Collection Logistics and Waste Pre-Processing

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Collection Logistic

Safe containment of the waste is a key

• To reduce the smell

• To reduce the environmental risk

• To protect the workers

• Improve the customer and neighbors experience
Background

Need for development in waste pre-processing

• Most waste-to-value treatment systems require pre-processing

• Removal of contaminants

• Particle size reduction

• Other thermal, chemical or biological treatment
Waterless toilet waste is contaminated!

Whether by design or by accident...

- Many waterless systems use additives or consumables to enable toilet function, safe capture and transport

- Polymer films feature in many container based toilets

- Other contaminants will get into the toilet

- Simple and robust pre-processing technologies can enable safe and efficient handling and processing
Industrial Bag Shredder-Separator (IBS)
Plug-in at utility Anaerobic Digester, United Kingdom

Whole-waste input: 2% film (UK festivals)
98% human waste

Two Outputs

1. Separated film portion
   - Composting
   - Recycling
   - ~ 4% of total output

2. Human waste portion
   - Pumped direct to AD
   - Or other primary process
   - ~ 96% of total output
IBS
Processed 20T UK events waste in Summer 2016

• Innovative and streamlined two-stage process can fit in a 10-foot container

• Unique combination of technologies to achieve result with minimal complexity and cost

• Shreds and screens organics, providing particle size control

• Separates films from organics, enabling multiple materials and treatment / pretreatment processes
## UK Trial Results
### Machine performance

<table>
<thead>
<tr>
<th>Feature</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>Up to 1 tonne/hr&lt;br&gt;Trials processed &gt; 20 tonnes</td>
</tr>
<tr>
<td>Power requirement</td>
<td>Max 3.2kW electrical</td>
</tr>
<tr>
<td>Processing energy</td>
<td>Max 3.2kWh per wet tonne</td>
</tr>
<tr>
<td>Separation effectiveness</td>
<td><strong>Output 1: Separated film portion (~4%)</strong>&lt;br&gt;Composed of:&lt;br&gt;55% film&lt;br&gt;45% human waste</td>
</tr>
<tr>
<td></td>
<td><strong>Output 2: Human waste portion (~96%)</strong>&lt;br&gt;Only trace amounts of film identified visually in human waste output, @ &lt; 5mm particle size</td>
</tr>
<tr>
<td>Particle size control</td>
<td>Organics fraction screened to &lt;5mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.5 tonne machine</td>
</tr>
<tr>
<td>Size</td>
<td>Can fit inside 10ft shipping container</td>
</tr>
</tbody>
</table>
Composting the Film Portion
Research project at Cranfield University, UK

• Masters’ project by Mr Lepekola Lepekola
• Lab testing (BS EN ISO 14855:2004)
• Windrow / in-vessel tumbler pilot study
• Grass clippings added to create autothermal mix
Composting the Film Portion

Compost mix

<table>
<thead>
<tr>
<th>Material</th>
<th>Parts by mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film Portion</td>
<td>21</td>
</tr>
<tr>
<td>Grass clippings</td>
<td>22</td>
</tr>
<tr>
<td>Sawdust</td>
<td>1</td>
</tr>
</tbody>
</table>

C:N Ratios

<table>
<thead>
<tr>
<th>Material</th>
<th>% N</th>
<th>C:N Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film portion</td>
<td>0.36</td>
<td>139</td>
</tr>
<tr>
<td>Grass clippings</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Sawdust</td>
<td>0.40</td>
<td>500</td>
</tr>
</tbody>
</table>
Composting the Film Portion

Research project at Cranfield University, UK
After 7-days
After 28-days

Lab test
10% degradation over 28 days

Tumbler System
(lesser affect on film)

Windrow System
(substantial breakdown)
Future Impact of Technology

**Separation** → Composting Option → Cheaper Materials + Thinner Materials film options

**Separation** → Chemical / Heat pre-treatment option → Cheaper AD-compatible option

**Separation** → Recycling Option (PE) → Much cheaper materials + Much thinner materials + Circular economy + Local availability
Future Impact of Technology

Projected 5m Film Refill Prices
(AD-compatible refill used as index)