APPLICATION NOTE

ADVANCED ON-LINE INSTRUMENTATION HELPS FACILITY MEET BNR GOALS

Advanced BNR technology coupled with new on-line process instrumentation helps optimize wastewater plant efficiency and eliminates much of the time-consuming lab work for process control.

By Bob Dabkowski, Hach Company

Introduction

Nutrient levels in wastewater treatment plant effluent are a rising concern as regulatory agencies seek further improvements in effluent quality. Wastewater treatment plant managers and operators are today facing more demanding requirements to improve nutrient removal, especially in locations threatened with eutrophication. Plus, many managers know their wastewater utilities will be facing future nutrient removal requirements and, in anticipation of tightening regulations, a large number of plants today operate to "goal" levels, removing even currently unregulated nutrients.

What this means for the average wastewater treatment plant is ever-increasing emphasis on meeting even more stringent standards while maintaining plant efficiency. A critical element to that efficiency is a plant's ability to best utilize new on-line instrumentation that optimize plant processes and promotes efficiency.

This has been the case for the Greenville, Alabama, wastewater treatment plant. The facility uses on-line instruments that provide real-time monitoring of the facility's biological nutrient removal (BNR) process, allowing it to make critical immediate adjustments that increase performance and efficiency.

The Greenville plant is a mechanical aeration, activated sludge plant that treats an average of 1.2 million gallons per day (MGD) and serves approximately 2,800 customers. Following primary aeration, the flow is split between two continuously sequencing reactor (CSR) basins.

The Schreiber CSR system at the Greenville plant is designed to be a constant flow, single basin, complete mix reactor. Activated sludge is added to basin influent and a bridge that runs from the middle of the basin to the edge rotates, maintaining a constant mix of solids independent of aeration. Meanwhile, oxygen levels are manipulated to create oxic, anoxic and anaerobic phases that generate specific bacterial biological reactions aimed at nutrient removal. In addition to occupying a small footprint, the automated energy efficient CSR system operates by running blowers only intermittently.

To optimize the CSR process, the plant has installed on-line instruments to continuously monitor DO, mixed liquor suspended solids (MLSS), and oxidation/reduction potential (ORP).

“Our aeration basins basically operate individually from the other,” Bruce Branum, plant superintendent, says. “In each basin we primarily monitor DO and, to aid process treatment and energy savings, we also utilize on-line ORP measurement. To help us keep a better eye on our bugs (bacteria), we also use on-line sensors to monitor our suspended solids.”

On-line MLSS Measurement

The accurate measurement of MLSS is critical to the CSR system. “By knowing the mixed liquor concentrations, the volume of the tank and the BOD, we calculate an accurate food to mass ratio,” Branum says. “We want to know if there is adequate food coming in for the activated sludge microorganisms in the tank.”

The Greenville WWTP had long relied on laboratory analysis for MLSS readings. But the plant recently installed new on-line sensors that provide real-time MLSS measurements, and this has significantly reduced the plant’s reliance on intermittent and time-consuming laboratory analysis.

The plant’s new suspended solids analyzers (Hach SOLITAX sc) use dual-beam infrared scattered light photometers and receptors to monitor the mixed liquor. The analyzer provides accurate and continuous measurements completely independent of color. Real-time monitoring of MLSS concentrations in its aeration basins has allowed the Greenville plant to consistently maintain target MLSS levels.

“Before we installed the probes, we had to go out and take samples, measure the mixed liquor of each basin through lengthy laboratory tests and then make our judgment of whether or not to waste sludge for further processing,” says Branum. “Now, it’s instantaneous. We can look at a screen and see how many solids we currently have in each basin, 24 hours a day.” Knowing the MLSS concentration at all times allows plant operators to optimize the biomass quantity and quality to meet variations in influent flow and load.

The plant has installed a SOLITAX probe in each aeration basin and one at the plant headworks, along with a Hach UVAS sensor. “The probe installed at the headworks monitors solids loading of the influent wastewater and lets us know when certain industries are discharging to the plant,” Branum says. “The UVAS probe measures the mixture for toxic shock and tells us if we are receiving an influx of high BOD.”

DO & ORP Process Monitoring

Two primary process control measurements in the CSR process are oxidation/ reduction potential (ORP) and dissolved oxygen (DO). The Greenville WWTP has installed ORP and DO probes in each aeration basin and can utilize either DO or ORP for blower control. Using DO control for aeration allows for a steady rate of air delivery, while using ORP control allows the air delivery rates to be maximized for the BNR process. “Think of

it this way," explains Branum, "DO tells us how well the bugs are breathing, ORP tells us when they should breathe to maximize nutrient removal.

To meet DO measurement requirements, the Greenville WWTP installed Hach Luminescent Dissolved Oxygen probes (LDO) in each aeration basin. When DO reaches a certain level, the bacteria have enough air and are satisfied. The blowers can then be cycled on and off to create anoxic and anaerobic environments. "The great benefit of this process is that it's power efficient," says Branum. "We save power by not having to aerate all day long."

Prior to installing the LDO probes, the plant had used membrane-based DO probes. "The LDO is much more robust and definitely requires less maintenance. About once a month we clean them off a little bit and once a year we replace the tips," says Branum. "With the membrane probes, we had to replace the tips three times a year—and do lots of recalibration."

Optimizing CSR System

BNR processes typically require three different tanks for the nutrient removal process. With the Schrieber CSR system used at the Greenvile plant, one tank is used for all three stages. As influent enters the basin, activated sludge provides the necessary bacteria or biomass for the biological reactions that result from manipulation of the oxic, anoxic and anaerobic phases. The changes between phases at the Greenville plant are automated based on real-time DO and ORP readings.

During the oxic stage, the blowers are adding sufficient oxygen to the mixture to obtain a DO value of 2.0 ppm. During this time when the DO is high, the ORP increases to a predetermined set point and turns the blowers off. During the oxic stage nitrification occurs, converting ammonias to nitrates and water. After the blowers shut off, the process enters the anoxic stage and DO drops to an undetectable amount. During this time, the nitrates reduce to nitrogen gas, producing oxygen which is used in the respiration of the denitrifying organisms.

When there is no more free oxygen, the basin enters the anaerobic stage and bacteria become stressed and release orthophosphate. At a low enough ORP level, the system triggers the blowers and oxygen is reintroduced into the basin -- now the basin is back in the oxic phase and the stressed bacteria reabsorb the phosphorous, but at two to three times the normal level. The phosphorous is removed when the sludge is wasted.

The Greenville WWTP discharges an effluent that is well under regulatory standards as established in its National Pollutant Elimination Discharge System (NPDES) permit.

System Provider Recommends

The CSR system provides an efficient and productive BNR process, and the technology provider has long understood the benefits in both efficiency and cost savings by optimizing the system with state-of-the-art instrumentation. These were the primary motivations behind Schreiber's recommendation of Hach on-line instrumentation for the CSR system. In addition to the Hach LDO, ORP and SOLITAX probes, Schreiber has developed and patented the SchreiberFlex control system. Utilizing Hach on-line Nitratax, NH4D sc Ammonium sensors and Phosphax analyzer, along with LDO, the system controls the process phases via real-time analysis of the actual nutrients to control aeration.

"We're always seeking ways to optimize our process and these instruments are a key," Debra Waller, Manager of Process Services at Schreiber, LLC, says. "Our goal is to aid our customers in maximizing energy savings and adopting more environmentally-friendly methods. Using these instruments helps us to do that. They offer tighter control over an already efficient process."

About the Author: Bob Dabkowski is a Wastewater Specialist for Hach Company and a Licensed Colorado Wastewater Operator. He is the author of several papers, articles, and application notes concerning wastewater treatment and has over eight years' experience at Hach, advising process control & automation solutions. Phone: 970-663-1377 x2191. BDabkows@hach.com

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