Hygienic Pit Emptying with Low Cost Auger Pump

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What happens when pits fill up?

Low Accessibility and Affordability
What is the problem?

Manual waste extraction

[Links]
http://newsneteast.com/will-patna-drown-in-its-own-sh1t/
Gates Foundation Request for Proposals

- More pits/day
- Hygiene
- Easy transport in narrow lanes
- 2 person-operation
- Heavy sludge/debris at bottom
- Affordable, robust, and locally available components.
- Low emptying costs per latrine

http://www.memoireonline.com/02/07/348/m_sanitation-in-urban-peri-urban-areas-cap-haitien-social-marketing-approach5.html
Typical Power Earth Auger
The Extraction Auger Design
Screw Conveyor Theory

\[ Q = \Gamma \omega D^3 \eta_v \]

where,

\[ \Gamma = \frac{1}{8} \left[ \left( 1 + \frac{2C}{D} \right)^2 - \left( \frac{D_i}{D} \right)^2 \right] \left[ \frac{p}{D} - \frac{t_s}{D} \right] \]

- \( D \) screw diameter (m)
- \( D_i \) core or shaft diameter (m)
- \( p \) screw pitch (m)
- \( \omega \) angular velocity of screw (rev/s)
- \( C \) radial clearance (m)
- \( t_s \) thickness of screw blade (m)

Lab Testing
Design Variables

- Electric Motor for rotational speed control
- Vertical Orientation
- Variables:
  - Submergence
  - Choke length
  - RPM
  - Auger Length
- Data collection:
  - Auger RPM
  - Flow Rate
  - Pressure throughout lift
Lab Testing

Simulant Waste: Bentonite Clay

Comparison of Human Stool and Simulated Waste (Bentonite Clay)

Viscosity vs. shear rate for human stool (Woolley et al., 2012) and simulated waste (varying concentrations of bentonite clay)

Viscosity (cP) vs. Shear Rate (1/s)
Flow rates produced for varying auger rotational speeds at 22.5% submergence with three concentrations of simulated waste.
Head produced at outlet for varying auger rotational speeds at 22.5% submergence with three concentrations of simulated waste.
Flow rates and corresponding vortex efficiencies produced for varying auger rotational speeds at 32.5% submergence with three concentrations of simulated waste.
Lab Testing

Results

- Flow Rate and Outlet Pressure increase with viscosity and rotational speed.

- Flow rates of over 50 Liter/ min (13 gpm) at typical gas engine speed (300 rpm).

- Submergence has small effect on flow rate.

- Pressure produced at outlet is minimal, so waste cannot be pumped uphill.

- The Extraction Auger can empty a 1 m$^3$ pit in less than 30 minutes.
Extraction Auger Scenario

Extraction Auger Schematic
Current Pit Screw Auger Technology

Improving the Extraction Auger

- Auger and Pipe extensions available
- 1.2 m (4ft) lengths
Extraction Auger Modifications

- Metal Support Piece
- Heavy
- ~ 25 – 40 kg
- Free standing once in pit
- Plastic Auger and Pipe
Improving the Extraction Auger

- Difficult to Clean
- HDPE Auger
- Reversible drive
- Compaction near top
- Wye fitting
- Reverse flighting
The Extraction Auger’s Current Status

- Ready for Wet Latrines with small amounts of Rubbish in Early 2013.
- Dry Pits?
- High trash content pits?
Next steps

• Alterations to Current Design

• Partnerships

We are looking for Partnerships with organizations to facilitate:

❖ Field testing in selected regions (Early 2013)
  - Data collection
❖ Eventual implementation of Extraction Auger in these regions
❖ Setup of local business or integration into current system
Extraction Auger Survey

3 ways to take the survey:

https://www.surveymonkey.com/s/ExtractionAuger

Send email to rcborden@ncsu.edu

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