A Sustainable Alternative for Whiskey Stillage Management to Produce Animal Feed and Biogas: Case Study at Makers Mark Bourbon Distillery

Presented at:
Anaerobic Treatment of High Strength Wastes Workshop
Marquette University
September 17, 2009
Presentation Agenda

• About Maker’s Mark Distillery
• What were the drivers for this project?
• Potential solutions considered and vetted
• What was selected – a total alternate solution for stillage management and PWW treatment
• Benefits
• Some Performance Data
• Questions
About the Maker’s Mark Distillery

- Samuels family Scotch / Irish heritage making whisky since 1771
- Old distillery purchased by TW Samuels family in 1953, changes the family recipe and renames the distillery Maker’s Mark.
- First case sold in 1958
- Distillery recognized by the Guinness Book of World Records as the world’s oldest operating bourbon distillery
- Named a National Historic Landmark in 1980
- One of the world’s best selling premium bourbons
- The site consists of 620 acres, most of which is treated like a nature preserve
- Longstanding tradition of environmental stewardship
What were the drivers for this project?

• Current practice of giving away “thick slop” or whole stillage to local farmers was risky, burdensome and bottlenecked facility production

• Planned capacity expansion (50%) could not be supported by current practice

• Energy prices (natural gas) climbing and long-term outlook for energy costs not positive

• Desire to implement a more sustainable solution (compared to a conventional dry house) that would not increase distillery carbon footprint
Houston, we have a problem.
Potential Solutions Considered

• Traditional dry house approach → DDGs production
• Truck to another facility with excess dry house capacity
• Whole stillage digestion
• High-rate anaerobic digestion after novel solids separation to produce DWG equivalent product and low TSS, high COD liquid stream
# Whole Stillage (Thick Slop) Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Thick Slop</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current flow</td>
<td>631,400</td>
<td>gallons per week</td>
</tr>
<tr>
<td>Future flow</td>
<td>970,200</td>
<td>gallons per week</td>
</tr>
<tr>
<td>Total COD</td>
<td>86,000</td>
<td>mg/L</td>
</tr>
<tr>
<td>Soluble COD</td>
<td>28,000</td>
<td>mg/L</td>
</tr>
<tr>
<td>TSS</td>
<td>38,750</td>
<td>mg/L</td>
</tr>
<tr>
<td>Phosphorus – P</td>
<td>472</td>
<td>mg/L</td>
</tr>
<tr>
<td>Nitrogen – TKN</td>
<td>3,450</td>
<td>mg/L</td>
</tr>
<tr>
<td>Temperature</td>
<td>&gt;200</td>
<td>°F</td>
</tr>
<tr>
<td>pH</td>
<td>3.0 – 4.0</td>
<td>s.u.</td>
</tr>
</tbody>
</table>
Selection Process & Considerations

• Solicited technical and cost proposals for whole stillage digestion and high-rate anaerobic treatment
• On-site pilot test of whole stillage digestion for 1 year
• Conducted treatability studies of novel solids separation followed by high-rate anaerobic treatment
• Developed dry house cap-ex and op-ex for comparison
Whole Stillage Digestion

- Difficult process to control – unstable
- Solids destruction efficiency was low
- Residual solids have no little to no value after digestion, whereas DWG has significant value as an animal feed
- More biogas generated compared to Treatment of the soluble fraction of the stillage but $ value vs. additional costs not good
- CONCLUSION: Determined that whole stillage digestion was not feasible
What Was Selected

• Integrated Solution delivered as design-build
  – Heat from whole stillage used to preheat water for mashing
  – Thick slop solids recovery using FKC screw press (with lamella clarifier to capture “extruded” solids in the pressate and return back to the SP head box)
  – Produce Distiller’s Wet Grains (DWG) for animal feed and pressate to high-rate anaerobic treatment
  – Anaerobic treatment of pressate followed by anoxic/aerobic polishing by modifying existing SBRs
  – All other process wastewaters introduced after anaerobic step for treatment
  – Biogas integrated into existing boiler to supplement natural gas purchase
Maker’s Mark Site Layout
Benefits of the Integrated Treatment System

• De-bottleneck production and allow distillery expansion
• Remove risk of relying on farmers for disposal of co-product
• Significant Capital and operational cost savings over conventional dry house approach
• Produce renewable fuel-offset purchase of natural gas by 15 to 20%
• Ability to incorporate existing assets (WWTP) into design
• Heat recovery from whole stillage for mash H$_2$O preheating
• Reduce carbon footprint of distillery by renewable fuel substitution and avoidance of additional fossil fuel required for traditional dry house approach
Screw Press For Solids Separation
Benefits of Screw Press Solids Separation

• Stillage Solids retained as animal feed, where they have value (~98% TSS capture achieved)
• Higher total solids content of screw press cake solids (~40% vs. 32% typical using decanting centrifuge)
  – Reduced trucking costs
  – Reduced drying costs if grains to be used in biomass boiler in the future
• Screw press filtrate suitable for high-rate anaerobic treatment for conversion of soluble organics to energy in the form of biogas
• Lower energy needed – ~25% the hp of a centrifuge
• Lower maintenance requirements
Stillage After Preconditioning
Screw Press Solids (Distillers Wet Grain)
Pressate from the Screw Press
Screw Presses at Makers Mark
Load out of DWG

- Distillers Wet Grains (>40% DS)
- DWG equivalent as animal feed; virtually the same composition as normal DWG:
  - Protein
  - Crude fat
  - Crude fiber
  - Amino acid profile
  - Metabolizable energy
- Polymer(s) used are GRAS [Generally Regarded As Safe] for use in animal feed
Clarifier, MFT & DAF
High Rate Anaerobic Treatment
MFT Anaerobic Reactor
Biogas Integration Skid
Anoxic - Aerobic Polishing for Direct Discharge
AIS - Anoxic/Aerobic Final Treatment
The AIS System: Aerobic Polishing & Nitrification/Denitrification
## Final Effluent Discharge Requirements

### Discharge Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Discharge Criteria</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>31.7 max</td>
<td>°C</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>7.0 min</td>
<td>mg/L</td>
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<tr>
<td>pH</td>
<td>6.0 - 9.0</td>
<td>s.u.</td>
</tr>
<tr>
<td>TSS</td>
<td>30/60</td>
<td>mg/L</td>
</tr>
<tr>
<td>Nitrogen, Ammonia</td>
<td>4/8</td>
<td>mg/L</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>5</td>
<td>mg/L</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>10/15</td>
<td>mg/L</td>
</tr>
<tr>
<td>BOD-5</td>
<td>15/30</td>
<td>mg/L</td>
</tr>
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Discharge from Ecovation System
## Summary of Compliance Testing Results - June/July 09

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Pressate</th>
<th>Anaerobic Effluent</th>
<th>Final Effluent</th>
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<tbody>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>21,230</td>
<td>3,050</td>
<td>159</td>
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<tr>
<td>sCOD</td>
<td>mg/L</td>
<td>18,990</td>
<td>2,220</td>
<td>72</td>
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<tr>
<td>TSS</td>
<td>mg/L</td>
<td>1,430</td>
<td>800</td>
<td>19</td>
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<tr>
<td>VSS</td>
<td>mg/L</td>
<td>1,230</td>
<td>580</td>
<td>11</td>
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<tr>
<td>NH$_4$-N</td>
<td>mg/L</td>
<td>NA</td>
<td>258</td>
<td>1.1</td>
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<tr>
<td>OP</td>
<td>mg/L</td>
<td>NA</td>
<td>NA</td>
<td>0.7</td>
</tr>
<tr>
<td>TP</td>
<td>mg/L</td>
<td>NA</td>
<td>NA</td>
<td>1.3</td>
</tr>
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</table>
Compliance Testing - June/July 09

• **Average Daily System Inputs**
  – Thick Slop Production – 43,600 gpd
  – Process WW Produced – 29,670 gpd

• **Average Daily System Outputs**
  – 45,500 scfm biogas (65 – 70% CH₄)
  – YYYY ton of DWG
  – 70,460 gpm Treated Effluent Discharged
  – 780 gpd of Excess Biological Solids
Special Thanks

Makers Mark
- Denny Potter
- Kevin Smith
- Dale Burroughs

Environ-Advent
- Carl Adams
- Gaines Barry
- Scott Reese

Ecovation
- Tim Nock
- Bob Franklin
- Mark Motylewski
Always Ready to Help with the Proper Project PPE
New Aeration / Tank Inspection System
Questions ?

Thank you for listening