Overview of Lystek Approach to Biosolids Management

Low Temperature Thermal-Alkaline Hydrolysis Process for Biosolids and Organics Management

Presentation to OWEA
December 7th, 2017
Lystek Overview

• Multi award-winning provider of beneficial management solutions for biosolids & organics

• Founded in 2000 at the University of Waterloo, Ontario with offices & successful operations in the USA & Canada

• Patented & protected Clean/Green technology that has been repeatedly recognized as environmentally responsible & sustainable

• Low temperature thermal-alkaline hydrolysis process (THP)

• Produces a completely hydrolyzed, multi-use, end product:
  • Biofertilizer product - Class A EQ (U.S. EPA) & CDFA (California) & CFIA (Canada) registered
  • Anaerobic Digestion enhancement - improves biogas yields, reduces solids
  • BNR – organic source of carbon source (vs. - methanol/glycerol)
General Overview - Fertilizer Production and Plant Optimization Approach

LysteCarb™

LysteGro™

LysteMize™
## Current Installations

<table>
<thead>
<tr>
<th>Location</th>
<th>Status</th>
<th>Capacity (WT/Y)</th>
<th>Location</th>
<th>LysteGro Class A EQ/CFIA</th>
<th>LysteMize Digester Enhancement</th>
<th>LysteCarb BNR Carbon Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guelph</td>
<td>2008</td>
<td>18,000</td>
<td>On Site</td>
<td>Yes</td>
<td>Full Scale Pilot</td>
<td>No</td>
</tr>
<tr>
<td>St. Mary’s</td>
<td>2010</td>
<td>3,500</td>
<td>On Site</td>
<td>Yes</td>
<td>Full Scale</td>
<td>Yes</td>
</tr>
<tr>
<td>*Southgate</td>
<td>2012</td>
<td>150,000</td>
<td>Off Site</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>*Iroquois</td>
<td>2012</td>
<td>40,000</td>
<td>Off Site</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Centre Wellington</td>
<td>2014</td>
<td>3,500</td>
<td>On Site</td>
<td>Yes</td>
<td>Aerobic</td>
<td>No</td>
</tr>
<tr>
<td>North Battleford</td>
<td>2014</td>
<td>3,500</td>
<td>On Site</td>
<td>Yes</td>
<td>Aerobic</td>
<td>No</td>
</tr>
<tr>
<td>*Fairfield, CA</td>
<td>2016</td>
<td>150,000</td>
<td>On Site</td>
<td>Yes</td>
<td>Full Scale</td>
<td>TBD</td>
</tr>
<tr>
<td>St. Thomas</td>
<td>2018</td>
<td>5,600</td>
<td>On Site</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Innisfil</td>
<td>2018</td>
<td>5,500</td>
<td>On Site</td>
<td>Yes</td>
<td>Aerobic</td>
<td>No</td>
</tr>
<tr>
<td>St. Cloud, MN</td>
<td>2018</td>
<td>15,000</td>
<td>On site</td>
<td>Yes</td>
<td>Anaerobic</td>
<td>TBD</td>
</tr>
</tbody>
</table>

- Regional facilities serving several cities is the USA & Canada:
  - California – Fairfield, San Francisco, EBMUD, Santa Rosa, Central Marin, Petaluma
  - Ontario - Toronto, Ottawa, Waterloo, Niagara, Peterborough; Owen Sound
United States Customers

Canadian Customers
Example Onsite Plant - Elora, ON

Lystek Reactor – 5 WT/h
Regional Processing Center (OMRC)

Township of Southgate, Ontario, Canada

Capacity = 150,000 tons/year
12.5 Acre Site
Regional Processing Center (OMRC)

Fairfield-Suisun, California, USA

- First US deployment
- Capacity = 150,000 tons/year
- Also features LysteMize option
How Does it Work?

• Processing time = generally 30-45 minutes
• Processes 1%-35% biosolids and/or non-hazardous organics w/combination of:
  • Heat - low pressure steam (15 psi), low temperature – 168°F
  • High speed shearing/mixing
  • Alkali for pH adjustment (between 9.5 - 12) depending on biosolids and EQ requirements
• Produces a nutrient rich, high solids (14-16% TS) liquid biofertilizer product (LysteGro™)
• Class A EQ recognized & CDFA/CFIA registered product
• Same system used for digester optimization (LysteMize™) or as a safer, cost effective, alternative carbon source in BNR systems (LysteCarb™)
• No additional waste (i.e. side streams/centrate) to further treat/manage
Lystek’s Low Temp Thermal Alkaline Hydrolysis Process

- Lystek process conditions: >70°C, pH >9.5 and high shear mixing using unique rotor blades cause:
  - Disintegration of biological cells
  - Hydrolysis and solubilization of complex organic compounds into simpler molecules
  - Production of a high solids liquid product with multiple benefits
- High level of soluble COD (>40% of total) in the product
- High level of volatile fatty acids (10,000 – 15,000 mg/L)
- Readily biodegradable residual volatile solids in the treated biosolids for further digestion in AD system after recycling
- Excellent C source to completely replace commercial methanol or glycerol in BNR system for N & P removal
- Excellent biofertilizer source
No proprietary or specialized equipment is used
The Lystek System

Process Reactor & High Speed Shearing Blade
Biofertilizer Product - LysteGro™

- Homogeneous liquid/ high solid (14-16%) product
- Viscosity <5,000 cP
- Fully pumpable using conventional equipment
- Enhanced treatment = pathogen-free/Class A EQ
- Nutrient rich (NPK 4:3:2)
- Long-term storage stability
- No pathogen regrowth issues
Excellent Product Dewatering Properties

Lystek Product:
- Dewatered Lystek cake: >33% TS, polymer dose ~15 kg/DT
- Centrate: Solids capture rate >99.5%

AD sludge:
- Only 19% TS cake generated under similar dewatering conditions
Meeting/Exceeding Class A EQ Criteria

• **Pathogen Reduction**
  - Alternative 1 – Temperature/time criteria; >168°F for >30 min
  - Fecal coliforms (<1000 MPN/g) & Salmonella (<3 MPN/4g)

• **Metals Levels**
  - Table 1 & Table 3 (40 CFR 503.13) for Class A (EQ)
  - As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn

• **Vector Attraction Reduction (VAR)**
  - Option 6, 503.33(b)(6) – addition of sufficient alkali to raise the pH to >12, maintaining for at least 2 hours and >11.5 for 22 more hours
  - Option 2, 503.33(b)(2) - additional 40 day digestion test showing <17% VS reduction, as applicable
# Pathogens Below Detection Limits

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>MDL</th>
<th>Class A Criteria</th>
<th>Untreated dewatered biosolids</th>
<th>Lystek treated biosolids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal coliforms (MPN/g dry wt)</td>
<td>1.8</td>
<td>&lt; 1,000</td>
<td>&gt; 1,600</td>
<td>&lt; 1.8</td>
</tr>
<tr>
<td><em>Escherichia coli</em> (MPN/g dry wt)</td>
<td>1.8</td>
<td>-</td>
<td>&gt; 1,600</td>
<td>&lt; 1.8</td>
</tr>
<tr>
<td><em>Salmonella</em> (P-A / 25 g)</td>
<td>1</td>
<td>&lt; 3 MPN/4g</td>
<td>POS</td>
<td>NEG</td>
</tr>
<tr>
<td><em>Polio virus</em> (pfu / 4g)*</td>
<td>1</td>
<td>&lt; 1</td>
<td>776</td>
<td>&lt; 1</td>
</tr>
<tr>
<td><em>Ascaris</em> eggs (per 4g)*</td>
<td>1</td>
<td>&lt; 1</td>
<td>131</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>
## Product Characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Solids (%)</strong></td>
<td>14 - 16</td>
</tr>
<tr>
<td><strong>Volatile Solids (% of TS)</strong></td>
<td>55 - 60</td>
</tr>
<tr>
<td><strong>Total Organic Carbon (%)</strong></td>
<td>26 - 28</td>
</tr>
<tr>
<td><strong>Organic matter (%)</strong></td>
<td>45 – 50</td>
</tr>
<tr>
<td><strong>TCOD (mg/L)</strong></td>
<td>105,000 – 150,000</td>
</tr>
<tr>
<td><strong>SCOD (mg/L)</strong></td>
<td>40,000 – 60,000</td>
</tr>
<tr>
<td><strong>RbCOD (mg/L)</strong></td>
<td>25,000 – 30,000</td>
</tr>
<tr>
<td><strong>VFAs (mg/L)</strong></td>
<td>10,000 – 15,000</td>
</tr>
<tr>
<td><strong>Viscosity (cP) of product</strong></td>
<td>4,000 – 6,000</td>
</tr>
</tbody>
</table>
## Metals Analysis

### LysteGro Biofertilizer

<table>
<thead>
<tr>
<th>Regulated Metals (MOE)</th>
<th>LysteGro Average&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Maximum Allowable Concentration&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Percentage of Maximum Allowable Concentration</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>3.64</td>
<td>170</td>
<td>2%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Cadmium</td>
<td>2.21</td>
<td>34</td>
<td>6%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Cobalt</td>
<td>3.50</td>
<td>340</td>
<td>1%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Chromium</td>
<td>74.34</td>
<td>2800</td>
<td>3%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Copper</td>
<td>642.52</td>
<td>1700</td>
<td>38%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.39</td>
<td>11</td>
<td>4%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>9.66</td>
<td>94</td>
<td>10%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Nickel</td>
<td>23.77</td>
<td>420</td>
<td>6%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Lead</td>
<td>33.38</td>
<td>1100</td>
<td>3%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Selenium</td>
<td>3.18</td>
<td>34</td>
<td>9%</td>
<td>mg/kg</td>
</tr>
<tr>
<td>Zinc</td>
<td>765.59</td>
<td>4200</td>
<td>18%</td>
<td>mg/kg</td>
</tr>
</tbody>
</table>
July 10, 2017:

"...we believe our regulations are protective of environmental resources and public health"
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

February 27, 2014

Ward Janssen
Lystek International Inc.
1425 Bishop St. N. Unit 1B
Cambridge, Ontario, N1R 6G6

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

Dear Mr. Janssen,

Thank you for your e-mail and attached paper from Dr. George Nobbe of February 9, 2014 with results of volatile solids reduction tests on anaerobically digested biosolids treated with the Lystek Thermo-Anaerobic treatment process.

The results showed that for the sampling periods in question, VAR Option 2 was met where the volatile solids were reduced by less than 1% 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 250 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 Table 1 and 3 limits demonstrates "exceptional quality" biosolids that may be distributed without further restrictions.

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

Thank you,

Lauren Fondahl
Biocides Coordinator, WTR-6
Global Acceptance – By the Numbers

Globally, land application is the dominant practice, compared to the other two dominant practices of landfilling and/or incineration.

<table>
<thead>
<tr>
<th>Table 1: Disposition of Nations to Practice of Application of Biosolids to Land as Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Allow</strong></td>
</tr>
<tr>
<td>Australia</td>
</tr>
<tr>
<td>Austria</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Brazil</td>
</tr>
<tr>
<td>Bulgaria</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>China</td>
</tr>
</tbody>
</table>

Reported percentages of total biosolids applied to land as fertilizer:

Norway (95%), Australia (81%), Italy (69%), Slovakia (69%), New Zealand (66%), USA (55%), China (50% & growing), Hungary (39% & growing), Canada (40% & growing), European Union Average (40% & growing)

Source: Dr. Owen Ward-2013
Benefits

- Improves Soil Health
  - Increases Soil Microbial Activity
  - Improves soil water holding capacity
  - Improves Aggregate Stability
  - Improves resilience to extreme wet or dry conditions
Best Management Practices

- Incoming feedstock monitoring/analysis
- Fertilizer analysis (both as it is produced & in storage)
Best Management Practices

- Agronomic rates, **NOT** maximum loading rates
- Soil sampling
- Sub-surface injection
- Set backs – based on state regulations & nutrient management best practices
- Watching the weather
Best Management Practices
Utilizing Agricultural Technology

- Focus on producing a quality product and providing a quality service to the customer
- GPS
- Flow meters
In 2017: +1,000 acres and 3.5 million gallons of LysteGro were land applied in Solano County; farmers paid a competitive rate
"The use of biosolids provides a valuable renewable source of nutrients and soil structure enhancement for the agricultural industry. Treatment of biosolids into a liquid fertilizer, with sub-surface application at computer system-controlled loading rates, allows for an additional level of management of nutrient loadings and for ensuring compliance with US EPA regulations. We support innovative technologies such as this which provide benefits to generators and enhance the quality of the product for end-users."

- Lauren Fondahl, Biosolids Coordinator, USEPA, Region 9, California
Summary

• Lystek system is simple to operate & inexpensive to maintain
• Small footprint – easy to retrofit to existing facility infrastructure
• Can be deployed as post- or pre-digestion solution
• Can also be deployed as an alternative to AD systems
• One system – multiple beneficial applications for resource recovery
• Class A EQ fertilizer product registered with CFIA, Canada and CDFA, California
• Performance of Anaerobic Digesters and BNR systems can be improved by increasing biogas yield, reducing biosolids generation and by replacing commercial carbon requirement in BNR
Multiple Awards & Recognitions

2005 Regional Innovation Award for Sustainable Development
Ontario Region
Awarded to
Lystek International Inc.

In recognition of your innovative contribution to the advancement of Sustainable Development

Terry Hui, Director General
Peter Caldemeyer, Executive Director

water's next awards 2017
WINNER!

EXEMPLARY BIOSOLIDS MANAGEMENT AWARD
Presented to
Lystek International Inc.
In the
TECHNOLOGY DEVELOPMENT CATEGORY
2013
Fertilizing the Prairies

A better way to land-apply biosolids

A promising future for treated biosolids on the farm

Application of municipal biosolids on farmland has traditionally presented some nuisance problems. But a new treatment process offers an array of nutrients for farm use without the risk
Thank You – Q & A!

Nothing wasted.  Everything to gain.

Jim Belcastro
Business Development Manager – Eastern USA

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