Lystek Technology for Biosolids Processing
Contents

• The Company, Experience & Technology
• The Multi-Purpose Process & Product
• Anaerobic Digester & BNR Enhancement
• Performance, Product Value & Investment
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The Company, Experience & Technology
Lystek - The Company

- Biosolids and organics processing through on and off-site solutions:
  - Producing Class A EQ product with enhanced fertilizer value
  - Improving WWTP processes utilizing Lystek’s hydrolyzed product
- Developed at University of Waterloo, Canada in year 2000
- Experienced management team in the organic waste management, wastewater industry, agriculture and marketing
- Ownership: Management & RW Tomlinson, Ottawa (>1000 employees, billion dollar (+) corp. = financial strength & backing)
Who Uses Lystek Now?

<table>
<thead>
<tr>
<th>Location</th>
<th>Guelph</th>
<th>St. Marys</th>
<th>Southgate</th>
<th>Iroquois</th>
<th>Elora</th>
<th>North Battleford</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (WT/Y)</td>
<td>18,000</td>
<td>3,500</td>
<td>150,000</td>
<td>20,000</td>
<td>3,500</td>
<td>3,500</td>
</tr>
<tr>
<td>Location</td>
<td>On site</td>
<td>On site</td>
<td>Off site</td>
<td>Off site</td>
<td>On site</td>
<td>On site</td>
</tr>
<tr>
<td>Ownership</td>
<td>Guelph</td>
<td>St Marys</td>
<td>Lystek</td>
<td>DES/Third Farms</td>
<td>Centre Wellington</td>
<td>North Battleford</td>
</tr>
<tr>
<td>Solution</td>
<td>Design Build License</td>
<td>Design Tech License</td>
<td>Design Build Own Operate</td>
<td>Design Build License</td>
<td>Design Build License</td>
<td>Design Build License Product Market</td>
</tr>
</tbody>
</table>

Serving Cities of Toronto, Ottawa, Peterborough, Oakville, Burlington, and Regions of Waterloo and Halton & more in Canada...

....and, coming soon to California, USA.
Lystek Technology – Overview

• Low Temperature Physical Chemical Hydrolysis Technology
  - A back-end solution, installed after dewatering

• Produces a multi-purpose, hydrolyzed product for:
  - Anaerobic Digester Enhancement
    • Improve biogas yields by >30%
    • Reduce biosolids volumes by >20%
  - BNR System Enhancement – a cost effective, alternative carbon source
  - Liquid fertilizer – Class A EQ (USA) / CFIA registered (Canada) – high organic matter & NPK – huge demand by farmers
Technical/Scientific Basis

- Cell disintegration & hydrolysis of complex organic molecules into simpler compounds

- Process makes the residual recalcitrant volatile solids in digested biosolids more amenable to further biodegradation when re-fed to anaerobic digester = “LysteMize”

- Hydrolyzed product provides readily available organics for AD and BNR system + nutrients for soil/plants

- Product contains >40% of the TCOD as SCOD

- Product contains 10-fold higher VFA as compared to standard, biosolids cake
Lystek Process - Simple PFD
LysteGro™ Product

- Homogeneous liquid/high solid (15-19%) product
- Viscosity <5,000 cP
- Fully pumpable using conventional liquid equipment
- Enhanced treatment = pathogen-free/Class A EQ
- Nutrient rich (NPK 4:3:2)
- Long-term storage stability
- No pathogen regrowth
- Huge demand from the agricultural sector
Regional OMRC – Southgate, ON

Lystek Reactor – 10 WT/h
Product Storage

Lined & Covered Storage Lagoon
Anaerobic Digester & BNR Enhancement
(PRACTICAL SCALE & RESEARCH)
LysteMize - Digester & BNR Optimization

Diagram showing the process flow of wastewater treatment with the LysteMize process highlighted in red.
Digester Enhancement

• City of Guelph, Ontario – Full-scale pilot study:
  - >40% extra biogas and >25% solids reduction by re-feeding the Lystek product into the test digester
  - Biodegradability of Lystek product was 65-70%

<table>
<thead>
<tr>
<th>Parameters (average of different feed rates over 6 months study)</th>
<th>Control Digester without Lystek biosolids</th>
<th>Test Digester with Lystek biosolids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent VSS primary sludge (kg/d)</td>
<td>2307</td>
<td>2278</td>
</tr>
<tr>
<td>Lystek VSS (kg/d)</td>
<td>0</td>
<td>921</td>
</tr>
<tr>
<td>Combined Influent VSS (kg/d)</td>
<td>2307</td>
<td>3199</td>
</tr>
<tr>
<td>Effluent VSS (kg/d)</td>
<td>1118</td>
<td>1222</td>
</tr>
<tr>
<td>VSS Destroyed (%)</td>
<td>51</td>
<td>62</td>
</tr>
<tr>
<td>Biogas production (m³/d)</td>
<td>1189</td>
<td>1977</td>
</tr>
</tbody>
</table>
BNR/Digester Enhancement

- St Marys, Ontario: Integrated BNR-AD-Lystek system significantly improved effluent quality and reduced biosolids generation by >25%
- Specific denitrification rates of Lystek comparable to acetic acid

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>INTEGRATED BNR-LYSTEK PROCESS</th>
<th>CONVENTIONAL ACTIVATED SLUDGE PROCESS WITH DIGESTION AND DEWATERING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge yield, gTSS/gCOD</td>
<td>0.37</td>
<td>0.66</td>
</tr>
<tr>
<td>VSS destruction in digester, %</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Dewatered sludge flow, m³/d</td>
<td>1.63 @ 15 wt%</td>
<td>2.96 @ 15 wt%</td>
</tr>
<tr>
<td>Lystek Sludge flow, m³/d</td>
<td>1.77 @ 14 wt%</td>
<td>N/A</td>
</tr>
<tr>
<td>Recycled Lystek to BNR, m³/d</td>
<td>0.65</td>
<td>N/A</td>
</tr>
<tr>
<td>Recycled Lystek to Digester, m³/d</td>
<td>0.46</td>
<td>N/A</td>
</tr>
<tr>
<td>Disposed Sludge, m³/d</td>
<td>0.66</td>
<td>2.96</td>
</tr>
</tbody>
</table>
Lab Testing - Potential C Source for BNR

- Manhattan College, New York: 2014
  - Independent study on potential of Lystek biosolids as a carbon source in BNR systems - using a variety of sludges
  - Lystek shows significantly higher specific denitrification rates (SDNR)
  - Additional, detailed studies underway

<table>
<thead>
<tr>
<th>Carbon Source</th>
<th>Early Rates - First 30 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stamford</td>
</tr>
<tr>
<td>Endogenous</td>
<td>-0.0208</td>
</tr>
<tr>
<td>Primary Effluent</td>
<td>-0.0284</td>
</tr>
<tr>
<td>Methanol</td>
<td>-0.0443</td>
</tr>
<tr>
<td>Glycerol</td>
<td>-0.0491</td>
</tr>
<tr>
<td>Lystek</td>
<td>-0.0491</td>
</tr>
</tbody>
</table>

Average SDNR Values (mg NOx-N/mg VSS)
# Greenhouse Gas Reduction Potential

<table>
<thead>
<tr>
<th>Biosolids management scenarios</th>
<th>GHG Estimate (Mg CO$_2$ eq. / 100 DT AD biosolids eq.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td>297 to 335</td>
</tr>
<tr>
<td>Incineration</td>
<td>- 23 to 224</td>
</tr>
<tr>
<td>Heat drying</td>
<td>51 to 71</td>
</tr>
<tr>
<td>Compost</td>
<td>6 to 34</td>
</tr>
<tr>
<td>Land application (Class B cake)</td>
<td>- 40</td>
</tr>
<tr>
<td>Lystek AD biosolids to land</td>
<td>- 49</td>
</tr>
<tr>
<td>Lystek, 30% recycle to AD, electricity production, rest to land</td>
<td>- 47</td>
</tr>
<tr>
<td>Lystek, 30% recycle to AD, heat production, rest to land</td>
<td>- 63</td>
</tr>
</tbody>
</table>

BEAM Model 1.1
Performance, Product Value & Investment
On-Site Example (Post Dewatering)

40,000 WT facility/1000 sq. ft.
Design, Build, Transfer investment: $3.0 M US
Regional Facility (Off-Site)

Southgate, Ontario - 150,000 WT/year
Design, Build, Own, Operate investment: $11 M US
Performance Indicators

- **Biosolids:** (Un)digested biosolids & source separated organics - 1% to 35% biosolids @ 15-19% solids level in the reactor
- **Power input** (pumps/mixer): 52-58 KWH per dry ton
- **High speed shear:** Tip speed >3000 ft./min
- **KOH/NaOH input** (45-50% sol): 175-195 lbs/dry ton to pH 9.5-10.0
- **Natural gas** (low pressure boiler) input: 13-15m³ per dry ton to 70-75°C / 158-167°F / 30 min / Class A regime
- **Labour:** <2 man hours per day; Fully automated SCADA – minimum operator attention
- **Small footprint:** 1000 sq. ft - 25,000 WT / 2500 sq. ft. - 100,000 WT
- **Side streams:** none
Performance Indicators

• **Re-feeding into BNR**
  
  - Up to 30% of the product can be re-fed into BNR as a C source
  - Replaces Methanol and Glycerol

• **Re-feeding into anaerobic digesters**
  
  - 30 - 50% of the product can be re-fed into digesters
  - 30 - 50% more biogas yield potential
  - 20 - 30% additional solids breakdown after re-feeding
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

February 27, 2014

Ward Janssens
Lystek International Inc.
1425 Bishop St. N, Unit 16
Cambridge, Ontario, N1R 6J0

Re: Demonstration of Vector Attraction Reduction using Option 2 for Lystek Thermo-Alkaline Treatment

Dear Mr. Janssens,

Thank you for your e-mail and attached paper from Dr. George Nahkla of February 3, 2014 with results of volatile solids reduction tests on anaerobically digested biosolids treated with the Lystek Thermo-Alkaline treatment process.

The results showed that for the sampling periods in question, VAR Option 2 was met, as the volatile solids were reduced by less than 17% during additional digestion. This option may be used in the future to demonstrate vector attraction reduction.

The frequency at which the test must be run is specified in 40 CFR 503.16, ranging from once per year for facilities producing less than 290 dry metric tons of biosolids per year, to once per month for facilities producing over 15,000 dry metric tons per year.

Demonstration of VAR using this method, in conjunction with demonstration of Class A pathogen reduction and pollutant concentrations meeting 40 CFR 503.13 Tables 1 and 3 limits, demonstrates “exceptional quality” biosolids that may be distributed without further restrictions.

Please contact me at 415 972-3514 or Fondahl.lauren@epa.gov with any questions regarding this.

Thank you,

Lauren Fondahl
Biosolids Coordinator, WTR-5
Summary
of
Beneficial Applications
One System = Multiple Benefits

Produce a Class A EQ Fertilizer Product

Optimize Digesters & BNR systems

Feedstock
- Dewatered biosolids
- Organic food "waste"

Processing
- Alkali is added
- Steam is injected
- High speed shearing occurs

Product
- Class A quality
- Liquid fertilizer
- Sold to market

Storage
- Product is stored in tanks or lagoons until application

Application
- Product is applied using standard equipment

LIQUID STREAM
- Aeration
- Clarification
- Filtration & Disinfection
- Lystek Reactor
- Clean water to waterways

SOLID STREAM
- Anaerobic Digestion
- Dewatering
- Lystek Reactor
- Class A fertilizer to land
Advanced Technology & Benefits

• **Lystek System**
  - Low capital cost - Small foot print - modular system – easy to expand
  - Minimum operator attention – Fully automated / SCADA
  - Simple to operate, easy to maintain – standard equipment, low pressure steam, no heat exchangers
  - No side centrate or waste stream for further treatment
  - Flexible, back-end solution (after dewatering) - no interferences
  - Can be paired with (other), existing, pre-treatment processes
  - Multi-use end product

• **Strong R&D program**
  - Academic and industrial collaborations for continuous process and product improvement
Advanced Technology & Benefits

• **Strict Odor Control**
  - Totally enclosed facility – feedstock material receiving and processing area, enclosed reactors, air handling and odor abatement train
  - Storage: enclosed storage tanks, covered lagoons
  - The product: stable, homogeneous, reduced odor, no pathogen regrowth, limited exposure to air
  - Transport: enclosed tanker vehicles
  - Land application: sub-surface injection
Driving the “Circular Economy”

Growth Challenges = Broken Cycle

- Increasing social, environmental & economic pressures
- Increase in organic waste
- Increasing disposal costs
- Increasing use of finite resources
- Decrease in productive farmland
- Increase in use of chemical fertilizers
- Increasing demand on food production

Resource Recovery = Responsible Re-Use

- Alleviate social, environmental & economic pressures
- Decrease organic “waste”
- Decrease management costs
- RECOVER ORGANICS & ENRICH SOILS
- RESPONSIBLE RE-USE
- AREA GROWERS
- DECREASE RELIANCE ON FINITE RESOURCES
- DECREASE USE OF CHEMICAL FERTILIZERS
- Meet demand for food production
- Increase use of organically based fertilizers & nutrients

Nothing wasted. Everything to gain.
A Unique Project & Alliance with FSSD, California
Overview of Project & Status

• Conversion of FSSD biosolids into LysteGro “biofertilizer” product
• Reduced volumes through digester enhancement (LysteMize)
• Project CEQA (Mitigated Negative Declaration) accepted and approved by the FSSD Board of Directors
• Construction scheduled to commence in Summer 2015 w/commissioning in Q-1, 2016
• Annual processing capacity of 150,000 at full build-out
• Multiple Letters of Interest from Bay Area agencies already secured with more to come
Benefits of Project

• Long-term price stability and assurance of regulatory conformance

• Production of a Class A-EQ biofertilizer product (LysteGro) that conforms with local ordinances for agricultural applications

• Producing a truly valuable product that can be sold to generate revenue – unlike traditional Class B biosolids

• A project that delivers a much needed product, jobs and responsible organics management to the local community = “Circle Economy”

• Synergistic with the recently introduced Healthy Soil Initiative (CA)

• Liquid nature of product is perfect for drought-ridden areas
Thank You & Discussion

Nothing wasted.
Everything to gain.

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