A Sustainable Nitrogen Removal Program using Nitrack® Automation at Tyson Foods

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Introduction:

This presentation will provide a look at how an industrial facility met stringent nutrient limits.

Strategies in achieving a more consistent effluent nitrogen discharge while optimizing chemical usage and performance.

Benefits of online monitoring and automation to improve treatment stability.
EOSi Company Background

Founded in **2003**. Based in Bourne, MA (Cape Cod)

Focus – Green & economically sustainable solutions for biological contaminant removal applications

2 issued US patents, international applications pending

Customer and Supply Chain

560+ Customers
35 States
5 countries

51% Municipal
30% Industrial
19% Decentralized

12 Existing Manufacturing Locations Across the US; additional sites identified
<table>
<thead>
<tr>
<th>Primary Feedstock</th>
<th>Carbohydrate</th>
<th>Glycerin</th>
<th>Alcohol</th>
<th>Customized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity (20°C)</td>
<td>1.22</td>
<td>1.22</td>
<td>0.83</td>
<td>0.83-1.22</td>
</tr>
<tr>
<td>Bulk Density (lbs/gal)</td>
<td>10.17</td>
<td>10.17</td>
<td>6.92</td>
<td>6.5-10.2</td>
</tr>
<tr>
<td>Flammability</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Freezing Point</td>
<td>18°F (-6.7°C)</td>
<td>0°F (-17°C)</td>
<td>-143°F (-98°C)</td>
<td>-143°F-18°F</td>
</tr>
<tr>
<td>Viscosity (cPs @20°C)</td>
<td>20</td>
<td>45</td>
<td>0.6</td>
<td>0-45</td>
</tr>
<tr>
<td>Viscosity (cPs @0°C)</td>
<td>50</td>
<td>130</td>
<td>0.8</td>
<td>0-70</td>
</tr>
<tr>
<td>COD Value (mg/L)</td>
<td>670,000</td>
<td>1,040,000</td>
<td>1,150,000</td>
<td>1,050,000</td>
</tr>
</tbody>
</table>
Programs & Solutions:

Process Solutions & Programs

Complete Solutions

Regulatory Compliance
Comprehensive Contaminant Removal Programs

Lowest Lifecycle Cost
Continuous Program Optimization to Lower Costs

Services Capabilities

Objective Based Programs

S&IA
Sensor & Instrumentation Analysis

DPA
Diagnostic Process Analysis

ME&AS
MicroC Evaluation & Application Support

PM&DM
Performance Monitoring & Data Management

Nitrack®
Automated Nutrient Control Program

PTS
Process Trouble Shooting

PO
Process Optimization
Facility Overview:

- About 220,000 chickens processed per day
- About 5-7 gal water per chicken processed
- The wastewater facility was upgraded in 2010 from 1.5 MGD to 2.3 MGD flow and AS to 4-stage
Challenges:

1. Very Stringent Nutrient Limits

2. The facility receives a high influent load of nutrient

3. The flow into the BNR plant is not continuous
   - Variability daily between shifts
   - No flow on weekends

4. Effect of nutrient load fluctuations on consistency of eff quality in post anoxic
Chesapeake Bay Watershed:

- Largest estuary on the continent covering around 64,000 mi²
- Includes VA, MD, WV, DE, PA, NY and Washington, DC
- Supports more than 17 million people live in watershed
- The TMDL for Chesapeake Bay watershed limits of 185.9 million pounds of N, 12.5 million pounds of P or a 25 percent reduction in nitrogen and 24 percent reduction in phosphorus by 2025. (from EPA.gov) established on Dec 29, 2010. These limits should be fully met by 2025, and by 2017 60% of the necessary pollution reductions should be met.
Very Stringent Nutrient Limits:

- Nutrient limits set by Virginia Department of Environmental Quality
- Total Nitrogen Discharge limit – 22,824 lbs/year [62 lbN/d]
- Total Phosphorus Discharge limit – 1,142 lbs/year [3.1 lbP/d]
- Total nitrogen limit 6 mg/L
  – Targeted 5 mg/L
- Total phosphorus limit 0.3 mg/L
  – Targeted 0.2 mg/L
Facility Overview:
**Influent Flow Regime:**

- **EQ TANK**

![Graph showing influent flow regime with data on TSS, BOD, and flow rates over time.]

**Graph Details:**
- **X-axis:** Dates from 12/17/12 to 3/21/16
- **Y-axis:**
  - TSS: mg/L
  - BOD: mg/L
  - Flow: mg/L

**Key Observations:**
- **TSS RAW AVE:** 1650 mg/L
- **TSS DAF AVE:** 400 mg/L (75%)
- **BOD RAW AVE:** 3000 mg/L
- **BOD DAF AVE:** 1350 mg/L (55%)
Influent Flow Regime:

- Sundays
- Saturdays
- Mondays
- Tuesdays
- Wednesdays
- Thursdays
- Fridays

Flow rates:
- 0 MGD
- 0.17 MGD
- 0.91 MGD
- 1.31 MGD
- 1.26 MGD
- 1.17 MGD
- 0.95 MGD
High Influent Nutrient Load:

TN AVE= 190 mgN/L  
TP AVE=55 mgP/L

TN AVE = 2030 lbN/d  
Limit = 62 lbN/d  
~97% TN Removal

TP AVE = 570 lbP/d  
Limit = 3.1 lbP/d  
~99.5% TP Removal
High Influent Nutrient Load:

TN RAW AVE = 190 mg/L
BOD/N RAW = 18.2

TN DAF AVE = 112 mg/L (40%)
BOD/N DAF = 13.9 mg/L (23%)
Strategies for Success:

- Flow management
  - Split DAF influent to partially bypass anaerobic zone to BNR
    - Allows for anaerobic zone to feed flow on weekends
    - Lowers flow during week and increases flow on weekends to reduce variation in addition to carbon redirection
Strategies for Success:

• Flow management
  – Flow variability during week (weekdays vs. weekend) in 2014 and 2015

![Average effluent flow rate with DAF partial bypass](chart.png)
Strategies for Success:

• Carbon redirection
  – Redistribution of flow allowed internal BOD to be used for denitrification in first anoxic zone
  – Feed additional carbon to pipe between aerobic lagoon to anoxic reactor for further denitrification
Strategies for Success:

• **Nitrack® Controller**
  – Single or Multi Basin Continuous flow-through applications, regardless of configuration
  – Allen-Bradley Programmable Logic Controller (PLC) and Human Machine Interface (HMI)
  – Designed to accept up to 32 input signals tagged to specific parameters via analogue (wired), WiSi (transmitters included), or EtherNet/IP options
  – 4-20 mA pump output signal
  – Alarm auto-dialer for critical alarms
  – Uninterruptible power source (UPS) with an estimated 25 minutes of battery back-up power
  – Firewall-protected remote internet access
Nitrack® Controller:

• Relies on influent nitrate, DO sensors, flow, effluent nitrate sensor, and MicroC™ pump
  – Placement of these are dependent on plant layout

• Solids can interfere with sensors and give false readings
  – Controller uses sensor data so they must be accurate to avoid over/under feeding carbon
Nitrack® Controller:

- **Feedforward** uses flow, DO and influent nitrate concentration to calculate loading
  - Controller calculates how much MicroC™ is needed to denitrify based on nitrate loading to reach desired set point
  - Real-time adjustments as loading changes to consistently reach set point
- **Feedback** uses effluent nitrate sensor to read if set point is met
  - Adjusts MicroC™ feed in real-time based on effluent nitrate
  - If set point is not meet, Controller will adjust feed rate
  - Residence time between influent and effluent sensor readings must be taken into account for the Controller to preform optimally
COD/N and Nitrate Removed Post-ANX:

Theoretical COD/N = 5.8    Operational COD/N=6.08 based on 68000 data points

Nitrate Removal (lbs/day)

- 144 per. Mov. Avg. (COD/N Ratio)
Nitrate in post anoxic zone:

INF NOX AVE= 15-25 mgN/L
EFF NOX Pre Controller= 6.6 mgN/L
EFF NOX Post Controller=2.3 mg/L
MicroC™ Usage and EFF NOx:

![Graph showing MicroC Usage and Effluent NOx concentration over time]

- MicroC Usage (GPD)
- Influent Nitrate (mg/L)
- Effluent Nitrate (mg/L)

Dates:
- 6/2/2014
- 8/31/2014
- 11/29/2014
- 2/27/2015
- 5/28/2015
- 8/26/2015
- 11/24/2015
**Nitrack® Controller:**

**Automation**

- Maintain compliance and performance constantly
- Data collection to review performance
- Reduce risk and redundancy
  - Sends alarms to Operators and EOSi staff of any problems
  - Eliminate repetitive tasks

**Optimization**

- Lowered effluent NO$_3$-N < 3 mg/L on average
- Reduced dosing rate
- Reduced chemical costs
COD/N and Nitrate Removed:

- Influent load averaged 318 lb/day post anoxic reactor

- Effluent load averaged 40.8 lb/day post anoxic reactor + 13 lb N/d NH3-N & SON versus limit of [62 lbN/d]

- Actual achieved effluent nitrate was averaged at ~2.3 mg/L
Strategies for Success:

• MicroC-IM
  – Chemical inventory management service offered with MicroC™ programs
  – Can connect from anywhere with internet access
  – Track and report on historical chemical usage
  – Hassel free deliveries
    • Monitored by EOSi and scheduled on an as-needed basis
    • Automatic refill based on inventory level
    • Regularly scheduled refill
Conclusion:

• Redistribution of flow
  – more unified flow for the week
  – better denitrification in first anoxic zone

• Nitrack® Controller and MicroC™ addition
  – allowed plant to optimize MicroC™ feed
  – plant consistently met nutrient limits

• The plant successfully met the N&P stringent limits in 2014 & 2015
Questions?