



◀ While automation and instrumentation can centralize operations control, having the right equipment and systems is essential.

Most aeration systems that use real-time control are based on dissolved oxygen (DO) measurements, but these measurements often are slow to react to changing conditions. New control strategies use predictive parameters that are based on influent wastewater quality as opposed to DO. Real-time ammonia-nitrogen monitoring plays an increasingly important role for successful biological nutrient removal at water resource recovery facilities (WRRFs).

Better real-time technology

Nutrient monitoring and analyzing technologies have made great advances during the past decade. Many ammonia probes and electrodes currently available provide real-time, or near real-time, conditions in the treatment system through continuous monitoring. Immediate feedback helps operators take fast corrective action if a shock or toxic load occurs. It also allows timely process adjustments for less energy consumption or chemical usage.

Three case studies help illustrate how ammonia-based aeration control can help WRRFs save money and meet compliance more easily. These full-scale studies were conducted comparing DO and ammonia-based control strategies in an activated sludge system to judge their relative treatment efficiency and process stability.

- Ammonia measurement was chosen for one of two reasons:
- To limit aeration: Aeration is limited to prevent complete nitrification, which has the potential benefits of energy savings, increased denitrification, and, in some cases, improved biological phosphorus removal performance.
 - To reduce effluent ammonia peaks: Aeration is controlled to reduce the extent of effluent ammonia peaks.

J.D. Phillips Water Reclamation Facility

The J.D. Phillips Water Reclamation Facility (WRF) in Colorado Springs, Colo., has a design capacity of 89,000 m³/d (23.6 mgd) and an average flow of 30,300 m³/d (8 mgd). The activated sludge facility has a three-pass secondary treatment system. Pass A is used for phosphorus removal and denitrification, while passes B and C are used for nitrification. The facility discharge limit is 5.0 mg/L ammonia.

One major challenge is rapid changes in influent ammonia concentration. Because of these fluctuations, DO was not an ideal control parameter, and the facility was over-aerating during off-peak hours, which amounted to 18 hours per day. During the study, Pass A was left alone and continued performing phosphorus removal and denitrification. Real-time controls were installed in Pass B, and the DO control setpoint in Pass C was set to below 0.5 mg/L to ensure that the DO level did not drop below 0.5 mg/L regardless of influent ammonia concentrations.

The real-time control system was tested from August to October 2010. Effluent ammonia concentrations were compared to those from 2009 (see Figure 1, p. 42), when the facility received similar influent ammonia loading.

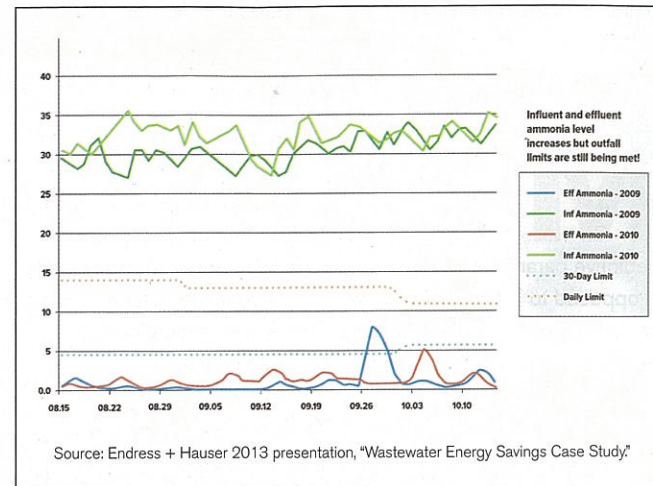
After real-time control was installed, the facility consistently made its effluent discharge limit of 5.0 mg/L ammonia. Real-time control

Ammonia-based aeration

Real-time online probes save energy costs **of**

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Figure 1. Results for J.D. Phillips WRF



enabled the system to react to the peak ammonia concentrations and turned down blowers during off-peak hours, cutting energy costs 20%. Table 1 (below) shows total costs for implementation as well as savings. The energy use reduction has saved the J.D. Phillips WRF \$150 per day, providing a payback period of less than 2 years.

Grand Rapids, Mich., Wastewater Treatment Plant

The City of Grand Rapids partnered with a manufacturer in March 2013 to determine potential energy savings with a nitrification real-time control system. The facility has two parallel sludge processes, a North Plant and a South Plant. The North Plant receives an average of 84,000 m³/d (22.2 mgd), and the South Plant receives an average of 75,700 m³/d (20 mgd). The facility's permitted discharge limit is 8.0 mg/L ammonia.

The South Plant, with three parallel aeration basins, was selected for the real-time control study. Each aeration basin has five 75-kW (100-hp) turbine draft mixers. Additionally, the South Plant has two 373-kW (500-hp) multistage blowers, resulting in a

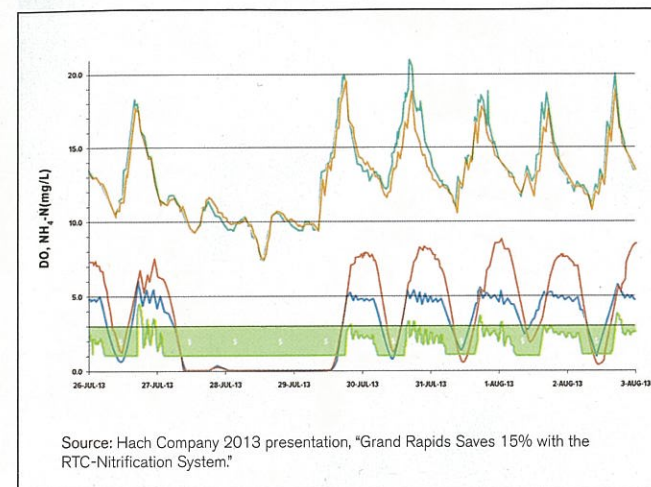
Table 1. Cost of real-time control implementation and savings for J.D. Phillips WRF

Cost of implementation	
Instrumentation purchase	\$50,000
Installation material	\$6,000
Installation labor	\$7,000
Programming	\$10,000
Total	\$73,000
Cost savings	
Daily power cost saving	\$150
Annual power savings	\$55,000

Table 2. Real-time control results at Grand Rapids, Mich.

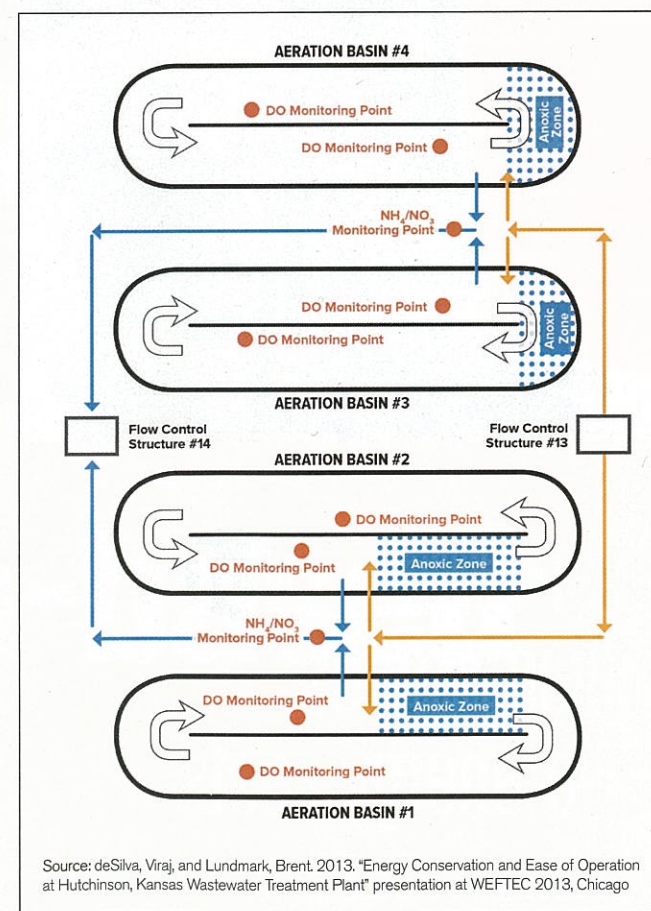
	Aeration Tank 1	Aeration Tank 2
Dissolved oxygen setpoint	3.0 mg/L	Variable
Influent ammonia	6.0–21.0 mg/L	6.0–19.3 mg/L
Effluent ammonia	0.0–8.5 mg/L	0.0–5.1 mg/L

Figure 2. Results for Grand Rapids South Plant



system of 1865 kW (2500 hp) of total connected power. Aeration Tank 1 was used as the control and was operated in the same manner with a DO setpoint of 3.0 mg/L. Real-time nitrification control was installed in Aeration Tank 2, which was operated with a variable DO setpoint. Aeration Tank 3 was left un-monitored and operated in the same manner as Aeration Tank 1 with a DO setpoint. Both tanks 1 and 2 were monitored for influent ammonia, effluent ammonia, and DO concentrations. Aeration Tank 2 also was monitored for temperature and total suspended solids, as the real-time nitrification controller requires additional data inputs.

Figure 3. Ammonia and dissolved oxygen monitoring locations at Hutchinson



Real-time monitoring and predictive parameters can aid biological nutrient removal as well as reduce energy use.

The objective for Aeration Tank 2 was an effluent ammonia concentration of 4.0 mg/L ammonia.

Testing and evaluation began in June 2013. As can be seen in Figure 2 (p. 42), both tanks had similar influent loads. Aeration Tank 1 effluent ammonia concentrations fluctuated between 0.0 to 8.5 mg/L due to varying influent loadings. Aeration Tank 2 had smaller fluctuations in effluent ammonia (0.0 to 5.1 mg/L), due to the variable DO concentration, which could alter in response to influent loadings. These results are displayed in Table 2 (p. 42).

Hutchinson, Kan., Wastewater Treatment Plant

The 8.3-mgd City of Hutchinson facility has an average influent flow around 17,000 m³/d (4.5 mgd). The facility uses four biological treatment trains: Basins 1 and 2 (two south basins) use jet aeration and Basins 3 and 4 (two north Basins) use fine-bubble diffused aeration. The jet aerators are supplied by 75-kW (100-hp) single-speed blowers and use a 37-kW (50-hp) motive pump for circulation. Throttling the inlet valve adjusts air output. Though four blowers are available for these two basins, only one blower is needed most of the time. Similar to Basins 1 and 2, only one of five 93-kW (125-hp) blowers is needed most of the time for Basins 3 and 4.

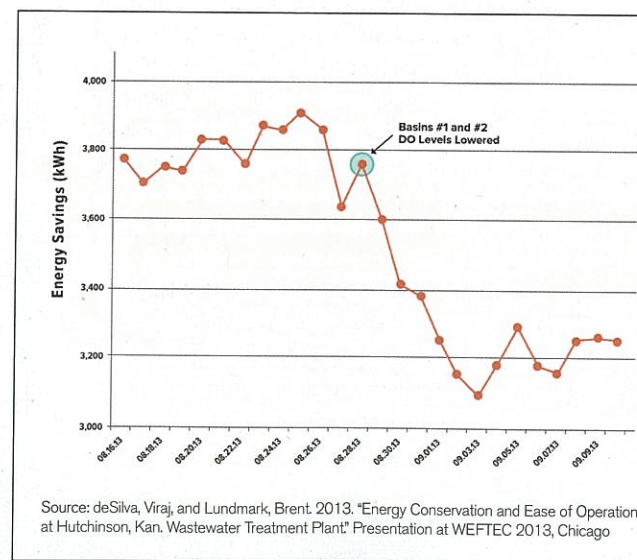
All four basins include an anoxic zone at the influent and effluent end. Two (4.7-hp) submersible mixers are used only at the influent end. DO probes are used for monitoring oxygen levels at various locations (see Figure 3, p. 42). Energy costs for aeration significantly dropped after the probes and operating blowers were installed. On August 30, 2013, DO levels in Basins 1 and 2 were lowered, with resulting full nitrification and some denitrification. (See Figure 4, left.)

Ammonia/nitrate and DO probes along with SCADA upgrades helped create energy savings at Hutchinson. Energy meters also were installed to monitor ultraviolet and blower energy usage at the facility.

Overall, these case studies demonstrate how instrumentation is key to power monitoring. By utilizing real-time control for ammonia-based aeration, all three WRRFs were able to reduce their energy consumption and save on energy costs.

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Figure 4. Controlling lower dissolved oxygen



Source: deSilva, Viraj, and Lundmark, Brent 2013. "Energy Conservation and Ease of Operation at Hutchinson, Kan. Wastewater Treatment Plant" Presentation at WEFTEC 2013, Chicago