Nutrient Treatment Technologies for Manure Using Solid Separation Methods

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Application

• Data - 699 animals, flushed dairy farm in Florida.

• No sand used for bedding.

• Raw waste solids captured with inclined screen and removed from the farm.

• Effluent after screening was applied to hay crop for irrigation purposes.

• Farmer wanted to double his dairy size but land limited. Nitrogen was limiting nutrient.
Objective

• Recover the solids
  o Settleable solids (large - fine particles)
  o Suspended solids

• Treat effluent

• Understand nutrient change with size/amount
Solid Separation Process for Wet Waste

Results:
95% Solids Captured
90-95% P Removed
50% N Removed

Outputs:
Solids to be removed off farm
Clear water to be reused on farm

Step 1: Pit storage of untreated dairy waste
Step 2: Screw Press
Step 3: Fiber Filter
Clear Water

STEP 1 - Coarse fiber removal
STEP 2 - Large particle removal
STEP 3 - Chemical separation using Ferric Sulfate to remove fine particles
## Controlling Variability of the Waste Stream

### Total Solids Data

<table>
<thead>
<tr>
<th>Test</th>
<th>Pit Slurry (mg/Liter)</th>
<th>Screw Press (Step 1) (mg/Liter)</th>
<th>Fiber filter (Step 2) (mg/Liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10,300</td>
<td>9,200</td>
<td>n/a</td>
</tr>
<tr>
<td>2</td>
<td>n/a</td>
<td>n/a</td>
<td>4,000</td>
</tr>
<tr>
<td>3</td>
<td>n/a</td>
<td>n/a</td>
<td>4,100</td>
</tr>
<tr>
<td>4</td>
<td>7,900</td>
<td>6,000</td>
<td>3,600</td>
</tr>
<tr>
<td>5</td>
<td>6,700</td>
<td>6,700</td>
<td>4,400</td>
</tr>
<tr>
<td>6</td>
<td>11,900</td>
<td>7,100</td>
<td>5,000</td>
</tr>
<tr>
<td>7</td>
<td>4,600</td>
<td>7,100</td>
<td>5,100</td>
</tr>
<tr>
<td>8</td>
<td>7,600</td>
<td>5,500</td>
<td>4,400</td>
</tr>
<tr>
<td>9</td>
<td>n/a</td>
<td>n/a</td>
<td>4,600</td>
</tr>
<tr>
<td>10</td>
<td>12,000</td>
<td>8,200</td>
<td>5,200</td>
</tr>
<tr>
<td>11</td>
<td>n/a</td>
<td>n/a</td>
<td>5,300</td>
</tr>
<tr>
<td>12</td>
<td>6,900</td>
<td>6,100</td>
<td>3,900</td>
</tr>
<tr>
<td>Mean</td>
<td>8,488</td>
<td>6,987</td>
<td>4,509</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2,652</td>
<td>1,222</td>
<td>579</td>
</tr>
<tr>
<td>Variability in Percent</td>
<td>31</td>
<td>17</td>
<td>13</td>
</tr>
</tbody>
</table>

n/a: Data Not Collected or Rejected
Strategy

Because of high variability of the raw dairy waste, fully characterize the waste stream:

- Use a multi-step separation approach
- Employ commercially available mechanical separators when possible
- Minimize cost of chemical additions where possible
- Evaluate solids and nutrient removal at each step
Particle Size - Characterization

- Pit Slurry
- Screw Press Effluent
- Fiber Filter Effluent

Volume, Percent

Particle Size, Micron

0.01 0.1 1 10 100 1000 10000
### Multi-Step System's Performance

<table>
<thead>
<tr>
<th>Step</th>
<th>Total Solids Concentration, mg/l</th>
<th>Total Phosphorus Concentration, mg/l</th>
<th>Total Nitrogen Concentration, mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw (Pit Slurry)</td>
<td>8,500</td>
<td>125</td>
<td>428</td>
</tr>
<tr>
<td>Step 1 (Screw Press)</td>
<td>7,000</td>
<td>122</td>
<td>413</td>
</tr>
<tr>
<td>Step 2 (Fiber Filter)</td>
<td>4,500</td>
<td>119</td>
<td>388</td>
</tr>
<tr>
<td>Step 3 (Chemical Separator)</td>
<td>2,500</td>
<td>11.7</td>
<td>195</td>
</tr>
</tbody>
</table>
In Conclusion:

• Multi step process reduces particle size of solids and variability of raw waste stream

• Treating anaerobic digestate will be easier - more stable, homogenous and should exhibit less variability

• For AD, expect combination of mechanical separation followed by a chemical separation will generate similar results and be cost effective
  
  ▪ Total settleable/suspended solids by as high as 99%
  ▪ Total Phosphorus by as high as 95%
  ▪ Total Nitrogen by as high as 54%
Thank you,
Any questions?