Evaluation and Pilot Testing of a Direct Turbo Dryer at a 5.0 MGD Facility

Brandon Gott
Agenda

• Background
• EPA regulations
• Project drivers
• Pilot goals & objectives
• Pilot
  – Unit
  – Tests
  – Sampling
• Dryer modifications
  – Results
  – Product
  – Odors
Background

- Westminster WWTP located in Carroll County, Maryland
- Operated by City of Westminster
- ENR Upgrade to include a new Biosolids Processing Facility
- ENR Class A study evaluation completed in 2010: Thermal Dryer selected
US EPA, 40 CFR Part 503 Rule

- Per US EPA Part 503, in Class A biosolids, it must not only meet, but exceed, all Class A pathogen and vector reduction requirements as specified in.
- Various processes can be utilized to achieve this Class A designation, such as anaerobic digestion, lime stabilization, composting, or thermal drying.
- Thermal Drying Process – accepted as a process to significantly reduce pathogens to produce Class A. Must meet the following:
  1. 90% dried solids “Dried Solids %Target”
  2. Temperature of biosolids material or wet bulb temp of gas in contact with material be 176 F (80 C)
Project drivers

• ENR design project
• Existing municipal dryers
  – Dryer operational & maintenance concerns
  – Safety hazards (dust & smoldering)
  – Construction startup
  – Odors
• WYSE direct turbo dryer pilot
  – Reported less odors and dust
  – Operates at lower temperatures
  – Not proven in municipal market
Direct dryer pilot goals and objectives

1. Characterize physical and chemical properties of the dried biosolids
2. Evaluate dried biosolids for end uses (92%) and compliance with Federal/State regulations (90%)
3. Evaluate dryer operation using plant’s dewatered biosolids
4. Familiarize plant staff with the direct dryer
5. Characterize odor emissions to evaluate odor control requirements
# Direct dryer pilot unit

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>LHT-17 (17 trays)</td>
</tr>
<tr>
<td>Height</td>
<td>13'-09” (w/feeder)</td>
</tr>
<tr>
<td>Diameter</td>
<td>7 ft</td>
</tr>
<tr>
<td>Footprint (LxW)</td>
<td>20 ft x 15 ft</td>
</tr>
<tr>
<td>Evaporation rate</td>
<td>~80 lbs/hr</td>
</tr>
<tr>
<td>Inlet screw feed rate</td>
<td>100 lbs/hr</td>
</tr>
<tr>
<td>Air flow</td>
<td>1,000 ACFM</td>
</tr>
<tr>
<td>Air burner</td>
<td>400,000 BTU/hr</td>
</tr>
<tr>
<td>Fuel source</td>
<td>Propane</td>
</tr>
</tbody>
</table>

![Direct dryer pilot unit diagram](image-url)
Direct dryer pilot
Direct dryer pilot schematic

- MULTI-SHAFTLESS SCREW CONVEYOR
- DRYER FEED
- LUMP BREAKER
- TURBO DRYER
- MANIFOLD
- AIRLOCK
- DRIED PRODUCT
- GAS FIRED HEATER
- COMBUSTION FAN
- EXHAUST FAN
- RECIRCULATION FAN
- OUTSIDE AIR

KEY:
- PROCESS AIR
- MOTORIZED VALVE
- FAN
- CONVEYOR
- DAMPER
- THERMOCOUPLLE
Direct dryer on-site pilot testing

Pilot testing period
• May thru July 2014
• Manufacturer onsite for setup and start-up
• Pilot operated by City personnel
• City collected samples and performed testing

Sampling/testing approach
• City sample collection and testing
• Pilot test/sampling protocol
• Testing schedule
## Dryer sampling/testing protocol

Loading Time = 1.5 x retention time = 4 hrs

<table>
<thead>
<tr>
<th>Time</th>
<th>Load Dryer</th>
<th>Record/Sample Input</th>
<th>Collect/Sample Biosolids</th>
<th>Dispose of Dried Product</th>
</tr>
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<tbody>
<tr>
<td>8:00 AM</td>
<td>Blue</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00 AM</td>
<td>Blue</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>Blue</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>11:00 AM</td>
<td>Blue</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>12:00 PM</td>
<td>Blue</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1:00 PM</td>
<td>Blue</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2:00 PM</td>
<td>Blue</td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3:00 PM</td>
<td>Blue</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>4:00 PM</td>
<td>Blue</td>
<td>9</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Recommended Loading Time prior to Beginning Testing (1.5 times the retention time or 240 minutes)

<table>
<thead>
<tr>
<th>Loading Time</th>
<th>240 minutes</th>
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</thead>
<tbody>
<tr>
<td>4 hrs</td>
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</table>

<table>
<thead>
<tr>
<th>Est. Retention Time, min to achieve 90% Solids</th>
</tr>
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<tbody>
<tr>
<td>14% DS</td>
</tr>
<tr>
<td>15% DS</td>
</tr>
<tr>
<td>16% DS</td>
</tr>
<tr>
<td>17% DS</td>
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</table>

Estimated Retention Time = 120 minutes

Time Load Dryer Record/Sample Input Collect/Sample Biosolids Dispose of Dried Product
Direct dryer pilot initial testing (May-June 2014)

Dryer set points

- Top damper - 20% open
- Middle damper - 90% open
- Bottom damper – controlled by bottom temp
- Feed - 90 to 100 lbs/hr @ 15.3 % DS (avg)
- Dryer temperature - 245 F to 325 F
- Retention time – 80 to 140 min
Direct dryer pilot testing (May-June 2014)

**Initial results**

- Dried product was granular and lumps
- Dried product solids: 50% to 99.4%
- Significant heat loss between burner and dryer
- Evaporative capacity: 81 lbs/hr (avg)
- Exhaust air temp: 86°F to 127°F
- Thermal efficiency: 2,200 BTUs/lb
Direct dryer pilot modifications

- Rotocage Lumpbreaker installed
- Increased % of recirculated air – reduce fresh air
- Reduced top damper opening
- Two new trays:
  - Expanded metal frame for semi-dry material
  - Radial Wires – across material movement for semi-wet material
- Modified “plow” wiper (1/8” clearance)
- Installed spill baffles
- Higher turndown ratio on feeder drive/gear
- Adjusted retention time
- Insulated manifold & pipe
Direct dryer pilot testing (June 2014 – July 2014)

**Dryer set points**
- Top damper closed
- Middle damper at 50% open
- Dryer Set Points: 285 °F to 300 °F
- Feed: 65 to 117 lbs/hr @ 14.97% DS (avg)
- Retention Time: 120 to 160 min
Direct dryer pilot testing (June 2014 – July 2014)

Results

- Granular coarse material
- Smaller (walnut) size lumps: 55% to 85% DS
- Pea size material: 92% to 99% DS
- Evaporative Capacity: 88 lbs/hr (avg)
- Exhaust air temp: 102 F to 184 °F
- Thermal efficiency: 1,700 BTU/lb
- Dried product temperature: 200 °F
Direct dryer pilot results

- Test Runs
- Wet Feed Cake Solids
- Temperature Setpoint
- Retention Time
- Dried Product % Solids

Initial Testing
Dryer Modifications
Final Testing

92%
**Dried product size**

- EPA Target % DS: 90% DS
- End User Product Targets
- Particle Size: ~6 mm
- BTU Heating Value: >5,500 BTU
- % Dried Solids: 88 – 90% DS
- Two-deck round vibratory separator
- Dried Product – 108 lbs
- Top Deck – 7/16” mesh (11.2 mm)
- Bottom Deck – ¼” mesh (6.35 mm)

**Results**

- Top deck screen captured 9%
- Bottom deck screen captured 45%
- 45% went straight thru
- 91% of all material > 92% DS
<table>
<thead>
<tr>
<th>Compound</th>
<th>Odor Threshold, ppb</th>
<th>Avg. Concentration, ppb</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Indirect</td>
<td>Direct</td>
<td></td>
</tr>
<tr>
<td><strong>A. Sulfur Compounds</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>0.4</td>
<td>1,162</td>
<td>&lt;5</td>
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<tr>
<td>Methyl mercaptan</td>
<td>0.01</td>
<td>1,210</td>
<td>&lt;7</td>
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<tr>
<td>Dimethyl sulfide</td>
<td>1</td>
<td>338</td>
<td>&lt;1.3</td>
<td></td>
</tr>
<tr>
<td>Dimethyl disulfide</td>
<td>2.2</td>
<td>1,089</td>
<td>&lt;1.8</td>
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<tr>
<td>Dimethyl trisulfide</td>
<td>0.01</td>
<td>301</td>
<td>&lt;0.1</td>
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<tr>
<td><strong>B. Nitrogen Compounds</strong></td>
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<tr>
<td>Trimethylamine</td>
<td>1</td>
<td>133</td>
<td>3.0</td>
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</tr>
<tr>
<td>Ammonia</td>
<td>5 ppm</td>
<td>2 ppm</td>
<td>4 ppm</td>
<td></td>
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<tr>
<td><strong>C. Aldehydes</strong></td>
<td></td>
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<tr>
<td>Propanal</td>
<td>1</td>
<td>168</td>
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<tr>
<td>2-methyl propanal</td>
<td>?</td>
<td>1,856</td>
<td>&lt;0.1</td>
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</tr>
<tr>
<td>3-methyl butanal</td>
<td>100</td>
<td>357</td>
<td>&lt;0.1</td>
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<tr>
<td>Hexanal</td>
<td>1</td>
<td>84</td>
<td>&lt;0.3</td>
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<tr>
<td>Decanal</td>
<td>0.4</td>
<td>65</td>
<td>&lt;0.1</td>
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<tr>
<td>“Total aldehydes”</td>
<td>-</td>
<td>2,530</td>
<td>&lt;8</td>
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<tr>
<td><strong>D. Fatty Acids</strong></td>
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<tr>
<td>N-butyric acid</td>
<td>0.2</td>
<td>5.6</td>
<td>&lt;0.1</td>
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<tr>
<td>Propyl 2-methyl butanoate</td>
<td>?</td>
<td>34</td>
<td>&lt;0.1</td>
<td></td>
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</tbody>
</table>
Direct dryer summary results

Operation compliant with Federal/State Regulations

Dried Product
- Dried Material Product (200 F)
  - 90% > 90% DS achieved at 275+F
- Reduced odor concentrations
- BTU Heating Value: 7,420 BTU/lb
- Sludge Smoldering Test: >450F
- Recycle needed for 9% of dried material

Thermal Efficiency
- Final Pilot Thermal Efficiency: 1,700 BTU/lb
- Industrial Industry: 1,500 BTU/lb
- Typical Municipal Thermal Efficiency Range: (1,200 to 1,600 BTU/lb)

Bacteria
- Fecal, Bacteria, Coliform: <0.18 MPN/gram dry weight
Acknowledgements

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