CASE STUDY

PENNSYLVANIA BEEF-PROCESSOR CONQUERS BNR OBSTACLES & COMPLIANCE WITH EOSI'S MICROC® 2000

A Pennsylvania industrial beef-processing facility partners with EOSi to overcome multiple denitrification process challenges and meet max-load-limit permit compliance goals during commissioning of a biological nutrient removal upgrade to their wastewater treatment plant.

Client: Industrial Beef-Processing Facility

Location: Eastern Pennsylvania

Flow Design/Actual: 0.8 MGD/0.5 MGD

Treatment Technology: Four-Stage Bardenpho Activated Sludge

TN Discharge Objective: <8 mg/L

Study Period: <8 mg/L

Background

An Eastern Pennsylvania Industrial beef-processing plant seeking to comply with their total maximum daily load (TMDL) permit limits upgraded their onsite wastewater treatment plant (WWTP) from a conventional activated-sludge plant to a dual-train, four-stage Bardenpho activated-sludge process.

Prior to the plant's biological nutrient removal (BNR) upgrade, it historically discharged greater than 200 mg/L total nitrogen (TN). However, the plant's new National Pollutant Discharge Elimination System (NPDES) permit required an annual TN average concentration of less than 8 mg/l and a daily maximum TN of 130 mg/l at a flow rate of 0.5 MGD.





Post Anoxic Tank Before and After Photos

With very high nitrogen loading with peaks of up to 300 mg/l TN and low carbon/nitrogen ratios in the anoxic zones, the plant design required using supplemental carbon to facilitate denitrification to comply with the NPDES permit limits. Citing safety, low cost, and high quality, EOSi's MicroC® 2000 was chosen as the supplemental carbon source for the wastewater treatment facility.

Incomplete Denitrification & Nitrite Accumulation

During the commissioning of the upgraded plant, the facility experienced several denitrification challenges. The high COD utilization rate in the post anoxic reactor combined with short HRT and low concentration of available nitrogen for assimilation created several challenges:

- Incomplete denitrification and nitrite accumulation.
- Debilitating thick brown foam and accumulation and sludge bulking.
- Process instability with food-to-mass (F/M) ratios.
- Mean cell residence time (MCRTs)
- Unequal performance in the parallel BNR treatment trains.

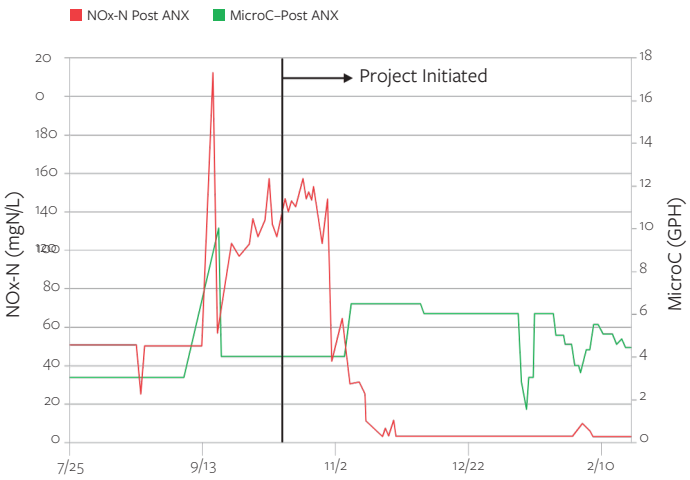
Systematic EOSi Evaluation

The beef-processing facility engaged EOSi to evaluate these process challenges and propose potential solutions. EOSi's systematic evaluation approach included:

- Microbial analysis.
- COD and nutrient profiling throughout the entire system.
- Real-time monitoring of critical parameters (nitrate and other operational parameters) impacting performance.
- Modeling and dynamic simulation of the process utilizing the data collected.

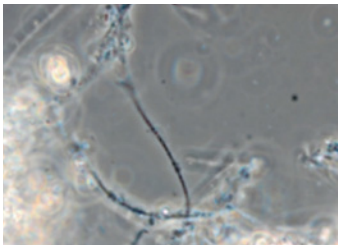
MicroC® Premium Carbon Sources

Train 1

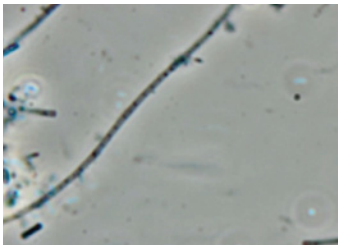


Train 2

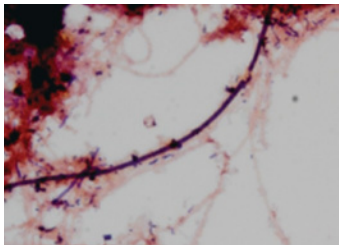




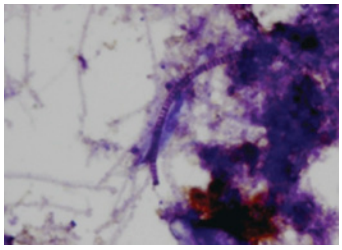
Thiothrix spp., X1000



Thiothrix spp., X2000



Foam samples observed after Gram staining. Incidental observations of Gram (+) Type 0041/0675 filaments were observed, X1000. 'Nocardia' filaments were not observed in samples.



Foam samples observed after Neisser staining. Incidental observations of Neisser (+) 'Nostocoida limicola' fiolaments were observed, X1000.

EOSi conducted a detailed review of the plant operating data to develop a cost-effective solution. The first step in the assessment was microbial analysis to determine the nature of the thick brown foam, which revealed the presence of Thiothrix spp. in several foam samples (Thiothrox spp. filamentous bacterial growth is known to be caused by different factors (Eikelboom and van Buijsen, 1983; Jenkins et al., 2004)) and other issues:

- Excessive readily biodegradable soluble substrates.
- Nitrogen or phosphorus deficiency in mixed liquors.
- The presence of hydrogen sulfide and septic wastewater.

Multiple onsite visits by EOSi technicians collected data and observed system response using static modeling and simulation analysis. EOSi's investigation revealed the presence of high dissolved oxygen (DO) in the anoxic zones caused by excessive aeration from an oversized blower with limited turndown control. DO was also being entrained within the manhole splitter box that divides flow from the anaerobic zone into the two pre-anoxic zones.

Additionally, chemical oxygen demand (COD) overloading in the pre-anoxic tank was identified, and the carbon addition rate was rebalanced by adjusting the feed to the pre- and post-anoxic zones from 75%/25% to 50%/50%, respectively. This change eliminated nutrient deficiencies within the reactors. EOSi and plant staff developed an operating strategy that incorporated changes achieving a more stable biological process, and reduce effluent total nitrogen (TN) from >200 mgN/L to less than 3 mgN/L, thereby bringing the plant into compliance.

EOSi-initiated operational changes included:

- Replacing the blower with another capable of better turndown control.
- Piping changes in the influent manholes to reduce dissolved oxygen entrainment.
- A revised carbon feed strategy as recommended by EOSi.

Full Denitrification with MicroC® 2000

Within weeks of deploying MicroC® 2000 and implementing process enhancements (see Train 1 & 2 graphs), dissolved oxygen concentrations were optimized throughout the process, and thick brown foam was virtually eliminated throughout the entire plant. Using MicroC 2000, the plant achieved full denitrification with an effluent of NOx <0.2 mg/L, stabilized mean cell residence time and clarifier performance — and attained consistent compliance with the strict NPDES permit requirements.