CASE STUDY

FLORIDA WWTP MEETS FUTURE PERMIT USING EOSi'S NITRACK® CARBON SOURCE AUTOMATION

A Florida municipal wastewater treatment facility becomes "future-ready" for meeting more stringent nitrogen permit requirements — and avoids a full plant upgrade — after implementing EOSi's Nitrack® automated monitoring and dosing control feed system delivering MicroC® 2000 carbon sources.

Client: Florida Municipality

Facility: Municipal Water Reclamation Plant

Flow Actual: 3.4 MGD

Treatment Technology: Activated Sludge

Study Period: November-April

Background

A Florida municipal water reclamation plant operating with a daily average flow of 3.4 MGD through a 4-stage Bardenpho Process configuration was meeting their current TN (total nitrogen) permit readily and consistently, but the facility was struggling with meeting the AWT (Advanced Wastewater Treatment) requirements and reducing the average annual TN effluent concentration to 3 mg/L or below.

Receiving leachate sporadically and without warning throughout the year, the plant's lack of leachate flow equalization or pretreatment made the plant's incoming TN load difficult to predict and accommodate and caused many process upsets. Seeking a solution that would solve both their present and future permit challenges, the facility conducted a two-week evaluation using manually applied doses of carbon to determine if meeting future effluent goals was possible — without resorting to a full plant upgrade.

EOSi's Nitrack® System

The Florida facility's initial evaluation determined that adding carbon sources to reduce the nitrogen oxides (NOx) in the post-anoxic basin was sufficient for achieving a final TN effluent of 3 mg/L. However, the daily loading/flow-fluctuations combined with the unpredictable leachate load required a high carbon dosage.

The facility's longer-duration trial using carbon sources targeted two primary objectives: reduce the post-anoxic NOx (NO_3+NO_2) concentration to 1.5 mg/L or below to achieve AWT requirements, while cutting carbon costs or reducing periods of carbon overdosing by implementing an automated dosing strategy controlled by EOSi's full-service Nitrack® system.

EOSi supplied a turnkey Nitrack program system, including Nitrack advanced dosing and monitoring controls, EOSI's MicroC® 2000 chemical peristaltic pumps, Hach® NitrataxTM sc nitrate sensors and SC200TM Universal Controller equipment, with system installation, configuration, and support from EOSi technical and maintenance service experts.

Nitrack Control Strategy

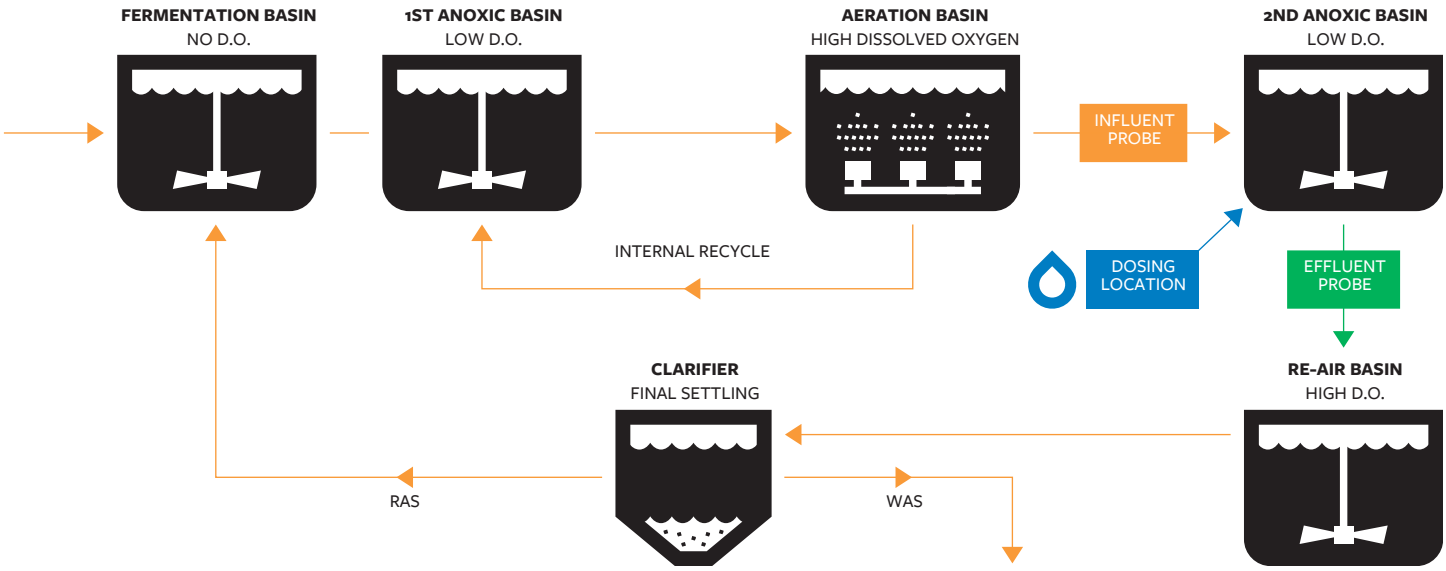
Only two trains were operating in the Florida plant's four-train process, so the temporary feed system was installed so both trains received a calculated dose of carbon sources to the beginning of the post-anoxic basins in each train. Data from the evaluation trial was collected using two different methods for comparison, and four installed Hach Nitratax probes provided real-time data for monitoring the fluctuations throughout each day.

Two probes were installed at the post-anoxic influent of each "influent-NOx" train, and another pair of probes at the end of the post-anoxic basins of each "effluent-NOx" train (see locations in Figure 1 above). Operational staffers collected 24-hour composite samples from the plant influent and effluent 3-4 times per week for subsequent analysis by a third-party certified lab.

EOSi technicians deployed a Nitrack controller for optimizing the carbon sources dosage going into the post-anoxic basin to support a control strategy

MicroC® Premium Carbon Sources

FIGURE 1 Process Diagram and Equipment Locations



that is a unique combination of a "feedforward-and-feedback" control algorithm. Feed-forward (FF) control actively adjusts the process conditions to changes in the influent, and feedback (FB) control actively adjusts manipulated variables based on system performance and the effluent NOx concentration. The combination of FF and FB control ensures the effluent NOx limit can be achieved through continuous adjustment based on dynamic conditions, such as leachate.

Trial Results and Conclusions

Baseline data was collected prior to carbon sources dosing for comparison. The post-anoxic effluent NOx setpoint (controlling the dosing) was started at 3 mg/L, and slowly decreased to 1.5 mg/L. The NOx loading was calculated using the probe data with the influent and RAS (return- activated sludge) flows provided by the facility.

As shown in Figure 2 below, the NOx removal was the lowest during the baseline collection and increased after the dosing began. The fluctuation in removal is attributable to the carbon sources dosage, but also the increase in influent NOx loading — thus creating more NOx for removal.

When the influent NOx was higher between mid-January through April the NOx removal was roughly 480 lbs. NOx removed per day vs. the non-dosing periods of 380 lbs. NOx removed per day.

Challenges and Troubleshooting

Influent Loading Fluctuations The average NOx concentration going into the post-anoxic basin varied significantly during the evaluation. For example, when the carbon sources dosing evaluation began the average NOx concentration was <6 mg/L, and by the end of the evaluation the concentration had increased to > 9 mg/L (see Figure 2 below). These fluctuations are likely due to several factors, including but not limited to the incoming leachate, seasonal changes, and spring-break tourist season.

East Train vs. West Train Independent dosing occurred in each of the two online trains. Throughout the baseline collection and the entire evaluation, the west and east trains had very different removal rates, thus requiring different amounts of carbon sources to achieve the same effluent NOx setpoint.

Several factors contribute to this variation in removal rates, including but not limited to the aeration and flow distribution. As the air and flow distributed between the trains is achieved with a manual valve, there are no flow meters present for monitoring the distribution. This made the operation more difficult and caused the flow and loading to vary significantly throughout a 24-hour period, thus changing the distribution.

FIGURE 2 The daily average NOx removed from the post-anoxic (lbs./day) vs the totral carbon dosed (gpd).

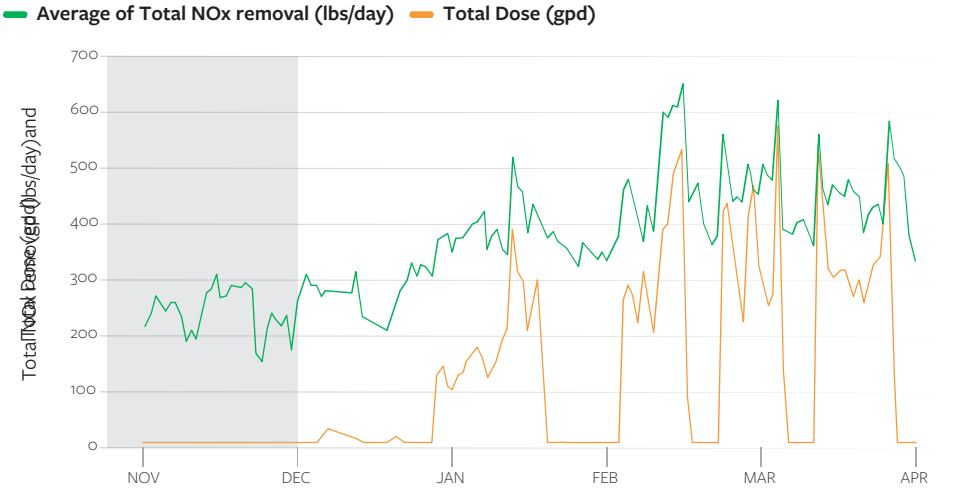
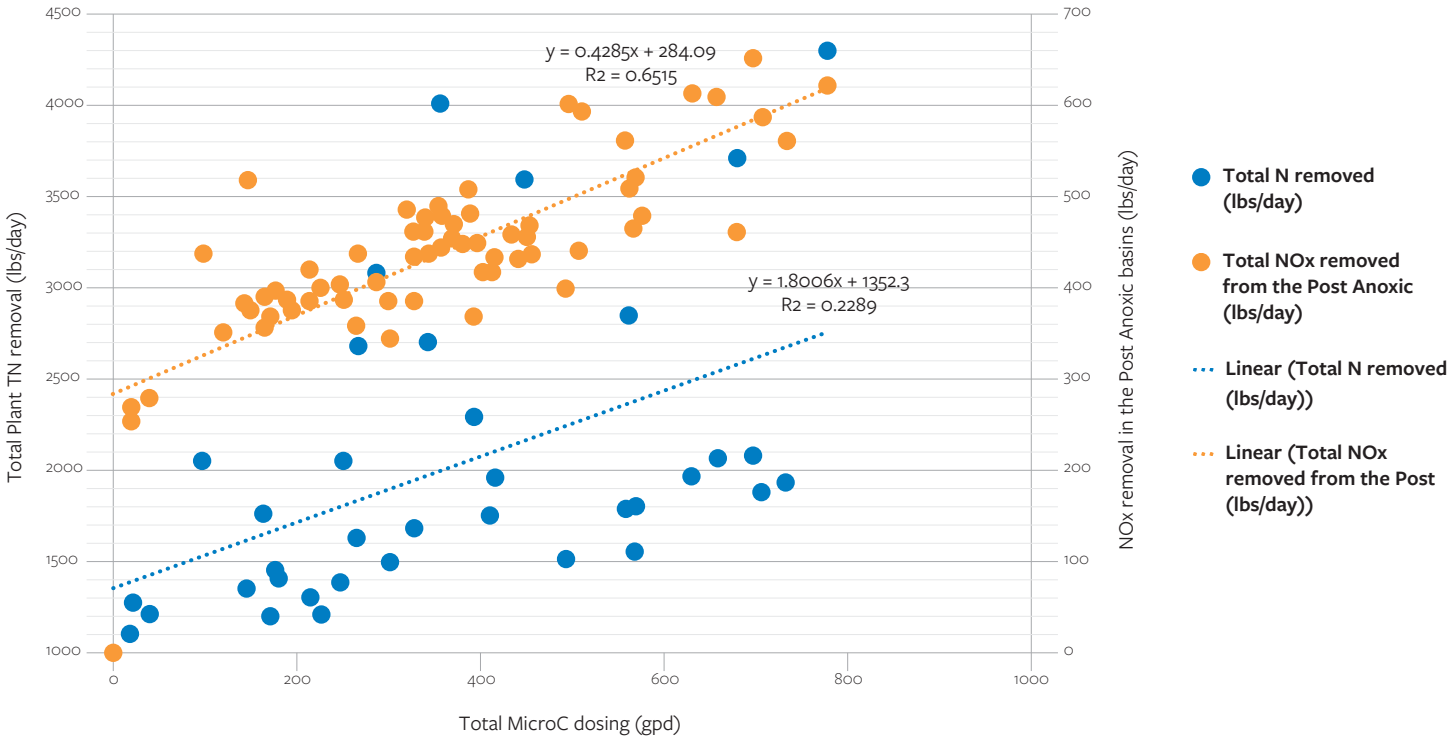


FIGURE 3 The TN removed from the plant (composite samples) vs. total NOx removed from the post-anoxic (probe data).



Carbon Sources Storage and Usage Efficiency

As shown in Figure 3 above, the influent NOx is the highest when the MicroC 2000 dosing stops with an average of 11.7 mg/L. This could indicate that some of the dosed MicroC is being stored within the secondary-treatment microbial "bugs" then recycled with the RAS (return activated sludge) to the pre-anoxic basin, enhancing the denitrification in the pre-anoxic basin and thereby lowering the NOx coming into the post anoxic basin (influent NOx) during dosing periods.

It is evident after examining the data that measuring only the post-anoxic removal does not reveal true total carbon efficiency. The influent total nitrogen (TN) concentration and effluent TN concentration 24-hour composite samples analyzed by a certified laboratory were used to calculate the carbon usage efficiency (gal. MicroC/lb. TN removed), instead of evaluating only the post-anoxic basin removal. As such, the overall carbon usage efficiency of the plant was found to be 0.78 gallons of MicroC 2000 per lb. TN removed from the entire plant.

Leachate and Organic Nitrogen The leachate received by the facility is highly concentrated without flow equalization or any form of pre-treatment. A sample reported the leachate TKN concentration of 813 mg/L. The highest daily leachate dose was 106,000+ gallons, which added roughly 719 lbs. of TN into the process that day.

In addition, the effluent organic nitrogen without leachate is 1.2 mg/L, and the effluent organic nitrogen increased to 1.7 mg/L when leachate was added. In contrast, the effluent organic nitrogen was 3.1 mg/L during one of the high-leachate dosing days.

Conclusions

The Florida municipal water reclamation plant successfully improved their overall denitrification performance by consistently reducing their effluent NOx concentration below the target of 1.5 mg/L — despite the facility's dynamic loadings — by deploying an automated carbon dosing system like EOSI's Nitrack system and MicroC carbon sources. The data from this evaluation provided additional insight into future optimization strategies useful for further reducing chemical costs and improving the consistency of nitrogen removal throughout the plant.

Despite the noticeable spike in the loading when leachate was dosed, the facility successfully met their future permit goals and requirements while carbon is being dosed. In addition, dosing with EOSi's MicroC carbon sources have shown to potentially provide additional benefits with biological phosphorus removal, as a strong correlation was observed between increasing the carbon dosage and a decreasing effluent TP (total phosphorus) concentration at the plant.