METHANE DIGESTION FROM A PRODUCER’S POINT OF VIEW

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Green Valley Dairy
Green Valley, Wisconsin

GREEN VALLEY DAIRY PROFILE

- 2500 cows on site
- 2000 – 2150 milking
- Built in 2000 & expanded in 2001 as a mattress facility using sawdust
- Used sand from 2003 thru 2005
- Introduced Bio-Solids in January 2006
Decision

- Install a Sand Separator / $350,000
- Install a Methane Digester/ $2-2 ½ million
  - Plug Flow
  - Complete Mix
    - Mesophilic (100 Degrees Fahrenheit)
    - Thermophilic (120 Degrees Fahrenheit)

Why Now?

- Long Term Solution to Manure
- Odor Control (Problem w/Sand Separators)
- Grant Available
- Favorable Green Power Buy Back Rates
- Satisfied Found Right Technology

Benefits of Sand

Forgiving of Management
Cow Comfort=Higher Production
Better Traction=Lower Cull Rate (less injuries)
Better Breeding
Udder Health=Lower Cull Rate (lower SCC)
Disadvantages of Sand

- Disposal (Winter Spreading)
  - Use extra water (More Disposal Cost)
  - Winter Storage
  - Spreading

Cost Benefit Analysis

<table>
<thead>
<tr>
<th>Operating Cost</th>
<th>Digester</th>
<th>Sand Sep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand for Bedding</td>
<td>$0</td>
<td>$78,000</td>
</tr>
<tr>
<td>Sand Disposal</td>
<td></td>
<td>$70,000</td>
</tr>
<tr>
<td>Digester Manure Reduction 5%</td>
<td>$0</td>
<td>$15,000</td>
</tr>
<tr>
<td>Extra $2O for Sand Separation</td>
<td>$0</td>
<td>$50,000</td>
</tr>
<tr>
<td>Or Sand Disposal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase Bedding Frequency</td>
<td>$50,000</td>
<td>$0</td>
</tr>
<tr>
<td>Manure Irrigation vs. Hauling</td>
<td>$0</td>
<td>$50,400</td>
</tr>
<tr>
<td>Total Operating Expenses</td>
<td>$50,000</td>
<td>$263,400</td>
</tr>
<tr>
<td>Net Operating Cost Savings</td>
<td>$213,400</td>
<td></td>
</tr>
</tbody>
</table>

Undeveloped Opportunities

- Bio-Solids Sales $31,200 - $62,400
- Carbon Credits
- Excess heat energy
Management Risks & Unknowns

- **Udder Health**  
  100,000 SCC = $186,500
- Hospital waste milk (lost revenue)
- Increased operating costs (drugs & labor)
- **Cull Rate**  
  1% = $45,000
- **Cow Comfort**  
  Deep Beds vs. Bio-Solids on mattresses  
  Milk Production 1lb = $100,000
- Crop production increase, resulting from better manure application practices

The Transition

- **Interim Bedding Source**  
  - Sawdust – clinical mastitis increase  
  - Straw – flies, and cow bunching  
  - Soybean Stubble  
  - Bio-solids not available
- **Milk Production Loss 5 lbs.**
- **SCC 50,000-75,000**
- **Culls**  
  - Injuries, 30-50 head  
  - Clinical Mastitis, 30-50 head

Transition Lessons

- Critical to start-up during mid summer
- **Floor Surfaces**  
  - Grooved before sand removed.
- Sawdust!!
- Straw = Flies and Bunching
- Do not mix beddings
- Dry Bio-Solids to 33-34% DM minimum
- **Dry wipes in parlor is critical**
Questions Answered

- Digester Retention Time – target 25-30 days
- Manure Production – 34 to 36 gal/cow/day
  - GVD retention time 20 days
  - Results in a manure pre-heating step during extreme cold
  - Size generator to production
- Complete Mix Mesophilic Digester 3 cows/kw
- 80% of digestion occurs within first 48 hours
- Copper Sulfate footbaths – lowers gas production about 15%?
- Cow comfort with Bio-Solids comparable to Sand

Manure Nutrient Profile

<table>
<thead>
<tr>
<th></th>
<th>To Digester</th>
<th>After Separation 1st Pit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>lbs/1000g</td>
<td>lbs/1000g</td>
</tr>
<tr>
<td></td>
<td>DM 8.3%</td>
<td>DM 2.8%</td>
</tr>
<tr>
<td>Total N</td>
<td>22.4</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Total P</td>
<td>7.7</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>4.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Total K</td>
<td>16.7</td>
<td>15.3</td>
</tr>
<tr>
<td></td>
<td>13.4</td>
<td>12.27</td>
</tr>
<tr>
<td>2nd Pit to Pivot</td>
<td>lbs/1000g</td>
<td>lbs/1000g</td>
</tr>
<tr>
<td></td>
<td>DM 1.4%</td>
<td>DM 37.5%</td>
</tr>
<tr>
<td>Total N</td>
<td>12.5</td>
<td>14.4</td>
</tr>
<tr>
<td></td>
<td>3.7</td>
<td>5.8</td>
</tr>
<tr>
<td>Total P</td>
<td>1.6</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>.96</td>
<td>5.5</td>
</tr>
<tr>
<td>Total K</td>
<td>15.3</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>13.8</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Solids lbs/ Ton

<table>
<thead>
<tr>
<th></th>
<th>Total N</th>
<th>1 year N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14.4</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>15.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Are Digesters the Solution to Manure Management?

- Manure is nearly odorless!
- Able to irrigate larger vol. of diluted soluble nutrients when crops require it.
  - Lagoon nutrient stratification
  - Pathogen kill is 98-100%
  - Reduced road traffic
- More N and K appear to be splitting off into the liquid.  P2O5 is split evenly.  Soluble portion moving toward the liquid manure and the particulate portion staying with the solid.
**Project:**
Complete Mix Mesophilic Methane Digester w/600 KW Cat Powered Genset & Manure Separation System

**Capital Costs**
- 2 -1 million gal Digester Tanks $1,000,000
- 1-600 KW Cat Powered Genset $ 550,000
- 2- Fan Separator, Bldg & conveyor $ 220,000
- Switch gear, controls, site work, pumper, wiring plumbing, etc $ 430,000
- Total $2,200,000

**Maintenance**
- Routine $/yr
  - Oil change, plugs, chiller repairs, regular engine inspection $60,000
- Escrow for Rebuild
  - 60,000 hr $21,500
  - ($150,000 ~ 7yrs)
- Annual Maintainance $81,500

**Revenue**
- Electric Generation
  - 600kw
  - 540kw (95% load time)
- Total Annual KWH 4,500,000
- Total Electric Revenue $/KWH $270,000 $360,000 $450,000
- Bedding $ 75,000 $ 75,000 $ 75,000
- Gross Revenue $345,000 $435,000 $525,000

**Revenue**
Return on Equity

<table>
<thead>
<tr>
<th>Revenue/KWH</th>
<th>6¢</th>
<th>8¢</th>
<th>10¢</th>
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</thead>
<tbody>
<tr>
<td>Gross Revenue</td>
<td>$345,000</td>
<td>$435,000</td>
<td>$528,000</td>
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<tr>
<td>Maintenance</td>
<td>($81,500)</td>
<td>($81,000)</td>
<td>($81,000)</td>
</tr>
<tr>
<td>Depreciation</td>
<td>($110,000)</td>
<td>($110,000)</td>
<td>($110,000)</td>
</tr>
<tr>
<td>Interest</td>
<td>$1,650,000 @ 7.5%</td>
<td>($123,750)</td>
<td>($123,750)</td>
</tr>
<tr>
<td>Net Revenue</td>
<td>$29,750</td>
<td>$119,750</td>
<td>$209,750</td>
</tr>
<tr>
<td>Equity</td>
<td>$550,000</td>
<td>$550,000</td>
<td>$550,000</td>
</tr>
<tr>
<td>ROE</td>
<td>5.4%</td>
<td>21.8%</td>
<td>38.1%</td>
</tr>
</tbody>
</table>

What We Think …

- Select the right system to fit your climate
  - Dry moderate climate
  - Thermophilic & add a substrate?
    * Less parasitic load
    * 10% Substrate by volume can double gas production with same digester
- Copper Sulfate/ Lime has a negative effect on gas production (15% - 20%).

- Drop the H2O out of the Gas
- Control Hydrogen Sulfide
  * Green Valley Engine has 15000 hrs.
  (We mic the values every 3mo and are seeing no value recession)
  * We change the oil every 800 hours because of acid not metal contamination. (Further reducing our H2S could extend oil changes perhaps to every 1200 hrs or more.)
Buy a 42% efficient engine vs. 34%

19% more electric production?

What we think we know...

- 3 milking cows/kw (Mesophilic Complete Mix)
- Must keep tank temperatures constant within 2 degrees of 100 degrees Fahrenheit.
- Feed tanks consistent diet (80% of digestion occurs in the first 48 hrs.)
- Northern climate manure heat requirements
  - 25% to maintain temperature
  - 75% to bring manure to temperature
IT WORKS

Acceptance of technology and systems have come a long way.

Lender Acceptance

• 2 years ago lenders were weary of performance and the financial risks associated with financing the systems. Now the business risk of not properly managing manure is greater than the financial risk placed on large livestock operations.
• Manure management systems on large operations will become the norm and not the exception. You will need it as a part of your business plan long term.

THANK YOU!
John Jacobs

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