and no need to monitor and replace electrolyte solution.

## REAL-TIME DATA

The ORP probe in the outer channel helps ensure an anaerobic environment, and the LDO in the inner channel determines whether sufficient free DO is present for the aerobic bacteria to survive. When operators began studying data from the controller's dataloggers, they learned a lot. "We were going anaerobic part of the day in the outer channel, but for some reason, at about 3 a.m., the oxygen would start to rise and then eventually begin to drop off again midday," says Motycka. "This was adversely affecting biological phosphorus removal."

Once operators discovered that, they were able to restore anaerobic conditions in the outer channel during the identified period by adding a bigger pulley on the gear reducer that drives the outer channel's ditch drive. This enabled the plant to slow the drive from 42 rpm to 39 rpm, bringing more consistent anaerobic conditions to the outside channel.

"As soon as we did that, our biological removal improved significantly," Motycka says. "Within a week or two, our phosphorus dropped to between 0.4 mg/l and 0.5 mg/l without addition of alum."

When the weather began cooling off a few months later, however, operators again saw biological removal declining. "During the summer, we were achieving good biological removal in the inner channel with our DO ranging from 3.0 to 4.0 mg/l," says Motycka. "But during the fall, DO levels started climbing up to 6.0 and 7.0 mg/l, so we had to start adding more alum."

Real-time, continuous DO and ORP monitoring again provided the information to help operators resolve the issue. "Although the ORP in the outer channel didn't rise a great deal, it was enough that the phosphorus release wasn't sufficient and the luxury uptake in the middle and inside channels decreased," Motycka says. "DO in the inside channel was much higher, which indicated that we were recycling DO in the return activated sludge."

The Hach sc100 controllers were connected to the PLC that controls the plant's aerator drives. The PLC was programmed to automatically control the aerator drives to maintain a DO level in the inside channel between 2.0 and 3.0 mg/l, based on the current LDO probe readings.



ABOVE: American-Bath chief operator Jeff Bassitt downloads data from the Hach sc100 controller. With inline meters providing real-time and historical DO and ORP values, Bassitt and colleagues can establish trends to optimize DO control and determine the time and cause of transient conditions.

RIGHT: The probes plug into Hach sc100 controllers that continuously read the process sensors and can communicate via a 4-20 mA signal to a plant's PLC or SCADA system.



## CUTTING ENERGY COSTS

Programming of the aerator drive's PLC to maintain DO within the established set point further increased phosphorus removal efficiency. "Within a few days, effluent phosphorus decreased to about 0.5 mg/l with no alum addition," Motycka says. "And, as a side benefit, we considerably reduced our energy costs. We tracked the run time and the starts for the aerator drive. We went from running that ditch drive around the clock to running it only three or four hours a day, which will save us more than \$8,000 per year in power costs."

The use of the inline DO and ORP probes has significantly improved process control for biological phosphorus removal. "Some alum use will always be necessary, due to conditions beyond our control, such as very cold temperatures in the winter and high flows during wet weather, but we have effectively reduced alum use by more than half," Motycka says.

That savings combined with the power savings, total about \$11,800 per year, providing a payback of less than one-year payback on the DO and ORP probes and controllers.

"These probes finally allowed us to see what was going on in our system and make the necessary changes to significantly improve our process control," says Motycka. "Before this upgrade, we worked with lots of grab sample data, but nothing that really allowed us to look at the complete cycle of our biological system the way we do now with inline monitoring. You really can't compare grabbing a sample to having DO probes continuously monitoring key points in the system." **tpo**

### ABOUT THE AUTHOR

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