Profitability of Digesters

Lessons learned and Questions to ask

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Road Map

• Brief overview of the dairies
• Basic understanding of digester design and layout
• Discuss revenue streams and benefits from our digesters
• Illustrate good and bad choices we have made with the digesters
• Relate our experiences inside a digester
- 8,000 head Holstein cows
- 80 employees
- >75 vendors, >35 farmers
- 11,500 acres of cropland (not owned)
- 3,200 Calves
Manure System

Digester 1&2
16’x32’x290’ ea

Separated Solids
Separation System
Plug Flow, Modified Plug Flow, and Total Mix

• Variables
  – Time manure is in digester
  – Temperature of digester
  – Amount of stirring

• Implication
  – Nutrient levels
  – Type & number of bacteria
Total Mixed Digester
- Variable digestion time
  - Implies different bacterial population and nutrient levels
- Good heating
- Minimal stratification or settling
• Simple Plug Flow Design
  – Consistent digestion time
  – Stratification
  – Settling
  – Digestion time reduced with settling

Top View

End View
- Modified Plug Flow Design
  - Consistent digestion time
  - Consistent heating
  - Minimal Stratification
Revenue Streams from Digester
Revenue Streams from Digester

Electrical
Revenue Streams from Digester

- Electrical
- Bedding
Revenue Streams from Digester

- Electrical
- Bedding
- Tipping Fees
Revenue Streams from Digester

- Electrical
- Bedding
- Heating
- Tipping Fees
Revenue Streams from Digester

- Electrical
- Bedding
- Heating
- Carbon Credits
- Tipping Fees
## The $ Value of Digester per Year

<table>
<thead>
<tr>
<th>Income</th>
<th>Expenses</th>
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<tbody>
<tr>
<td>Electrical</td>
<td>Maintenance $210,000</td>
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<tr>
<td>Bedding</td>
<td>Manure Application $400,000</td>
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<tr>
<td>Fertilizer</td>
<td>Reduced Manure App. $(30,000)</td>
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<tr>
<td>Heating</td>
<td>Depreciation $102,000</td>
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<tr>
<td>Carbon C</td>
<td>Total $682,000</td>
</tr>
<tr>
<td>Tipping</td>
<td></td>
</tr>
<tr>
<td>Tax Credit</td>
<td></td>
</tr>
<tr>
<td>Total $1,216,000</td>
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</table>

- Electrical: $365,000
- Bedding: $275,000
- Fertilizer: $440,000
- Heating: $30,000
- Carbon C: $?
- Tipping: $86,000
- Tax Credit: $40,000
- Maintenance: $210,000
- Manure Application: $400,000
- Reduced Manure Application: $(30,000)
- Depreciation: $102,000
- Total: $682,000

**Total Income:** $1,216,000
Biogas Engines
Electrical Production

- 2 - 600 kW Glauscor Biogas Engines
- Engines run at fixed RPM of 1200
- All electricity generated is sold to grid
- Maintenance contract with Martin Machinery
- Contract pays based on kW’s produced and runtime.
- Preventative maintenance is critical
- Run times of 90+ % are achievable
Pros of Digested Solids as a Bedding Source

• Readily available.
• Reasonable cow comfort and traction
• Manure system friendly
• Not adding additional material to manure stream
• Potential revenue stream for the dairy
• Milk quality can be excellent!
Cons of Digested Solids as a Bedding Source

- Stigma of using Manure as bedding
- Material is moist when going into stalls
- Solids will blow around in strong winds
- Stall bedding levels are less forgiving
- Need storage and must manage inventories
Impact of Digested Solids on SCC

Irish Dairy (highest 600)

Elm Dairy

Digested Separated Bedding started
Tipping-Substrate

- All substrates need approval by DNR
- Foreign material huge concern
- Logistically how to add material to digester
- Impact of adding substrates to bedding solids from digester?
Tipping - Substrates

- Food process wash down water
- Food/Grocery store waste
- Rumen Paunch
- Paper Sludge
Heating Benefits

Use excess heat from gensets to heat:

- Digester
- Separator Room
- Parlor building
- Holding area
- Treatment and Veterinary area
- Shop and machinery room
- Calf nursery
Heat Controls/In floor Heat
Manure Management Benefits

- **Digester**-Reduces soluble phosphorus levels by 50%
- Liquid can be applied to growing crops
- >60 % typically applied to hay ground
  - High in Potash for growing hay
  - Applied right after hay is harvested (gives water to the plants at critical stress time)
  - Increases hay yield approx. 1.5 T/acre DM/year
  - Increase longevity of hay stand
- Apply higher solids manure to corn/wheat ground to match nutrient needs
# Manure Analysis (2010)

First year available (per 1000 gal.)

<table>
<thead>
<tr>
<th></th>
<th>% DM</th>
<th>Lb N</th>
<th>Lb P₂O₅</th>
<th>Lb K₂O</th>
<th>Lb S</th>
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<td>4.0</td>
<td>8.96</td>
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<tr>
<td>Third Pond</td>
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<td>9.58</td>
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<td>Ave. Manure</td>
<td>11</td>
<td>7</td>
<td>7</td>
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Arial View of our center pivot irrigation
Arial View of our center pivot irrigation
Major Mistakes

• Choose genset from experienced and dependable vendor.
• Place electrical switchgear and controls in clean air room.
• Cement block building and larger engine room.
• Purchase methane/fuel oil boiler
• Drainage in Separator Room.
• Don’t bed with soy straw/rice hulls.
• Install quality separators, no dryer.
• Place radiators away from solid separation.
• Don’t inject oxygen into digester.
Good Choices

• Digester with stirring capacity
• Full time maintenance person
• Overflow back to digester or storage
• Footbath fluid bypasses digester
• Martin Machinery for second genset
• Belt conveyor for separated solids
• Installation of backup systems
• Circulation of hot digester fluid back to drop structures
• Option to access inside of digester with equipment
Challenges

- Maximizing genset run times
- Planning enough capacity for future inputs
- Controlling Hydrogen Sulfide in gas emissions (shortens engine and oil life)
- Parameters to measure digestion quality and resulting bedding quality
  - Oxygen demand/availability
  - Bacteria counts
  - Sugars/starches (digestible nutrients?)
Learning a Digester from the Inside Out!

• The signs of an impending problem
  – Water level in the heat tank for the digester kept dropping
  – Struggling to maintain digester temps even in favorable weather
  – Decreased gas production for electrical generation
Tool of choice for emptying a digester
What did We Find?

- Sand buildup on floor and at entrance to digester
- Solids buildup varied from 4’ to 10’ deep
- An amazing amount of empty cotton seed hulls
- Rocks, metal gate hooks, plastic, rubber gloves
- Leaking and deteriorated steel water pipes
- Heating racks plugged with fiber solids
Heating pipe rack in acid chamber
Lessons From Our Experience

• Digesters are not a simple cement box, but rather an interesting and complex feat of engineering.
• Build a settling pit for the manure ahead of the digester.
• Be aware of what material is going into your digester.
• Plan for needing to maintain the inside of your digester.
• A drop pit at the exit to facilitate emptying digester.
• Protective gear inside the digester is important (especially Swim Goggles!).
• Digesters can be and are very profitable.
Thank You