The Flexcrevator: Development and Field Testing of Mechanized Pit Emptying with Trash Exclusion

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1.77 billion people use pit latrines for basic sanitation¹

Safe and efficient FS collection is a key part of the solution

- Until waste is seen to be moving, this issue remains invisible
- A PE technology enables the pit emptying industry to gain legitimacy
- A PE technology is a stimulant for the FSM industry at large
Why is it so difficult?
TRASH EXCLUSION:
Leave the trash behind!

• More efficient emptying – no more FISHING
• Closed system from pit to transfer tank
• Enables efficient downstream processing

• New business opportunities
• Service is contracted for fecal sludge removal
• Incentive for behavioral change
Imagine this ....
Development of New Design Concepts

Deflection mechanism

Clearing mechanism
2017 Prototype – System Layout
2017 Prototype – Field Testing Challenges (Lusaka, Zambia)

• Frequent clogs due to plastic bags and hair strands

• Flexible shaft did not withstand field conditions

• Ergonomic issues
Testing New Design Concepts

- Worked in the lab, but had issues in the field
- Had issues in the lab, not tested in the field
Deflection and Clearing Methods
Perforated Pipe + Auger

- Deflection Mechanism
- Clearing Mechanism
Simulating Pit Latrines in the Laboratory
Pipe length does not significantly affect flow rate

- Reached the pumpability limit above 50 Pa-s (10.5% bentonite)

Fecal sludge viscosity: 10 – 1000 Pa-s
At 1/s shear rate

Viscosity levels at 1/s shear rate

Water
0.05 Pa-s
= 5 Pa-s
50 Pa-s
200 Pa-s

Flow Rate (L/sec)

Perforated Pipe Exposed Length (cm)
Hole size can be used as a tool for trash exclusion

- Flow rate is mainly a function of material viscosity and pipe friction
Deflecting and Clearing mechanism prototypes were tested in the field (Kisumu, Kenya)
The clearing method successfully emptied wet pit latrines

<table>
<thead>
<tr>
<th>Pit No.</th>
<th>Sludge Type</th>
<th>% Solids in Sludge</th>
<th>Trash Excluder</th>
<th>Amount of Water Used for Fluidization (L)</th>
<th>Maximum Flow Rate (L/sec)</th>
<th>Average Flow Rate (L/sec)</th>
<th>Amount of Sludge Emptied (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wet</td>
<td>&lt;1%</td>
<td>Clearing</td>
<td>none</td>
<td>3</td>
<td>2</td>
<td>2.88</td>
</tr>
<tr>
<td>2</td>
<td>Wet</td>
<td>N/A</td>
<td>Clearing</td>
<td>none</td>
<td>4.3</td>
<td>2.3</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>Dry</td>
<td>14.8%</td>
<td>Clearing, Deflecting and Improved Clearing</td>
<td>90</td>
<td>1.5</td>
<td>N/A</td>
<td>0.95</td>
</tr>
<tr>
<td>4</td>
<td>Wet</td>
<td>&lt;1%</td>
<td>Improved Clearing</td>
<td>none</td>
<td>4.3</td>
<td>4.1</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Improved Clearing w/ Vac Truck</td>
<td>none</td>
<td>N/A</td>
<td>5.6</td>
<td>4.7</td>
</tr>
<tr>
<td>5</td>
<td>Dry</td>
<td>10.5%</td>
<td>Improved Clearing</td>
<td>260</td>
<td>0.5</td>
<td>0.2</td>
<td>0.3</td>
</tr>
</tbody>
</table>
# Less than 5 minutes active pumping time

<table>
<thead>
<tr>
<th>System Configuration</th>
<th>Set-up Time (min)</th>
<th>Active Pumping Time for 0.81 m³ (min)</th>
<th>Barrel Management Time (min)</th>
<th>Cleaning Time (min)</th>
<th>Total Process Estimated Time (min)</th>
<th>Maximum Volume per trip to the treatment plant (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trash Excluder and Vacuum System</td>
<td>11</td>
<td>3.4</td>
<td>27</td>
<td>16</td>
<td>57.4</td>
<td>0.81</td>
</tr>
<tr>
<td>Trash Excluder and Vacuum Truck</td>
<td>7</td>
<td>2.4</td>
<td>none</td>
<td>8</td>
<td>17.4</td>
<td>8</td>
</tr>
</tbody>
</table>
The Flexcrevator can be adapted to three different scenarios:

1. Custom Vacuum System
2. Vacuum Truck System
3. Trash Pump System

The Excluder can operate with 3 different vacuum based pit latrine emptying systems.
Summary: Trash Exclusion mechanism worked in the field; new design ready

- Trash exclusion will bring multiple benefits
- The clearing mechanism proved to be efficient in simulated and real pit latrines
- Opportunity to use the excluder head in conjunction with vacuum trucks (and basic pumps)
- Swappable excluder head to adapt to specific characteristics of various pit latrines
- Trash exclusion will bring multiple benefits
Next steps

• Field testing in Rwanda and Madagascar

• Partners to take to market

“Business case and market study for improved pit emptying”
Nicola Greene, Wednesday, 11:30 AM, Meeting Rm. 2.4.1.