Nutrient Recovery after Anaerobic Digestion

Eric Powell

REGENIS
Reimagining Renewable Resources
is now

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Company History

• Located In Ferndale, Washington
  • Established in 1935
• Specialize In All Facets Of Construction And Project Management
  • Over 150 Skilled and Experienced Men and Women Spread Over Seven Construction Trades
• Proven To Be A Leader In Specialty General Contracting (SGC)
  • Teamed Up With DVO Inc. In 2001 To Market, Construct, General Contract, and operate their Two-Stage Mixed Plug Flow™ Digesters.
• Our First Digester
  • Vander Haak Dairy - Lynden, Washington – November 2004
• 13 Digesters in Washington, Oregon, Idaho, and California
• SGC Division Was Branded Separately as in November, 2014.

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Two-Stage Mixed Plug Flow™ Digesters

Traditional Complete Mix + Traditional Plug Flow

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Digester Benefits

Renewable Energy ↔

Odor Reduction

Greenhouse Gas Emission Reduction

Separated Solids ↔

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Digester Benefits Continued

Waste Heat

Liquid Fertilizer

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Having a digester allows you to add Nutrient Recovery Technology

- Waste heat available for NR
- Digestion increases the amount of CO2 in the manure
- Digestion stabilizes manure/substrates
- Nutrients in the digester are changed from organic to in-organic
  - Nitrogen to Ammonia Nitrogen
  - Ammonia is what we’re after
- pH increase allows us to volatize ammonia
Why nutrient recovery?

- **Samish Bay Watershed, WA**
  - High in Fecal Coliform
  - Nutrient Loading
  - Shutting down commercial shellfish fishery at times.
- **Chesapeake Bay Watershed**
  - Nutrient Loading
- **Yakima Valley, WA**
  - Nitrogen in groundwater/air
  - Has lead to lawsuits. Increased burden on dairies.
- **Birch Bay, WA**
  - High Fecal Coliform
  - Shutting down native shellfish fisheries.
- **All list ag as a contributor**
Why nutrient recovery? - Nitrogen

Areas at risk of nitrate contamination to shallow ground water


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Economic Factors

• Co-Digestion is important to digester economic feasibility.
  • Additional revenue stream from tip fees
  • Additional gas
  • More nutrients

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DVO/WSU/Regenis Nutrient Recovery

- Regenis can install any combination of this system to meet the project and/or Farmers individual needs.
Nutrient Recovery for Co-Digestion
Food waste is dumped into the pre-digester collection pit.
Food waste is mixed with manure and pumped to the digester.
Primary solids from separator after digester.
First generation nutrient recovery system
Phosphorus Recovery

- **Input Parameters**
  - 192,000 gal/day
  - 800 tons/day
  - Processing 18 hrs/day

- **Cap-Ex - Equipment**
  - $435,000

- **Op-Ex Annual Expense**
  - $94,200 Organic biodegradable polymer
  - $9,500 Electrical, assuming $0.08/kWh
  - $103,700 annual operating expense
  - $0.0015 per-gallon treated (less than two-tenths of 1 cent)

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# Phosphorus Recovery

![Image of phosphorus recovery process]

## DAIRY MANURE DIGESTER

<table>
<thead>
<tr>
<th></th>
<th>% TN</th>
<th>% NH₃</th>
<th>P&lt;sub&gt;ppm&lt;/sub&gt;</th>
<th>% K</th>
<th>% TS</th>
<th>% TSS</th>
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</thead>
<tbody>
<tr>
<td>Influent - Post-Slopesscreens</td>
<td>0.23</td>
<td>0.100</td>
<td>330</td>
<td>0.11</td>
<td>2.7</td>
<td>2.000</td>
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<tr>
<td>Separation effluent (liquid)</td>
<td>0.17</td>
<td>0.087</td>
<td>63</td>
<td>0.10</td>
<td>0.9</td>
<td>0.180</td>
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<tr>
<td><em><em>TOTAL REDUCTIONS</em> by %</em>*</td>
<td><strong>26</strong></td>
<td><strong>13</strong></td>
<td><strong>81</strong></td>
<td><strong>9</strong></td>
<td><strong>67</strong></td>
<td><strong>91</strong></td>
</tr>
<tr>
<td>Dewatered Solids</td>
<td>1.00</td>
<td></td>
<td>3,200</td>
<td>0.10</td>
<td>25.4</td>
<td></td>
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</table>
Nutrient Recovery for Poultry
Nutrient Recovery: DVO/WSU/Regenis System

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Litter is belt-collected and falls into a collection auger.
The partially air-dried litter is transported from the barns via conveyor, to a nearby manure storage/staging building.
Inside the building litter collects in a pile. Periodically a loader scoops it up and brings it to the digester’s waste reception pit.
The loader feeds the fresh litter to the digester, where it is mixed with processed digestate to provide the desired dilution for the AD system.
Digested biosolids:
- No flies
- No feathers
- A saleable fertilizer product
NR: Ammonia-laden gas leaves the NR processing tank and is piped to the capture section.
• Ammonium sulfate (nitrogen) is temporarily stored in poly tank (s) until sold from the farm.

• As an alternative to selling liquid ammonium sulfate (AS), the farmer is mixing the liquid with biosolids before sending them to a dryer and producing a blended product high in N and P.
Nitrogen is converted into a stable, commercial fertilizer, **8-0-0-9s**

- **Dried Biosolids**
- **Crystallized Ammonium Sulfate**

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## Nutrient Recovery – Poultry Statistics

<table>
<thead>
<tr>
<th></th>
<th>TS%</th>
<th>TSS%</th>
<th>TN</th>
<th>NH₃</th>
<th>P</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
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</thead>
<tbody>
<tr>
<td>Effluent of Digester</td>
<td>9.50</td>
<td>7.00</td>
<td>7,800</td>
<td>4,100</td>
<td>5,200</td>
<td>5,000</td>
<td>1,700</td>
<td>11,000</td>
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<tr>
<td>AR Liquid</td>
<td>6.30</td>
<td>3.30</td>
<td>5,300</td>
<td>2,400</td>
<td>3,100</td>
<td>5,300</td>
<td>1,000</td>
<td>6,200</td>
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<tr>
<td>PR Liquid</td>
<td>2.50</td>
<td>0.22</td>
<td>3,600</td>
<td>1,500</td>
<td>320</td>
<td>4,200</td>
<td>27</td>
<td>330</td>
</tr>
<tr>
<td><strong>TOTAL REDUCTIONS by %</strong></td>
<td><strong>74</strong></td>
<td><strong>97</strong></td>
<td><strong>54</strong></td>
<td><strong>63</strong></td>
<td><strong>94</strong></td>
<td><strong>16</strong></td>
<td><strong>98</strong></td>
<td><strong>97</strong></td>
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<tr>
<td>Wet Solids (pre-drying)</td>
<td>17.10</td>
<td>8,000</td>
<td>2,400</td>
<td>12,000</td>
<td>2,500</td>
<td>4,300</td>
<td>28,000</td>
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</table>
# Nutrient Recovery – Industrial Waste

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<thead>
<tr>
<th>TEST</th>
<th>INFLUENT</th>
<th>DIGESTATE</th>
<th>SCREWPR LIQUID</th>
<th>PR LIQUID</th>
<th>AR LIQUID</th>
<th>AVG % TOTAL REDUX</th>
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</thead>
<tbody>
<tr>
<td>TS</td>
<td>14.0</td>
<td>6.7</td>
<td>5.5</td>
<td>1.6</td>
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<td>88.6</td>
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<td>TSS</td>
<td>81,000</td>
<td>41,000</td>
<td>50,000</td>
<td>2,000</td>
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<td>97.5</td>
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<tr>
<td>TVS</td>
<td>100,000</td>
<td>41,000</td>
<td>31,000</td>
<td>8,900</td>
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<td>91.1</td>
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<tr>
<td>BOD5</td>
<td>74,000</td>
<td>4,800</td>
<td>5,800</td>
<td>3,200</td>
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<td>95.7</td>
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<tr>
<td>COD</td>
<td>340,000</td>
<td>98,000</td>
<td>71,000</td>
<td>15,000</td>
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<td>95.6</td>
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<tr>
<td>Coliform</td>
<td>350,000,000</td>
<td>400,000</td>
<td>130,000</td>
<td>18,000</td>
<td>Non-D</td>
<td>99.9</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>3,300</td>
<td>1,900</td>
<td>1,800</td>
<td>510</td>
<td></td>
<td>84.5</td>
</tr>
<tr>
<td>N</td>
<td>2,700</td>
<td>2,700</td>
<td>2,600</td>
<td>1,000</td>
<td></td>
<td>63.0</td>
</tr>
<tr>
<td>NH₃</td>
<td>1,500</td>
<td>1900</td>
<td>1900</td>
<td>400</td>
<td></td>
<td>73.4</td>
</tr>
</tbody>
</table>
Nutrient Recovery – Value Added Products

• Nitrogen Fertilizer – Ammonium Sulfate
  • 8:0:0:9 NPKS Concentration

• Phosphorus Fertilizer
  • Fine Solids from Secondary Separation
  • Fine Solids from DAF/Weir

• Sell Fertilizers to Third Party
  • Gets nutrients off the farm
  • Generates $

• Use Fertilizer on Farm
  • Lower/Eliminate use of commercial fertilizer
  • Get nutrients where they need to be
    • More efficient use of nutrients
    • Lower trucking costs

• Nutrient Trading
  • Generate income by trading nutrients
  • Like Carbon Credits

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Nutrient Recovery – Other Benefits

• More Animals?

• More Substrates?

• Less Land?

• Stay in Business?
  • Increased regulations.
Nutrient Recovery – What’s Next?

• More efficient and effective ammonia removal
Questions?

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