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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 / CFIA product with enhanced fertilizer value
  - Improving WWTP processes utilizing Lystek’s hydrolyzed product

• Developed at University of Waterloo, Canada in year 2000

• 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 Highland 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...and several other communities.
Lystek Technology – Overview

- Low Temperature Physical Chemical Hydrolysis Technology
  - Installed after dewatering

- Produces a multi-purpose, hydrolyzed product for:
  - Anaerobic Digester Enhancement (mesophilic digesters)
    - 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)
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
- 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
Regional site – Dundalk, ON

Lystek Reactor –10 WT/h
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
Product Storage

Lined & Covered Storage Lagoons
Anaerobic Digester
&
BNR Enhancement
Digester & BNR Optimization
**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>
Digester Performance Enhancement

• **Los Angeles County, California: 2012**
  - Independent lab study at Western University, Ontario
  - Lystek biosolids ~65% biodegradable; compared to raw sludge 30-50% more biogas potential with Lystek product
  - Further lab & pilot studies at LA County site planned for 2014-2015

• **New York City: 2014**
  - Independent lab study at Manhattan College, New York
  - Lystek biosolids >50% biodegradable; higher biogas production compared to TWAS
  - Additional studies being executed in 2014-2015
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 sources
  - Lystek shows significantly higher specific denitrification rates (SDNR)
  - Additional, detailed studies underway

<table>
<thead>
<tr>
<th>Carbon Source</th>
<th>Stamford</th>
<th>26th Ward</th>
<th>Battery E</th>
<th>Hunts Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endogenous</td>
<td>-0.0208</td>
<td>-0.0309</td>
<td>-0.0495</td>
<td>-0.0597</td>
</tr>
<tr>
<td>Primary Effluent</td>
<td>-0.0284</td>
<td>-0.0493</td>
<td>-0.0277</td>
<td>-0.1384</td>
</tr>
<tr>
<td>Methanol</td>
<td>-0.0443</td>
<td>-0.0462</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycerol</td>
<td>-0.0491</td>
<td>-0.1832</td>
<td>-0.0656</td>
<td>-0.0920</td>
</tr>
<tr>
<td>Lystek</td>
<td>-0.0491</td>
<td>-0.1832</td>
<td>-0.0656</td>
<td>-0.0920</td>
</tr>
</tbody>
</table>

Average SDNR Values (mg NOx-N/mg VSS)
Performance, Product Value & Investment
Cost and Benefits

**Investment:**
- 25,000 tons/year Design, Build, Transfer
- 150,000 tons/year Design, Build, Own, Operate

**Operating:**
- Energy input (Electricity, natural gas or CHP heat)
- Alkali use
- Control system
- Labour

**Added benefits**
- Improved biogas / reduced solids
- Fertilizer value
On-Site Facility (Post Dewatering)

25,000 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

• (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: 13-15m$^3$ 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
  - 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 VS breakdown after re-feeding
Value of the LysteGro™ Fertilizer

- Balanced nutrient source, fertilizer value >$80/1000 gal
- N-P$_2$O$_5$-K$_2$O = 30-27-31 lbs/1000 gal, in the year of application
- S 10 lbs/1000 gal, Ca 40 lbs/1000 gal and other micronutrients such as Cu, Zn, B, Mg etc.
- Application rates = 3000 – 4000 gal/acre
- Organic matter = ~5%
Ease of Land Application
Ease of Land Application
LysteGro vs. Chemical Fertilizer Trial

With LysteGro - ear leaf strong color

With Chemical Fertilizer - ear leaf firing
LysteGro vs. Chemical Fertilizer Trial

Tassel stage - strong leaf color - critical stage of development

Tassel stage - leaves yellowing due to lack of available N & K
Class A EQ Letter – U.S. EPA

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 6J9

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 Forsdahl.lauren@epa.gov with any questions regarding this.

Thank you,

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

Produce a Class A EQ Fertilizer Product

Optimize Digesters & BNR systems
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
Thank You

Nothing wasted.
Everything to gain.

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